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2025 ACM Reference Manual Comments

Additional submitted attachment is included below.

Comments on the 2025 Title 24 ACM Reference Manuals

Docket Number 24-BSTD-03

December 12, 2024

Introduction

The California Statewide Utility Codes and Standards Enhancement (CASE) Team appreciates the opportunity to review the 2025 Alternative Calculation Method (ACM) Reference Manuals. We commend the California Energy Commission (CEC) for encouraging public participation in the proceeding and value the opportunity to offer suggestions to refine the draft ACM language to best align with the updated code language.

The Statewide CASE Team provided recommendations in support of the CEC's efforts to update the 2025 Energy Code with new or updated requirements for various technologies. The three California Investor-Owned Utilities (IOUs) — Pacific Gas and Electric Company San Diego Gas and Electric, and Southern California Edison — and two Publicly Owned Utilities — Los Angeles Department of Water and Power and Sacramento Municipal Utility District — sponsored this effort. For the 2025 Title 24, Part 6 Energy Code update, the program efforts will result in cost-effective enhancements that improve energy efficiency, energy performance, and GHG emissions reductions in California buildings.

The goal of the Statewide CASE Team in reviewing the ACM Reference Manuals is to assist the CEC in aligning necessary updates in the calculation methodology with the updates that have been approved by the CEC for adoption as the 2025 Energy Code.

Comments on the draft ACM Reference Manuals

The Statewide CASE Team has reviewed the draft ACM Reference Manuals and applaud the CEC's work in bringing the ACM language into alignment with the many code changes that have been incorporated into the 2025 Title 24, Part 6. Please see the attached table *Recommendations on ACM Reference Manuals* and Appendix A, which includes a total of 52 suggested revisions related to the Multifamily provisions, 27 suggested revisions related to the Nonresidential provisions, and 14 suggested revisions related to the Single Family provisions, along with justifications for each change.

For the marked-up language, our proposed revisions to the 2022 reference manuals are delineated with additions in <u>red underlining</u> and deletions in red ~~strikeouts~~.

Each suggested edit identifies the member of the Statewide CASE Team offering the recommendation. We welcome collaborative discussions between CEC staff and the individuals who recommended each revision so we can offer further descriptions, help address concerns, and resolve outstanding issues. Small improvements that make language clearer and less complex, including addressing the issues identified in the tables below, will allow the 2025 Energy Code to achieve high compliance, be enforceable and will lead to sustained energy savings and GHG reductions.

Conclusion

Thank you for considering these comments and for the constructive dialogue that went into developing and updating the 2025 Building Energy Efficiency Standards. Our team is available to assist CEC staff in resolving concerns or outstanding issues.

Recommendations on ACM Reference Manuals

Remark #	Building Type(s)	CASE Report	CASE Measure	Section(s) of ACM	Person Making Recommendation	CEC Staff Lead	Language Markup (deletions marked with red ~~strikethroughs~~; additions marked with red underlining)	Comment OR Justification
1	MF	MF HVAC	Indoor Air Quality	Building Air Leakage and Infiltration	Marian Goebes	Anushka Raut	~~The proposed design for dwelling units in multifamily buildings shall be 2.3 ACH50. The proposed design for defaults to 7 for multifamily building dwelling units and common use areas in all multifamily buildings shall be 7 ACH50.~~ The proposed design for zones in multifamily buildings that are primarily dwelling units shall be 2.3 ACH50. The proposed design for zones in multifamily buildings that are primarily common use and nonresidential areas shall be modelled with 7 ACH50. ~~Surfaces of dwelling unit zones in multifamily buildings shall be modeled with the mandatory required maximum leakage of 0.30 cfm/ft2 of surface area.~~	Multifamily IAQ CASE team - Current model doesn't allow user to input cfm50/sf, only ACH50. Unless this has changed in new software, need to input ACH50
2	MF	MF HVAC	Indoor Air Quality	Building Air Leakage and Infiltration	Marian Goebes	Anushka Raut	~~There is no credit available for reduced leakage or infiltration.~~	Multifamily IAQ CASE team comment: This conflicts with the performance path. While the ACM doesn't specify how the compliance credit can be earned for reduced leakage, the performance path language states credit can be earned for reduced leakage. We recommend the CEC remove the performance path language in the 2028 cycle (it was too late to do so in the 2024 cycle), but stay mute on how to earn the performance credit in this cycle
3	MF	Residential HVAC	Supplementary Heating	Building Mechanical Systems - Heating Subsystems	Kristin Heinemeier	Bach Tsan	Furnace capacity is determined by the compliance software as 200 percent of the heating load at the heating design temperature. Heat pump compressor size is determined by the compliance software as the larger of the compressor size calculated to meet 110 percent of the cooling load at the cooling design temperature, or the compressor size calculated to meet 110 percent of the heating load at the heating design temperature. ~~If the maximum heat pump heating capacity is insufficient to meet the load during any hour in the simulation, the unmet portion of the load would be met by electric supplemental heating. The exception is that electric supplemental heating is disabled when the outdoor air temperature is above 35 °F. Electric sSupplemental heating is provided by electric resistance in the standard design. In the proposed design, electric supplemental heating is provided by electric resistance except in the case of dual fuel heat pumps where electric supplemental heating is provided by gas.~~	Related to the Residential HVAC Performance CASE Report. This addresses an inconsistency in the amended language.
4	MF	Residential HVAC	Supplementary Heating	Building Mechanical Systems - Heating Subsystems	Kristin Heinemeier	Bach Tsan	Supplemental heating is to be controlled as follows : - When supplemental heating is provided by electric resistance: - If heat pump heating capacity is insufficient to meet load during any hour, the unmet portion of the load is met by supplemental heating. - When supplemental heating is provided by gas: - If heat pump heating capacity is insufficient to meet load during any hour, the entire heating load for the hour would be met by supplemental heating. - In applications where heating load is greater than or equal to cooling load, the heat pump is disabled whenever the outdoor air temperature is below the Heat Pump Lockout Temperature (selected by the user, the maximum allowed value is the maximum of the heating design temperature and 35°F). - In applications where cooling load is greater than heating load, the heat pump is disabled whenever the heating load is greater than the heating capacity.	Related to the Residential HVAC Performance CASE Report. This addresses an inconsistency in the amended language.
5	MF	Multifamily Domestic Hot Water	HPWH Ventilation	Building Mechanical Systems - Heating Subsystems - Proposed Design	James Haile	Danny Tam	Consumer-Sized Integrated Heat Pump Water Heaters If the proposed design includes a consumer-sized integrated HPWH, software includes a checkbox for the user to confirm the HPWH will be installed with ventilation that meets the mandatory ventilation requirements. Text next to the checkbox states, "HPWH ventilation that is the larger of either mandatory minimum or manufacturer specification is installed." If this checkbox is not selected, the user receives an error message and the simulation does not proceed. The error message states, "Verify that the design includes HPWH ventilation that meets the requirements of 110.3(c)7." If this checkbox is selected, the compliance report lists "HPWH ventilation meeting the requirements of 110.3(c)7 is installed." under Required Special Features.	Related to HPWH Ventilaiton measure of the Multifamily Domestic Hot Water CASE Report.
6	MF	Residential HVAC	Design	Building Mechanical Systems - Heating Subsystems - Standard Design	Rebecca Evans	Bach Tsan	When the standard design is a gas heating system, the equipment used in the standard design building is a gas furnace (or propane if natural gas is not available) ~~with default ducts in the attic~~ , and an annual fuel utilization efficiency (AFUE) meeting the Appliance Efficiency Regulations minimum efficiency for central systems.	Proposed revision given in Section 8.4 of the Residential HVAC CASE Report that was not yet implemeted.
7	MF	Residential HVAC	Refrigerant Charge Verification	Building Mechanical Systems - Cooling Subsystems	Rebecca Evans	Bach Tsan	VERIFIED REFRIGERANT CHARGE ~~OR FAULT INDICATOR DISPLAY~~	Related to Residential HVAC CASE Report and removal of FIDs for refrignerat charge verification.
8	MF	Residential HVAC	Refrigerant Charge Verification	Building Mechanical Systems - Cooling Subsystems	Kristin Heinemeier	Bach Tsan	Proper refrigerant charge is necessary for electrically driven compressor air-conditioning and heating systems to operate at full capacity and efficiency. For cooling, Compliance software calculations set the cooling compressor efficiency multiplier to 0.90 to account for the effect of improper refrigerant charge or 0.96 for proper charge. For heating, software calculations set the heating compressor efficiency multiplier to 0.92 to account for the effect of improper refrigerant charge or 0.96 for proper charge. ~~When an FID is installed the heating compressor efficiency multiplier is 0.96.~~	FID was removed for refrigerant charge verification so not sure why this line was added.
9	MF	Residential HVAC	Refrigerant Charge Verification	Building Mechanical Systems - Cooling Subsystems	Rebecca Evans	Bach Tsan	PROPOSED DESIGN The compliance software allows the user to indicate if systems will have diagnostically tested refrigerant charge ~~or a field-verified fault indicator display (FID)~~. This allowance applies only to ducted split-systems and packaged air-conditioners and heat pumps. STANDARD DESIGN The standard design building is modeled with ~~either~~ diagnostically tested refrigerant charge ~~or a field-verified FID if the building is~~ in Climate Zone 2 or 8–15, and refrigerant charge verification is required by §Section 170.2(c)3B and Table 170.2-K for the proposed cooling system type.	Related to Residential HVAC CASE Report and removal of FIDs for refrigerant charge verification.
10	MF	Residential HVAC	Refrigerant Charge Verification	Building Mechanical Systems - Cooling Subsystems	Rebecca Evans	Bach Tsan	VERIFICATION AND REPORTING Refrigerant charge ~~or FID~~ requires field verification or diagnostic testing and is~~are~~ reported in the HERS ECC required verification listings on the LMCC or NRCC Certificate of Compliance. Details on refrigerant charge measurement are discussed in Reference Appendices, Residential Appendix RA3.2. ~~Information on the requirements for FIDs is in Reference Appendices, Joint Appendix JA6.1.~~	Related to Residential HVAC CASE Report and removal of FIDs for refrignerat charge verification.
11	MF	Residential HVAC	Refrigerant Charge Verification	Building Mechanical Systems - Cooling Subsystems - Table 32: Summary of Space Conditioning Measures Requiring Verification	Kristin Heinemeier	Bach Tsan	~~Verified Fault Indicator Display A fault indicator display can be installed as an alternative to refrigerant charge testing. RA3.4.2~~	Related to Residential HVAC CASE Report and removal of FIDs for refrigerant charge verification.
12	MF	MF Restructuring	Verification Clean-up	Building Mechanical Systems - Cooling Subsystems - Table 32: Summary of Space Conditioning Measures Requiring Verification	Lucy Albin	Mikey Shewmaker Payam Bozorgchami	~~Evaporatively Cooled Condensers Must be combined with duct leakage testing, refrigerant charge, and verified EER/EER2. RA3.1.4.3, RA3.2, RA3.4.3, RA3.4.4.1~~	This measure is not relevant to MF buildings (SF only)
13	MF	MF Restructuring	Verification Clean-up	Building Mechanical Systems - Cooling Subsystems - Table 32: Summary of Space Conditioning Measures Requiring Verification	Lucy Albin	Mikey Shewmaker Payam Bozorgchami	~~Central Fan Ventilation Cooling System When compliance includes this type of ventilation cooling, airflow, and fan efficiency are verified. RA3.3.4~~	This measure is not relevant to MF buildings (SF only)

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14	MF	MF Restructuring	Verification Clean-up	Building Mechanical Systems - Distribution Systems - Table 34: Summary of Verified Distribution Systems	Lucy Albin	Mikey Shewmaker Payam Bozorgchami	Multifamily Buildings ~~Up to Three Habitable StoriesFloors~~ Low-Leakage Air-Handling Units Compliance credit can be taken for installing a factory-sealed air-handling unit tested by the manufacturer and certified to the CEC to have met the requirements for a low-leakage air-handling unit. Field verification of the air handler model number is required. Duct sealing is required. RA3.1.4.3.9	This measure was extended to all MF buildings
15	MF	MF HVAC	Indoor Air Quality	Building Mechanical Systems - Indoor Air Quality (IAQ) Ventilation	Antonea Frasier	Anushka Raut	For newly constructed buildings with dwelling units and additions greater than 1,000 ft2, the Energy Code requires that all dwelling units meet the requirements of ASHRAE Standard 62.2 with California amendments specified in Section 160.2(b)2 and 160.2(c)3. Ventilation for spaces that are not dwelling units within the building should follow the nonresidential ventilation described in Section 120.1, as calculated according to Section 5.6.8 in the ACM .	Multifamily IAQ team believes this should not be deleted. There are still requirements for additions >100sf. Multifamily IAQ is changing this sentence because there are ventilation requirements for non dwelling units buildings
16	MF	MF HVAC	Indoor Air Quality	Building Mechanical Systems - Indoor Air Quality (IAQ) Ventilation	Antonea Frasier	Anushka Raut	~~For multifamily common spaces, the user identifies the type of ventilation system in the proposed design (supply only, exhaust only, or balanced) and whether the system(s) are central or individual.~~	Multifamily IAQ team did not find space inthe software to make these changes. See suggested sentence above in row 18.
17	MF	MF HVAC	Indoor Air Quality	Building Mechanical Systems - Indoor Air Quality (IAQ) Ventilation	Antonea Frasier	Anushka Raut	All balanced and supply ventilation ~~individual IAQ~~ systems servicing from inside the attic or have an HRV/ERV ~~with a supply fan~~ must specify if the system includes an FID that meets the requirements in Reference Appendices, Joint Appendix JA17, Qualification Requirements for Indoor Air Quality System Fault Indicator Displays.	Multifamily IAQ team is changing this language to match the energy code
18	MF	MF Envelope	High Performance Windows	Zones - Exterior Surfaces	Avani Goyal, Elizabet	Mikey Shewmaker Payam Bozorgchami	The net wall area on each orientation is reduced by the fenestration area and door area on each façade. The U-factor, and SHGC, and VT performance factors for the standard design are taken from §Section 170.2 and Table 170.2-A. In cases where the SHGC is "NR" the standard design is equal to 0.35.	MF Envelope - Windows. The Statewide CASE Team does not agree with removing this language. If it is removed, what is the Standard Design when NR specified in Table 170.2-A?
19	MF	MF Envelope	High Performance Windows	Zones - Exterior Surfaces	Avani Goyal, Elizabet	Mikey Shewmaker Payam Bozorgchami	Fenestration area, U-factor, SHGC, VT, and orientation, and tilt are reported on the LMCCCertificate of Compliance. SHGC is reported on the Certificate of Compliance as an allowable maximum and minimum for each window calculated as the SHGC entered by the user plus or minus 0.01.	This language was added for single family and should be added for multifamily as well.
20	MF	MF Envelope	Cool Roof	Attics - The Roof Deck	Avani Goyal, Elizabet	Mikey Shewmaker Payam Bozorgchami	The solar reflectance and thermal emittance of the standard design roofing are as specified in ~~the~~ Table 170.2-A of the prescriptive standards.	The Statewide CASE Team suggests a more direct reference to the appropriate table.
21	MF	MF DHW	NA, Individual Dwelling DHW Distribution	Domestic Hot Water (DHW)	Amin Delagah	Danny Tam	Some distribution systems ~~have an option to~~can increase the amount of credit received if the option for ECC verification is selected. See Appendix B for the amount of credit and Reference Appendices, Residential Appendix Table RA2-6 for a summary of inspection requirements.	Moved this section upward under the individual dwelling unit section, it was out of place originally under the central system distribution section. It doesn't address any MF measures we worked on in this cycle, just helps with readability.
22	MF	MF DHW	Pipe Insulation Enhancement	Domestic Hot Water (DHW)	Amin Delagah	Danny Tam	Standard (all piping and plumbing appurtenances for domestic hot water systems shall be insulated and insulation shall be continuous). HERSECC required pipe insulation, all lines including the first 8 ft of inlet cold water piping from storage tank. If pipe insulation is not verified per Residential Reference Appendix RA3.6.3, then an energy compliance penalty is applied based on Appendix B Table B-6 via alternative correction factor to reflect imperfect insulation.	In the CASE report, additions related to this correction factor references residential RA 2.2, I changed that to the correct RA section.
23	MF	MF DHW	Pipe Insulation Enhancement	Domestic Hot Water (DHW)	Amin Delagah	Danny Tam	~~Some distribution systems have an option to increase the amount of credit received if the option for~~ HERS ~~ECC verification is selected. See Appendix B for the amount of credit and Reference Appendices, Residential Appendix Table RA2-1 for a summary of inspection requirements.~~	Looks like Table RA2-6 has the summary of measures requiring field verification and testing for single family DHW measures. I will move this section up to under single family insulation
24	MF	MF DHW	CPC Appendix M Pipe Sizing	Domestic Hot Water (DHW) - Pipe Sizing	Catherine Chappell	Danny Tam	CPC Appendix M establishes that the standard design pipe sizing methodology be used for all distribution piping. If CPC Appendix A methodology is followed, then an energy compliance penalty is applied based on Appendix B Table B-6.	Slight langauge clarification based on MF DHW CASE Report.
25	MF	MF DHW	Master Mixing Valves	Multiple Dwelling Units – Central Water Heating Standard Design	Catherine Chappell	Danny Tam	Thermostatic master mixing valve is the standard design used for central water heating systems. A correction factor is used to apply an energy credit or penalty based on the system characteristics. A 1.0 correction factor represents no energy credit or penalty, while ~~larger~~ correction factors greater than 1.0 result in increased energy usage penalties for the system.	Language added/amended as a summary of the new prescriptive measure, defining the function and importance of MMV systems for multiple dwelling units.
26	MF	MF DHW	Master Mixing Valves	Multiple Dwelling Units – Central Water Heating Standard Design	Amin Delagah	Danny Tam	This factor is dependent on the heating plant characteristics based on the heating source, heater and storage tank configuration, and heating plant hot water outlet and recirculation return temperature. The correction factor is also dependent on whether a mechanical master mixing valve, digital master mixing valve or no master mixing valve is specified. The standard design assumes a mechanical master mixing valve with a correction factor of 1.0.	Language added/amended as a summary of the new prescriptive measure, defining the function and importance of MMV systems for multiple dwelling units.
27	MF	MF Restructuring	Skylight Properties	Additions/Alterations - ExistingAdditionAndAlteration - Table 54: Standard Design for Fenestration (in Walls and Roofs)	Taylor Taylor	Mikey Shewmaker Payam Bozorgchami	Proposed Design Fenestration Type: Skylight: SHGC Addition < 400ft2: CZ 2, 4, 6 -15=~~0.23~~0.25 , CZ 1,3 5 & 16=0.35 Addition >400 and <400 ft2: CZ 2, 4, 6 -15=~~0.23~~0.25, CZ 1,3 5 & 16=0.35 Addition >700 ft2: CZ 2, 4, 6 -15=0.23 , CZ 1,3 5 & 16=0.35 Altered: CZ 2, 4, 6 -15=~~0.3~~ 0.25, CZ 1,3 5 & 16=0.35	Multifamily restructuring - skylight properties
28	MF	MF DHW	Pipe Insulation Enhancement, Appendix M, MMV, Balancing Valves, HPWH Ventilation, HPWH, all applicable measures	Domestic Hot Water (DHW)	Jose Garcia	Danny Tam	Water heating energy use is based on the number of dwelling units, number of bedrooms, fuel type, distribution system, water heater type, and conditioned floor area. Detailed calculation information is included in Appendix B: Water Heating Calculation Method.	This is an introductory statement covering all DHW measures in the ACM. Comment regarding *"Appendix B: Water Heating Calculation Method"* : MF DHW CASE Report. Note that this does not match the CASE report suggestion exactly. Recommend revising to "Appendix B: Water Heating Calculation Method of the Residential ACM Reference Manual. " for consistency with edits in Section 5.
29	SF	MF DHW	HPWH Ventilation	2.9.3 Domestic Water Heating Systems	James Haile	Danny Tam	(add as last paragraph in this section:) If the proposed design includes a consumer-sized integrated HPWH, software includes a checkbox for the user to confirm the HPWH will be installed with ventilation that meets the mandatory ventilation requirements. Text next to the checkbox states, "HPWH ventilation that is the larger of either mandatory minimum or manufacturer specification is installed." If this checkbox is not selected, the user recieves an error message and the simulation does not proceed. The error message states, "Verify that the design includes HPWH ventilation that meets the requirements of 110.3(c)7." If this checkbox is selected, the compliance report lists, "HPWH ventilation meeting the requirements of 110.3(c)7 is installed." under Required Special Features.	Related to MF Domestic Hot Water CASE Report.

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30	NR	MF DHW	HPWH Ventilation	5.9.2 Water Heaters	James Haile	Danny Tam	VENTILATION FOR CONSUMER-SIZED INTEGRATED HEAT PUMP WATER HEATERS Applicability: Water heating systems with consumer-sized integrated heat pump water heaters. Definition: Consumer-sized integrated heat pump water heaters have mandatory ventilation requirements per Section 110.3(c)7. This building descriptor shows that the user confirmed the HPWH will be installed with ventilation that meets the mandatory ventilation requirements. Units: None Input Restrictions: If the design includes a consumer-sized integrated HPWH, software includes a checkbox for the user to confirm the HPWH will be installed with ventilation that meets the mandatory ventilation requirements. Text next to the checkbox states, “HPWH ventilation that is the larger of either mandatory minimum or manufacturer specification is installed.” If this checkbox is not selected, the user receives an error message, and the simulation does not proceed. The error message states, “Verify that the design includes HPWH ventilation that meets the requirements of 110.3(c)7.” If this checkbox is selected, the compliance report lists “HPWH ventilation meeting the requirements of 110.3(c)7 is installed.” under Required Special Features. Standard Design: Not applicable. Standard Design: Existing Buildings: Not applicable.	Related to MF Domestic Hot Water CASE Report.
31	MF	MF DHW	CPC Appendix M, Pipe Insulation Enhancement	5.9.3 Recirculation Systems	Jose Garcia	Danny Tam	Recirculating systems shall follow the rules set forth in Appendix B: Water Heating Calculation Method. ~~E of the Residential ACM Reference Manual.~~	MF DHW CASE Report. Needed to reference correct Appendix
32	MF	MF DHW	CPC Appendix M, Pipe Insulation Enhancement	Appendix B: B4. Hourly Adjusted Recovery Load	Jose Garcia	Danny Tam	HARL_k=HSEU_k+HRDL_k+∑_1^(NL_k) HJL_l + HPPL_k	MF DHW CASE Report. This needs to be modified as shown
33	MF	MF DHW	CPC Appendix M, Pipe Insulation Enhancement, Thermostatic Balancing Valves, and Master Mixing Valve	Appendix B: B4. Hourly Adjusted Recovery Load	Jose Garcia	Danny Tam	Where HARLk = Hourly adjusted recovery load (Btu) HSEUk = Hourly standard end use at all use points (Btu), see Equation 4 HRDLk = Hourly recirculation distribution loss (Btu), see Equation 14 ~~15;~~ HRDLk is nonzero only for multifamily central water heating systems NLk = Number of unfired or indirectly fired storage tanks in the kth system HJLl = Tank surface losses of the lth unfired tank of the kth system (Btu), see Equation 43~~45~~	MF DHW CASE Report
34	MF	MF DHW	CPC Appendix M, Pipe Insulation Enhancement, Thermostatic Balancing Valves, and Master Mixing Valve	Appendix B: B4. Hourly Adjusted Recovery Load, Equation 3	Amin Delagah	Danny Tam	HPPLk = Hourly water heating plant pipe heat loss (Btu), see Equation 45.	The Statewide CASE Team developed new ACM modeling rules for calculating plant pipe heat loss that can be utilized for the pipe insulation and CPC Appendix M measures. This heating plant pipe heat loss value HPPLk is added to Equation 3 in Appendix B, Section B4 to solve for the hourly adjusted recovery load of the centralized water heating system.
35	MF	MF DHW	CPC Appendix M, Pipe Insulation Enhancement, Thermostatic Balancing Valves, and Master Mixing Valve	Appendix B: B4. Hourly Adjusted Recovery Load, Equation 4	Amin Delagah	Danny Tam	Equation 4 calculates the hourly standard end use (HSEU). The heat content of the water delivered at the fixture is the draw volume in gallons (GPH) times the temperature rise DT (difference between the cold water inlet temperature and the hot water supply temperature) times the heat required to elevate a gallon of water 1°F (the 8.345 constant). HSEU_k=8.345×GPH_k×(T_s-T_inlet) Equation 4 Where HSEUk = Hourly standard end use (Btu) GPHk = Hourly hot water consumption (gallons) from Equation 2 ~~HPPLk = Hourly water heating plant pipe heat loss (Btu), see Equation 45.~~	The HPPLk definition was unintentionally added to Equation 4 by the CASE team, and then correctly moved to Equation 3 (see remark 34, above). This comment reflect the HPPLk being deleted from Equation 4.
36	MF	MF DHW	Balancing Valve	Appendix B: B5. Hourly Distribution Loss for Central Water Heating Systems - Hourly Recirculation Loop Pipe Heat Loss Calculation	Jose Garcia	Danny Tam	Equation 16 Where Flown = Flowrecirc + Flown,draw (gph), assuming Flown,draw = Average hourly hot water draw flow (gph); for supply sections, n=1, 2, or 3, Flown,draw = GPHk/NLoopk; for return pipes, n=4, 5, and 6, Flown,draw = 0 Flowrecirc = Hourly recirculation flow (gph) ~~is assumed to be 360 gallons based on the assumption that the recirculation flow rate is 6 gpm.~~ Flowrecirc shall be calculated as Nunitk/ Nfloork×0.5×60×fBV. fBV is the balancing valve and variable speed recirculation pump recirculation flow reduction factor. For the standard design, fBV = 1.0. For the proposed design, if the recirculation system meets all the criteria of RA 4.4.3, fBV = 0.6. Otherwise, fBV = 1.0.	Additional factors added to equation to account for balancing valve and variable speed pump credit.
37	MF	MF DHW	Balancing Valve, Pipe Insulation Enhancement, Appendix M	Appendix B: B5. Hourly Distribution Loss for Central Water Heating Systems - Hourly Recirculation Loop Pipe Heat Loss Calculation	Amin Delagah	Danny Tam	~~Flown,draw = Average hourly hot water draw flow (gph); for supply sections, n=1, 2, or 3, Flown,draw = GPHk/NLoopk; for return pipes, n=4, 5, and 6, Flown,draw = 0~~	This new definition for Flown, draw is dublicated twice under Equation 16, it has been deleted in ACM
38	MF	MF DHW	Pipe Insulation Enhancement	Appendix B: B5. Hourly Distribution Loss for Central Water Heating Systems - Hourly Recirculation Loop Pipe Heat Loss Calculation	Amin Delagah	Danny Tam	Equation 19 Where Lenn = Section n pipe length (ft); for the proposed design, use user input; for the standard design, see Equation 30 Ubare,n, Uinsul,n = Loss rates for bare (uninsulated) and insulated pipe (Btu/hr-ft-°F), evaluated using Equation 20 with section-specific values, as follows: fUA = Correction factor to reflect imperfect insulation, insulation material degradation over time, and additional heat transfer through connected branch pipes that is not reflected in branch loss calculation. For the standard design, fUA = 2.0. For proposed designs, fUA = 2.0 if pipe insulation installation is verified per Residential Reference Appendix RA 3.6.3; otherwise, fUA = 2.4 Dian = Section n pipe nominal diameter (inch); for the proposed design, use user input; for the standard design, see Equation 31. Thickn = Pipe insulation minimum thickness (inch) as defined in the Title 24 Section 120.3, TABLE 120.3-A for service hot water system Condn = Insulation conductivity shall be assumed = 0.26 (Btu inch/h·sf·F) hn = Section n combined convective/radiant surface coefficient (Btu/hr-ft2-F) assumed = 1.5 ~~fUA = Correction factor to reflect imperfect insulation, insulation material degradation over time, and additional heat transfer through connected branch pipes that is not reflected in branch loss calculation. It is assumed to be 2.0.~~	Updated default values and text descriptions for Correction Factor, fUA, to reflect the energy impact without and with pipe insulation verification.

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39	MF	MF DHW	Master Mixing Valves	Appendix B: B5. Hourly Distribution Loss for Central Water Heating Systems - Recirculation System Plumbing Designs	Jose Garcia	Danny Tam	Recirculation System Plumbing Designs ~~A recirculation system can have one or several recirculation loops. Each recirculation loop consists of many pipe sections, which are connected in sequence to form a loop. Each pipe section could have different pipe diameter, length, and location. The compliance software shall use six pipe sections, with three supply pipe sections and three return pipe sections, to represent a recirculation loop. When multiple recirculation loops exist, all recirculation loops are assumed identical. The compliance software shall provide default and standard recirculation system designs based on building geometry according to the procedures described in the following sections. The default design reflects typical recirculation loop design practices. The standards design is based on one or two loops and is used to set recirculation loop heat loss budget.~~ ~~The first step of establishing recirculation system designs is determining the number of recirculation loops, Nloopk, in water heating system k. The standard design has one recirculation loop, Nloopk =1, when Nunit <= 8, or two recirculation loops, Nloopk =2 for buildings with Nunit > 8. The proposed design is allowed to specify more than one loop only if the design is verified by a HERS Rater. Otherwise, the proposed design can only be specified to have one recirculation loop.~~ ~~The standard and default recirculation loop designs are based on characteristics of the proposed building. There could be many possibilities of building shapes and dwelling unit configurations, which would determine recirculation loop pipe routings. Without requiring users to provide detailed dwelling unit configuration information, the compliance software shall assume the proposed buildings to have same dwelling units on each floor and each floor to have a corridor with dwelling units on both sides. Recirculation loops start from the mechanical room (located on the top floor), go vertically down to the middle floor, loop horizontally in the corridor ceiling to reach the dwelling units on both ends of the building, then go vertically up back to the mechanical room. At each dwelling unit on the middle floor, vertical branch pipes, connected to the recirculation loop supply pipe, are used to provide hot water connection to dwelling units on other floors above and below.~~ ~~Both the standard and default recirculation loop designs are assumed to have equal length of supply sections and return sections. The first section is from the mechanical room to the middle floor. The second section serves first-half branches connected to the loop, and the third section serves the rest of the branches. The first and second sections have the same pipe diameter. Pipe size for the third section is reduced since fewer dwelling units are served. Return sections match with the corresponding supply pipes in pipe length and location. All return sections have the same diameter. For the standard and default designs, mechanical room is optimally located so that only vertical piping is needed between the mechanical room and the recirculation pipes located on the middle floor. Pipe sizes are determined based on the number of dwelling units served by the loop, following the 2009 Uniform Plumbing Code (UPC) pipe sizing guidelines. The detailed recirculation loop configurations are calculated as follows:~~ ~~Pipe length in the mechanical room (ft): Lmech=8~~ ~~Height of each floor (ft): Hfloor=user input floor-to-floor height (ft)~~	Enhances the description of the standard design recirculation system with inclusion of mechanical MMV.
39 continued	MF	MF DHW	Master Mixing Valves	Appendix B: B5. Hourly Distribution Loss for Central Water Heating Systems - Recirculation System Plumbing Designs	Jose Garcia	Danny Tam	Recirculation System Plumbing Designs **[continued from Remark #41]** ~~Length of each dwelling unit (ft): L_unit=√(CFAU_k) (see Equation 7)~~ A recirculation system consists of multiple pipes, which are connected in sequence to form a loop. Within a recirculation loop, there can be multiple parallel flow paths formed by riser pipes between supply and return pipes. The compliance software shall use six pipe sections, with three supply pipe sections and three return pipe sections, to represent a recirculation loop. The compliance software shall model recirculation system according to the piping design described in the following sections. This piping design is based on typical recirculation system piping layout practices and pipe sizing methods defined in California Plumbing Code Appendix A and Appendix M. Supply pipes start from the water heating plant master mixing valve outlet located on the first floor then routed to the corridor ceiling. Supply pipes run horizontally to each end of the building. Horizontal riser pipes connected to supply pipes bring hot water to each first-floor dwelling unit. Each horizontal riser is connected to vertical riser pipes to bring hot water to dwelling units on upper floors. In the ceiling of the top floor, vertical riser pipes are connected to horizontal riser pipes, which bring hot water to recirculation return pipes in the corridor ceiling. A vertical recirculation return pipe brings hot water down to the heating plant on the first floor to complete the loop. This recirculation loop design uses risers to bring hot water to each dwelling unit and, therefore, branch pipes for connecting riser pipes and pipes leading to individual hot water fixtures are relatively short. All supply pipes and the bottom half of riser pipes are converted into three sections of supply pipes in the default recirculation loop design. All return pipes and the top half of riser pipes are converted into three sections of return pipes in the default recirculation loop design. The first pipe section includes pipes from the water heating plant master mixing valve outlet to the first riser. The second pipe section includes supply pipes for the first half risers and the bottom half of these first half risers. The third pipe section includes the remaining supply pipes and the bottom half of the second half risers. The first pipe section represents pipes for supplying the whole building and, therefore, has the largest pipe diameter. The second section has a smaller pipe diameter because it represents the supply pipes and riser pipes with smaller pipe diameters . Pipe diameter for the third section is smallest because it represents pipes serving the fewest dwelling units. Return pipe sections (4, 5, and 6) represent return pipes and the top half of riser pipes in a similar way as supply pipe sections. Each return pipe section has the same pipe length as the corresponding supply pipe section. Pipe diameters for all return pipe sections are 0.75 inch.	Enhances the description of the standard design recirculation system with inclusion of mechanical MMV.
40	MF	MF DHW	Appendix M	Appendix B: B5. Hourly Distribution Loss for Central Water Heating Systems - Recirculation System Plumbing Designs	Jose Garcia	Danny Tam	Length of recirculation pipe sections (ft): ~~Len_1=Len_6=L_mech+H_floor×Nfloor/2~~ ~~Len_2=Len_3=Len_4=Len_5=L_unit×(Nunit_k)/(4×Nloop_k×Nfloor)~~ $Len1 = Len6 = 0.3 \times Nunitk + 4$ Equation 30 $Len2 = Len3 = Len4 = Len5 = 5.5 \times Nunitk$ Equation 31 Method WH-LOOPLEN Pipe diameters for recirculation loop supply sections depend on the number of dwelling units being served ~~and return section diameters depend only on building type,~~ as follows: Dia1, Dia2, and Dia3: derived from Table B-6. ~~based on Nunit1, Nunit2, and Nunit3~~ The standard design shall use values listed under California Plumbing Code Appendix M Pipe Sizing Method in Table B-6. Proposed designs shall use the same values as the standard design if pipes are sized using California Plumbing Code Appendix M Pipe Sizing Method. Otherwise, values listed under California Plumbing Code Appendix A Pipe Sizing Method shall be used. Dia4 = Dia5 = Dia6 = 0.75 ~~in for low rise multifamily building and hotel/motel less than four stories~~ ~~Dia4 = Dia5 = Dia6 = 1.0 in for high-rise multifamily and hotel/motel more than three stories Equation 31~~	Table B-6 has been updated related to Appendix A and Appendix M pipe sizing method. Edits have been made in this section to support the measure.

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41	MF	MF DHW	Appendix M	Appendix B: B5. Hourly Distribution Loss for Central Water Heating Systems - Recirculation System Plumbing Designs	Jose Garcia	Danny Tam	Method WH-LOOPSZ ~~Where~~ ~~Nunit1 = Number of dwelling units served by the loop section 1 = (Nunit_k)/(Nloop_k)~~ ~~Nunit2 = Nunit1~~ ~~Nunit3 = (Nunit_1)/2~~ ~~Nunit values are not necessarily integers.~~ Branch pipe parameters include number of branches, branch length, and branch diameter. The number of branches in water heating system k is calculated as (note: not necessarily an integer): Nbranch_k= ~~(Nunit_k)/(Nunit_b~~)Nunit_k Equation 32	Table B-6 has been updated related to Appendix A and Appendix M pipe sizing method. Edits have been made in this section to support the measure.
42	MF	MF DHW	Appendix M	Appendix B: B5. Hourly Distribution Loss for Central Water Heating Systems - Recirculation System Plumbing Designs	Jose Garcia	Danny Tam	Method WH-BRN The branch pipe diameter shall be determined as follows: Diab = 0.75 ~~derived from Table B-6 based on Nunitb Equation 33~~ Method WH-BRSZ Branch pipes connect riser pipes to pipes connected to individual hot water fixtures in dwelling units. (Lenb) shall be 2. ~~The branch length includes the vertical rise based on the number of floors in the building plus four feet of pipe to connect the branch to the recirculation loop.~~ ~~Len_b=4+H_floor×Nfloor/2 Equation 34~~ Method WH-BRLEN Proposed designs shall use the same branch configurations as those in the standard design. ~~Therefore, compliance software does not need to collect branch design information.~~	Table B-6 has been updated related to Appendix A and Appendix M pipe sizing method. Edits have been made in this section to support the measure.
43	MF	MF DHW	Appendix M	Appendix B: B5. Hourly Distribution Loss for Central Water Heating Systems – Recirculation System Plumbing Designs	Amin Delagah	Danny Tam	[See Appendix A]	See the Appendix attached to the Statewide CASE Team comments for details; ACM Reference Manual Table B-6 has been updated related to Appendix A and Appendix M pipe sizing method.
44	MF	MF DHW	Appendix M	Appendix B: B5. Hourly Distribution Loss for Central Water Heating Systems - Recirculation System Plumbing Designs	Amin Delagah	Danny Tam	"Table B-6: Pipe Size Schedule" was deleted	As a result of "Pipe Size Schedule for Supply Pipe Sections (inch)" being added (remark 45, above).
45	MF	MF DHW	Not measure specific	Appendix B: B7. Energy Use of Water Heaters	Amin Delagah	Danny Tam	B7. Energy Use of ~~Individual~~ Water Heaters Once the hourly adjusted recovery load is determined for each water heater, the energy use for each water heater is calculated as described below and summed.	Unnessessary distinction removed. The section now is applicable to centralized systems.
46	MF	MF DHW	Appendix M	Appendix B: B7. Energy Use of Water Heaters - Consumer or Residential-Duty Commercial Storage Water Heaters	Amin Delagah	Danny Tam	The hourly energy use of storage gas water heaters is given by the following equation. WHEU_j=(HARL_j×HPAF_j)/(LDEF_j) Equation 33~~35~~ Where WHEUj = Hourly energy use of the water heater (Btu for fuel or kWh for electric); ~~Equation36~~ Equation 34 provides a value in units of Btu. For electric water heaters, the calculation result needs to be converted to the unit of kWh by dividing 3413 Btu/kWh.	Subsequent renumbering due to equation changes related to Appendix M measure.
47	MF	MF DHW	Appendix M	Appendix B: B7. Energy Use of Water Heaters - Consumer or Residential-Duty Commercial Storage Water Heaters	Amin Delagah	Danny Tam	LDEFj = The hourly Load Dependent Energy Factor (LDEF) is given by Equation 36. This equation adjusts the nominal EF rating for storage water heaters for different load conditions. Equation ~~36~~34	Subsequent renumbering due to equation changes.
48	MF	MF DHW	Appendix M	Appendix B: B7. Energy Use of Water Heaters - Small Instantaneous Gas Water Heaters	Amin Delagah	Danny Tam	Small Instantaneous Gas Water Heaters The hourly energy use for instantaneous gas or oil water heaters is given by ~~Equation 37~~Equation 35, where the nominal rating is multiplied by 0.92 to reflect the effects of heat exchanger cycling under real-world load patterns. WHEU_j=(HARL_j)/(EF_j×0.92) Equation ~~37~~35	Subsequent renumbering due to equation changes.
49	MF	MF DHW	Appendix M	Appendix B: B7. Energy Use of Water Heaters - Small Instantaneous Electric Water Heaters	Amin Delagah	Danny Tam	The hourly energy use for consumer instantaneous electric water heaters is given by the following equation. WHEU_(j,elec)=(HARL_j)/(EF_j 0.92 3413) Equation ~~38~~36	Subsequent renumbering due to equation changes.
50	MF	MF DHW	Appendix M	Appendix B: B7. Energy Use of Water Heaters - Mini-Tank Electric Water Heater	Amin Delagah	Danny Tam	Mini-tank electric heaters are occasionally used with gas tankless water heaters to mitigate hot water delivery problems related to temperature fluctuations that may occur between draws. If mini-tank electric heaters are installed, the installed units must be listed in the CEC Appliance Database and their reported standby loss (in Watts) will be modeled to occur each hour of the year. (If the unit is not listed in the CEC Appliance Database, a standby power consumption of 35 W should be assumed.) WHEU_(j,elec)=MTSBL_j/1000 Equation ~~39~~37	Subsequent renumbering due to equation changes.
51	MF	MF DHW	Appendix M	Appendix B: B7. Energy Use of Water Heaters - Large/Commercial Gas Storage Water Heaters	Amin Delagah	Danny Tam	Energy use for large storage gas is determined by the following equations. Large storage gas water heaters are defined as any gas storage water heater with a minimum input rate of 75,000 Btu/h. WHEU_j=(HARL_j)/(EFF_j)+SBL_j Equation ~~40~~38	Subsequent renumbering due to equation changes.
52	MF	MF DHW	Appendix M	Appendix B: B7. Energy Use of Water Heaters - Large/Commercial Instantaneous, Indirect Gas, and Hot Water Supply Boilers	Amin Delagah	Danny Tam	Energy use for these types of water heaters is given as follows: WHEU_j=(HARL_j)/(EFF_j×0.92)+PILOT_j Equation ~~41~~39	Subsequent renumbering due to equation changes.
53	MF	MF DHW	Appendix M	Appendix B: B7. Energy Use of Water Heaters - Consumer Storage Electric or Heat Pump Water Heaters	Amin Delagah	Danny Tam	Several issues arise from integration of a detailed, short time-step model into an hourly framework. HPWH is driven by water draw quantities, not energy requirements. Thus, to approximate central system distribution and unfired tank losses, fictitious draws are added to the scheduled water uses, as follows: Equation ~~42~~40	Subsequent renumbering due to equation changes.

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54	MF	MF DHW	Pipe Insulation Enhancement, Appendix M	Appendix B: B7. Energy Use of Water Heaters - Jacket Loss	Amin Delagah	Danny Tam	Water Heating Plant Pipe Heat Loss Pipes in the heating plant establish connection between water heating equipment, hot water storage equipment, and the master mixing valve. The hourly pipe heat loss of water heating plant in the kth system is calculated as: $HPPL_k = (PSA_{plant,k} \times f_{A\_plant}) \times (U_{plant,k} \times f_{U\_plant}) \times (T_{plant,k}) – T_{Amb\_plant,k})$ Equation 45 Where $PSA_{plant,k}$ = Pipe surface area (sqft) of pipes in the heat plant. Pipes downstream of the master mixing valve are considered part of the hot water distribution system. Pipe heat loss is calculated based on the number of dwellings units, Nunit, k, served by the heating system k as following: 2.4 × Nunitk for heat pump water heater-based heating plant 3.5 × Nunitk for natural gas water heater or boiler-based heating plant fA,plant = Correction factor to reflect improvement in pipe surface area reduction by using smaller pipes according to California Plumbing Code Appendix M. For the Standard Design, fA,plant = 0.8. For the proposed design, the default value is 1.0. If plant pipes in the proposed design are sized according to California Plumbing Code Appendix M and the number of dwelling units served by the heating plant, Nunitk, is more than 8, fA,plant =0.80. Uplant,k = Average heat transfer coefficient between pipes and the ambient air, 25.2 Btu/hr-oF-sqft. fU,plant = Correction factor to reflect field installation quality of pipe insulation. For the Standard Design, fU,plant = 1. For the proposed design, the default value is 1.40. If pipe insulation is field inspected and verified by a HERS Rater per Residential Reference Appendix RA2.2, fU,plant = 1. Tplant,k = Average pipe surface temperature for pipes in the heat plant, 125oF TAmb_plant,k = Ambient temperature of the heating plant, which can be outside air or unconditioned air. Outside air temperatures shall be the dry-bulb temperature from the weather file. Hourly unconditioned air temperatures shall be average of outside air dry-bulb temperature and conditioned air dry-bulb temperature. For proposed designs, heating plant ambient temperature shall be based on user input of heating plant location. The standard design shall have the same heating plant ambient temperature as that of the proposed design.	New equation developed to quantify water heating plant pipe heat loss. Previously only distribution pipe heat loss was being calculated.
55	NR	HVAC Controls	Guideline 36	Appendix 5.7 Performance Curves, "ACM Performance Curves" tab, new Row 26	Rupam Singla	Bach Tsan	SDD Object: Fan SDD Short Form: Pwr_fPLRCrvRef Curve Identifier: VSD with limited static pressure reset Curve ID Abv: VSDLimitedSpReset DOE-2.2 Keyword: FAN-EIR-FPLR E+ Object: Fan:VariableVolume E+ Field(s): Fan Power Coefficient 1-5 Curve Name: FanVSDLimitedSpResetPwrRatio_fCFMRatio Curve Type: Cubic Dependent: PwrRatio Var1: CFMRatio a: 0.055594373 b: 0.236687586 c: -0.266895119 d: 0.976471632 MaxOut: 1 MinOut: 0.1803 MaxVar1: 1 MinVar1: 0.419974484	Define a new curve that is halfway between the curves "FanVSDPwrRatio_fCFMRatio" (a curve that represents a fan with a VSD, but without any duct static pressure reset) and "FanVSDGoodSpResetPwrRatio_fCFMRatio" (a curve that represents a fan with a VSD and that has effective duct static pressure reset). The new curve represents a fan with a VSD and with less effective duct static pressure reset. As proposed by the NR HVAC Controls Guideline 36 Measure CASE Team, this new curve gets modeled in the Proposed Design if the user indicates that they do not meet the prescriptive Guideline 36 measure. This new curve is already referenced in the ACM, Section 5.7.3.2, under FAN PART-FLOW POWER CURVE.
56	NR	NR Envelope	Vestibules	5.4.2 Inflitration	Maureen Guttman	Payam Bozorgchami	Should vestibules be accounted for in this section?	Vestibules added as a mandatory provision to reduce air leakage in certain buildings.
57	NR	NR Envelope	Vestibules	2.1.7 Building Envelope Descriptions	Maureen Guttman	Payam Bozorgchami	Should vestibules be accounted for in this section?	Vestibules added as a mandatory provision to reduce air leakage in certain buildings.
58	NR	Laboratory Airflow	Nighttime Setback	5.6.7 Terminal Minimum Airflow	DJ Joh	Haile Bucaneg	*Input Restrictions:* Input must be greater than or equal to the outside air ventilation rate. Users may input separate minimum rates for occupied and unoccupied. The unoccupied rates shall be used when the occupancy schedule indicates an occupancy fraction below 0.10.	Updated to allow for the different ventilation rates between occupied and unoccupied conditions.
59	NR	HVAC Controls	Guideline 36	5.6.7 Terminal Minimum Airflow	Rupam Singla	Bach Tsan	For Systems 5, 6, and 15, Packaged VAV, Built-up VAV, and Built-up VAV with AWHP heating ~~systems 14a, 14b, packaged VAV units and built-up VAV air handling units~~ where the Control System Type Certified Guideline 36 Libraries specifies that certified Guideline 36 libraries are not being used, the modeled minimum airflow shall be the maximum of 2 times the minimum airflow input and ~~or~~ 2 times the minimum outside air ventilation rate.	Note that from air airside perspective, anywhere that Systems 5 and 6 are mentioned, System 15 should be included as well. This should be checked throughout the ACM, beyond just the G36 measure. The 'or' changed to an 'and' is a grammatical change.
60	NR	Daylighting	Reduce Threshold for Daylighting Control Exception	5.4.5 Daylighting Control	Yao-Jung Wen	Simon Lee	The primary ~~and skylit~~ daylit zone shall be defined on the plans and be consistent with the definition of the primary ~~and skylit~~ daylit zone in the Energy Code. Note that a separate building descriptor, fraction of controlled lighting, defines the fraction of the lighting power in the space that is controlled by daylighting.	Daylighting CASE Report
61	NR	Daylighting	Reduce Threshold for Daylighting Control Exception	5.4.5 Daylighting Control	Yao-Jung Wen	Simon Lee	The skylit daylit zone shall be defined on the plans and be consistent with the definition of the ~~primary and~~ skylit daylit zone in the Energy Code. Note that a separate building descriptor, fraction of controlled lighting, defines the fraction of the lighting power in the space that is controlled by daylighting.	Daylighting CASE Report
62	NR	NR Envelope	Opaque Assemblies	5.5.3 Roofs	Alamelu Brooks	Payam Bozorgchami	Climate Zones 6, 7, 8 R-21.34 (~~U – 0.0470~~ U-0.047)	Three decimal digits only.
63	NR	NR Envelope	Opaque Assemblies	5.5.4 Exterior Walls	Alamelu Brooks	Payam Bozorgchami	N/A	These R-values are slightly different from the CBECC construction values.
64	NR	HVAC Controls	Guideline 36	5.7.2 Systems Controls	Rupam Singla	Bach Tsan	Applicability: Systems 5 and 6 ~~-~~ , Packaged VAV, Built-up VAV, and Built-up VAV with AWHP heating, ~~packaged VAV units and built-up VAV air handling units~~ with Control Type DDC to the zone.	System numbers (5, 6, 15) are correct, but the System names were not correct.

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65	NR	HVAC Controls	Guideline 36	5.7.2.3 Supply Air Temperature Controls	Rupam Singla	Bach Tsan	- No control – For this scheme the coils cycle on/off based on control zone thermostat signal for heating/cooling. There is no controller to maintain a specific supply air temperature (SAT). - Fixed - The coils cycle on/off to maintain a constant SAT setpoint. - Warmest Reset - resets the cooling supply air temp of a central forced air HVAC system according to the cooling demand of the warmest zone - ~~Warmest zone, airflow first – The SAT is adjusted to meet the demands of the warmest zone by adjusting supply airflow before resetting temperature.~~ - ~~Warmest zone, temperature first - The SAT is adjusted to meet the demands of the warmest zone by adjusting temperature before resetting supply airflow.~~ - Outside air dry-bulb temperature – The SAT is adjusted based on the outdoor air temperature. The SAT is varied linearly between the max/min limits in proportion to the outside air max/mix limits, and constant above/below the outside air limits. - Scheduled setpoint – The coils cycle on/off to maintain a SAT setpoint specified by schedules.	Remove "warmest zone, airflow first" and "warmest zone, temperature first" as options since they are not representative of real practice. Replace them with new option "Warmest Reset" which more closely aligns with actual practice.
66	NR	HVAC Controls	Guideline 36	5.7.2.3 Supply Air Temperature Control	Rupam Singla	Bach Tsan	Standard Design: For healthcare facilities, same as the Proposed Design. For all others, for standard design systems 1 through 4 and 7 through 13, the SAT control is No Control. For systems 5, ~~and~~ 6, and 15, the SAT control shall be reset by Warmest Reset~~warmest zone~~.	Revise to match new option.
67	NR	HVAC Controls	Guideline 36	5.7.3.2 Fans, General Fan Part-Flow Power Curve	Rupam Singla	Bach Tsan	Input Restrictions: Prescribed, use curves in Appendix 5.7 based on fan control. For systems 5, 6, and 15, Packaged VAV, Built-up VAV, and Built-up VAV with AWHP heating, where the Control System Type Certified Guideline 36 Libraries specifies that certified Guideline 36 libraries are not being used, the fan curve shall be FanVSDLimitedSpResetPwrRatio_fCFMRatio	Use the newly-defined fan curve in the Proposed Design if Guideline 36 libraries are not being used.
68	NR	HVAC Controls	Guideline 36	5.7.3.2 Fans, General Fan Part-Flow Power Curve	Rupam Singla	Bach Tsan	Standard Design: For healthcare facilities with total system fan power less than 1 kW and system is not a DOAS, same as the Proposed Design. ~~For systems 5 and 6, packaged VAV units and built-up VAV air handling units, where the Control System Type Certified Guideline 36 Libraries specify that certified Guideline 36 libraries are not being used, the fan curve shall be FanVSDLimitedSpResetPwrRatio_fCFMRatio in Appendix 5.7.~~ For all others, not applicable for standard design constant volume systems. The curve VSD with static pressure reset fans shall be used for variable volume systems. For exhaust fans, if a linear curve is used, the same fan curve, in the proposed design is used.	Per Item 71, the newly-defined fan curve should be used in the Proposed Design, and not in the Standard Design.
69	NR	Laboratory Airflow	Reheat Limitation	5.1.3 HVAC System Map; Table 2: Nonresidential HVAC System Map	DJ Joh	Haile Bucaneg	**Column Heading: Space Type** Covered process laboratory with total building laboratory with ~~design maximum exhaust< 1520,000 cfm or less meets an exception5 and~~ total building ~~conditioned~~ area < less than 25,000 ft2 **Column heading: Standard Design** System 7~~b~~a – SZVAVHPAC	Conformance with adopted language
70	NR	Laboratory Airflow	Reheat Limitation	5.1.3 HVAC System Map; Table 2: Nonresidential HVAC System Map	DJ Joh	Haile Bucaneg	**Colume Heading: Space Type** Covered process laboratory ~~with design maximum exhaust 20,000 cfm or less or meets an exception5~~ required to meet 140.9(c)5 Reheat Limitation ~~with total building laboratory design maximum exhaust > 15,000 cfm and~~ and total building conditioned floor area 25,000 ft2 to < < 150,000 ft2 and serving a single zone **Column Heading: Standard Design** System 14a – ACSZVAV	Updated to follow new requirements around eliminating reheat limit exceptions.
71	NR	Laboratory Airflow	Reheat Limitation	5.1.3 HVAC System Map; Table 2: Nonresidential HVAC System Map	DJ Joh	Haile Bucaneg	**Column Heading: Space Type** Covered process laboratory ~~with a design maximum ehaust 20,000 cfm or less or meets exception5~~ required to meet 140.9(c)5 Reheat Limitation and total building conditioned floor area ≥ 150,000 ft2 **Column heading: Standard Design:** System 14b – WCSZVAV	Updated to follow new requirements around eliminating reheat limit exceptions.
72	NR	Laboratory Airflow	Reheat Limitation	5.1.3 HVAC System Map; Table 2: Nonresidential HVAC System Map	DJ Joh	Haile Bucaneg	**Column Heading: Space Type** Covered process laboratory exempt from 140.9(c)5 Reheat Limitation and total building conditioned floor area 20,000 ft2 to < 150,000 ft2 **Column Heading: Above-Grade Floors** No Limit **Column Heading: Climate Zone** No Limit **Column Heading: System Cooling Capacity** No Limit **Column Heading: Standard Design** System 5 PVAV	Updated to follow new requirements around eliminating reheat limit exceptions.
73	NR	Laboratory Airflow	Reheat Limitation	5.1.3 HVAC System Map; Table 2: Nonresidential HVAC System Map	DJ Joh	Haile Bucaneg	**Column Heading: Space Type** Covered process laboratory exempt from 140.9(c)5 Reheat Limitation and total building conditioned floor area ≥ 150,000 ft2 **Column Heading: Above-Grade Floors** No Limit **Column Heading: Climate Zone** No Limit **Column Heading: System Cooling Capacity** No Limit **Column Heading: Standard Design** System 6 - VAV	Updated to follow new requirements around eliminating reheat limit exceptions.
74	NR	Laboratory Airflow	Fan Controls	5.1.3 HVAC System Map; Table 3: System Descriptions	DJ Joh	Haile Bucaneg	**Column Heading: Detail** Single-zone system with variable-air-volume fan, direct expansion variable-speed-drive cooling, and gas furnace heating. Integrated economizer for standard design cooling capacities ≥ 33 kBtu/h.	Updated to follow new requirements around simplified fan controls.
75	NR	Laboratory Airflow	Fan Controls	5.1.3 HVAC System Map; Table 3: System Descriptions	DJ Joh	Haile Bucaneg	**Column Heading: Detail** Single-zone system with variable-air-volume fan, direct expansion heat pump cooling and heating, and electric resistance supplemental heating. Minimum fan speed ratio of 0.2 for laboratory spaces and 0.5 for all other spaces.	Updated to follow new requirements around simplified fan controls.

Remark #	Building Type(s)	CASE Report	CASE Measure	Section(s) of ACM	Person Making Recommendation	CEC Staff Lead	Language Markup (deletions marked with red ~~strikethroughs~~; additions marked with red underlining)	Comment OR Justification
76	NR	Laboratory Airflow	Reheat Limitation	5.7.7 Exhaust Air Heat Recovery	DJ Joh	Haile Bucaneg	**RECOVERY TYPE** Standard Design: For healthcare facilities, same as the Proposed Design. For all others, sensible if impacted based on requirements in 140.4(q) ~~and~~or 140.9(c)6. Not applicable for all systems.	Updated to follow new requirements around eliminating reheat limit exceptions.
77	NR	Laboratory Airflow	Reheat Limitation	5.7.7 Exhaust Air Heat Recovery	DJ Joh	Haile Bucaneg	**RECOVERY TYPE** Standard Design: Existing Buildings: For healthcare facilities, same as the proposed design. For all others, sensible if impacted based on requirements in 140.4(q) ~~and~~or 140.9(c)6. Not applicable for all systems.	Updated to follow new requirements around eliminating reheat limit exceptions.
78	NR	Laboratory Airflow	Reheat Limitation	5.7.7 Exhaust Air Heat Recovery	DJ Joh	Haile Bucaneg	**RECOVERY AIRFLOW RATE** Standard Design: For healthcare facilities, same as the Proposed Design. For all others, equal to the design outdoor airflow rate, and assume balance flow if impacted based on requirements in 140.4(q) ~~and~~or 140.9(c)6.	Updated to follow new requirements around eliminating reheat limit exceptions.
79	SF	SF HP Windows and Walls	High Performance Windows	2.1.5 Self-Utilization Credit	Claudia Pingatore	Payam Bozorgchami	The following envelope features were used to represent the 2025 Standards: ... Window U-factor of 0.27 for climate zones 1-5, 11-14 and 16, and U-factor of 0.30 for climate zones 6-10 and 15. If the home has 500 square feet or less of the conditioned floor area and is in climate zone 5, the U-factor is 0.30.	Taken directly from CEC edits in Section 2.5.6>Fenestration.
80	SF	SF HP Windows and Walls	High Performance Windows	2.5.6 Exterior Surfaces	Claudia Pingatore	Payam Bozorgchami	Exterior Walls PROPOSED DESIGN The compliance software will verify that the wall assembly entered by the user meets the mandatory U-factor or insulation requirements as listed in Section 150.0(c).	CASE Report: Single-Family High-Performance Windows and Walls.
81	SF	SF HP Windows and Walls	High Performance Windows	2.5.6 Exterior Surfaces	Claudia Pingatore	Payam Bozorgchami	Doors PROPOSED DESIGN The compliance software will check that the area weighted window U-factor for all fenestration meets the mandatory U-factor for window requirements as listed in Section 150.0(q).	CASE Report: Single-Family High-Performance Windows and Walls.
82	SF	SF HP Windows and Walls	High Performance Windows	2.10.4 Addition-Alone Approach	Rebecca Evans	Payam Bozorgchami	When a dual-glazed greenhouse or garden window is installed in an addition ~~or alteration,~~ the proposed design...	Related to SF High-Performance Envelope CASE Report. This is under the addition only approach so this section should not mention alteration.
83	SF	Residential HVAC	Supplementary Heating	2.4.1 Heating Subsystems	Kristin Heinemeier	Bach Tsan	Supplemental heating is to be controlled as follows: - For single-family homes greater than 500 square feet located in Climate Zones 1-6, 8-14, and 16, supplemental heating is disabled whenever the outdoor air temperature is greater than the larger of the Heating Design Temperature or 35°F. - When supplemental heating is provided by electric resistance: - If heat pump heating capacity is insufficient to meet load during any hour, the unmet portion of the load is met by supplemental heating. - When supplemental heating is provided by gas: - If heat pump heating capacity is insufficient to meet load during any hour, the entire heating load for the hour would be met by supplemental heating. - In applications where heating load is greater than or equal to cooling load, the heat pump is disabled whenever the outdoor air temperature is below the Heat Pump Lockout Temperature (selected by the user, the maximum allowed value is the maximum of the heating design temperature and 35°F). - In applications where cooling load is greater than heating load, the heat pump is disabled whenever the heating load is greater than the heating capacity.	Related to the Residential HVAC Performance CASE Report. This addresses an inconsistency in the amended language.
84	SF	Residential HVAC	Refrigerant Charge Verification	2.4.6 Cooling Subsystems	Rebecca Evans	Bach Tsan	**Verified Refrigerant Charge** ~~**or Fault Indicator Display**~~ ...compliance software calculations set the heating compressor efficiency multiplier to 0.92 to account for....	Related to Residential HVAC CASE Report: This change was also reflected in Appendix G.
85	SF	Residential HVAC	Refrigerant Charge Verification	2.4.6 Cooling Subsystems	Rebecca Evans	Bach Tsan	**PROPOSED DESIGN** The compliance software allows the user to indicate if systems will have diagnostically tested refrigerant charge ~~or a field-verified fault indicator display (FID)~~.	Related to Residential HVAC CASE Report and removal of FID.
86	SF	Residential HVAC	Refrigerant Charge Verification	2.4.6 Cooling Subsystems	Rebecca Evans	Bach Tsan	**STANDARD DESIGN** The standard design building is modeled with ~~either~~ a diagnotically tested refrigerant charge ~~or a field-verified FID~~. If the building is in Climate Zones 2 and ~~or~~ 8-15 for air-conditioners...For heat pumps in all other homes diagnostically tested, refrigerant charge ~~or a field-verified FID~~ is modeled in all climate zones...	Related to Residential HVAC CASE Report and removal of FID.
87	SF	Residential HVAC	Refrigerant Charge Verification	2.4.6 Cooling Subsystems	Rebecca Evans	Bach Tsan	**VERIFICATION AND REPORTING** Refrigerant charge ~~or FID~~ requires field verification or diagnostic testing and isare reported in the ~~HERS~~ ECC required verification listings on theCF1R...~~Information on the requirements for FIDs are in Reference Appendices, Joint Appendix JA6.1.~~	Related to Residential HVAC CASE Report and removal of FID.
88	SF	Buried Ducts and Roofs with Cathedral Ceilings	Buried Ducts	2.4.7 Distribution Subsystems	Simon Pallin	Payam Bozorgchami	**Buried Attic Ducts** Effective duct R-values used by the software are listed in Table 15: Buried Duct Effective R-Values	These tables should be updated to represent effective R-values as suggested in the CASE Report for Buried Ducts. However, the existing tables (as seen below) present R-values in color codes representing either deeply, fully, partially, or not buried ducts. Before we can make those updates, we need guidance on whether the current color code should still apply.

Remark #	Building Type(s)	CASE Report	CASE Measure	Section(s) of ACM	Person Making Recommendation	CEC Staff Lead	Language Markup (deletions marked with red ~~strikethroughs~~; additions marked with red <u>underlining</u>)	Comment OR Justification
89	NR	NR Envelope	Opaque Assemblies	5.5.4 Exterior Walls	Alamelu Brooks	Payam Bozorgchami	N/A	Building paper is not identified as a layer in the CBECC software. These are the layers per the CBECC construction: R-value for layers 2, 3, 4 and 5 varies based on the U-factor. Stucco - 7/8 in., !- Layer 1 Compliance Insulation Rxxxxx, !- Layer 2 Compliance Insulation R0.10, !- Layer 3 Compliance Insulation R0.10, !- Layer 4 Compliance Insulation R0.01, !- Layer 5 Air - Metal Wall Framing - 16 or 24 in. OC, !- Layer 6 Gypsum Board - 1/2 in.;
90	NR	Laboratory Airflow	Reheat Limitation	5.7.7 Exhaust Air Heat Recovery	DJ Joh	Haile Bucaneg	**RECOVERY AIRFLOW RATE** *Standard Design: Existing Buildings:* Assume balanced flow if impacted based on requirements in 140.4(q) ~~and~~<u>or</u> 140.9(c)6. Not applicable for all systems.	Updated to follow new requirements around eliminating reheat limit exceptions.
91	SF	Residential HVAC	Refrigerant Charge Verification	Appendix G: 1.15.1 Compression Air-Conditioner Model	Rebecca Evans	Bach Tsan	Fchg = Refrigerant charge factor, default = 0.9. For systems with ~~a verified charge indicator light (Reference Residential Appendix RA3.4) or~~ verified refrigerant charge (Reference Residential Appendix RA3), the factor shall be 0.96.	Related to HVAC CASE Report and removal of FID for refrigerant charge verification.
92	SF	Residential HVAC	Refrigerant Charge Verification	Appendix G: 1.15.2 Air-Source Heat Pump Model (Heating mode)	Rebecca Evans	Bach Tsan	Fchgheat = Heating refrigerant charge factor, default = 0.92. For systems with verified refrigerant charge (Reference Residential Appendix RA3), the factor shall be 0.96. Derived model parameters. Inp47 = Electrical input power at 47 °F = Cap47 / COP47, Btuh (not W) Inp17 = Electrical input power at 17 °F = Cap17 / COP17, Btuh (not W) Estimation of unavailable model parameters. "COP47 "=" (0.3038073"×"HSPF-1.984475"×"Cap17" /"Cap47" +"2.360116) × <u>Fchgheat"</u> "COP17 "=" (0.2359355"×"HSPF"+"1.205568"×"Cap17" /"Cap47" -0.1660746) <u>×Fchgheat</u> Cap35=0.9×[Cap17+0.6×(Cap47-Cap17)] Inp35=0.985×[Inp17+0.6×(Inp47-Inp17)] COP35= Cap35/Inp35	Related to Residential HVAC Case Report
93	SF	N/A	N/A	Appendix G: 2.4.2 Approach	Claudia Pingatore	N/A	2.4.2 Approach Internal mass objects are completely inside a zone so that they do not participate directly in heat flows to other zones or outside. They are co<u>n</u>nected to the zone radiantly and convectively and participate in the zone energy balance by passively storing and releasing heat as conditions change. For now only in Conditioned Zones.	Fixing typo of "connected".

Appendix A: Additional Mark-up Language

This appendix provides code language mark-up for longer edits or those in a table that do not fit neatly into the previous table.

Remark #43 Table B-6: Pipe Size Schedule for Supply Pipe Sections (inch), Appendix B

In the ACM Reference Manual Appendix B: B5, Hourly Distribution Loss for Central Water Heating Systems – Recirculation System Plumbing Designs.

Statewide CASE Team recommends updating Table B-6 as shown below and as related to Appendix A and Appendix M pipe sizing method. Delete Table B–6: Pipe Size Schedule, and replace with Table B-6: Pipe Size Schedule for Supply Pipe Sections (inch) as shown below.

Table B-6: Pipe Size Schedule for Supply Pipe Sections (inch)

Number of dwelling units served (NUnit$_n$) ~~or NUnit$_b$~~	~~**Loop pipe nominal size Dia$_n$ in**~~ California Plumbing Code Appendix A Pipe Sizing Method	~~**Loop pipe nominal size Dia$_n$ in**~~ California Plumbing Code Appendix A Pipe Sizing Method	~~**Loop pipe nominal size Dia$_n$ in**~~ California Plumbing Code Appendix A Pipe Sizing Method	~~**Branch pipe nominal size Dia$_b$ in**~~ California Plumbing Code Appendix M Pipe Sizing Method	~~**Branch pipe nominal size Dia$_b$ in**~~ California Plumbing Code Appendix M Pipe Sizing Method	~~**Branch pipe nominal size Dia$_b$ in**~~ California Plumbing Code Appendix M Pipe Sizing Method
NA	Dia$_1$	Dia$_2$	Dia$_3$	Dia$_1$	Dia$_2$	Dia$_3$
< ~~2~~5	~~1.5~~1	0.75	0.75	1	0.75	~~1~~0.75
~~2~~5 ≤ N < 8	1.5	1	0.75	1.5	1	~~1.5~~0.75
8 ≤ N < 21	2	1.5	1.5	1.5	1.5	~~2~~1
21 ≤ N < ~~42~~36	2.5	1.5	1.5	1.5	1.5	~~2.5~~1
~~42~~36 ≤ N < 68	3	1.5	1.5	2	1.5	~~3~~1
68 ≤ N < 101	3.5	2	1.5	3	1.5	~~3.5~~1
101 ≤ N < 145	4	2	1.5	3	1.5	~~4~~1
145 ≤ N < 198	5	2	1.5	3	1.5	~~5~~1
N >= 198	6	~~2~~	~~1.5~~	~~3~~	~~1.5~~	~~6~~1