Meeting Notes

Notes from 2022 Title 24, Part 6 Code Cycle
Utility-Sponsored Stakeholder Meeting for:

Nonresidential and Single Family HVAC Part 1: Data Centers, Boilers, Air Distribution, Variable Capacity

Posted April 13, 2020

Meeting Information:

Meeting Date: March 12, 2020

Meeting Time: 8:30am – 12:30pm PST

Location: Adobe Connect webinar (sign-up at title24stakeholders.com/events)

Meeting Host: California Statewide Utility Codes and Standards Team

Meeting Agenda

Start Time	Topic	Presenter
10 minutes prior to call	Live Attendee Poll	
8:30 am	Meeting Guidelines	Statewide CASE Team
8:35 am	Opening Remarks from the California Energy Commission	Energy Commission Staff
8:40 am	Overview and Welcome	Statewide Utility Codes and Standards Representative
8:45 am	**CASE Presentation I:** Nonresidential Air Distribution	Chad Worth and Benjamin Zank
9:45 am	**CASE Presentation II:** Computer Room Efficiency	Hillary Weitze
10:30 am	**CASE Presentation III:** Nonresidential High Efficiency Boilers and Service Water Heating	George Chapman
11:30 am	**CASE Presentation IV:** Single Family Variable Capacity HVAC Compliance Software Revisions	David Springer (Frontier Energy) and Curtis Harrington
12:15 pm	Wrap Up and Closing	Statewide CASE Team

Meeting Attendees

Statewide Utility Codes and Standards Team – Utility Staff:

First Name	Last Name	Email	Affiliation
James	Kemper	James.Kemper@ladwp.com	Los Angeles Department of Power and Water
Jeremiah	Valera	Jeremiah.valera@ladwp.com	Los Angeles Department of Power and Water
Mark	Alatorre	Mark.alatorre@pge.com	Pacific Gas and Electric
Kelly	Cunningham	KACV@pge.com	Pacific Gas and Electric
John	Barbour	jbarbour@sdge.com	San Diego Gas and Electric
Jeremy	Reefe	jmreefe@sdge.com	San Diego Gas and Electric
Josh	Rasin	joshua.rasin@smud.org	Sacramento Municipal Utility District

Codes and Standards Enhancement (CASE) Team Members:

First Name	Last Name	Email	Affiliation
Alanna	Torres	atorres@energy-solution.com	Energy Solutions
Sam	Chussid	schussid@energy-solution.com	Energy Solutions
Shaojie	Wang	swang@energy-solution.com	Energy Solutions
Heidi	Werner	hwerner@energy-solution.com	Energy Solutions
Chad	Worth	cworth@energy-solution.com	Energy Solutions
Simon	Silverberg	ssilverberg@energy-solution.com	Energy Solutions
George	Chapman	gchapman@energy-solution.com	Energy Solutions
Marisa	Lee	Mlee@energy-solution.com	Energy Solutions
Curtis	Harrington	Csharrington@ucdavis.edu	WCEC
Hillary	Weitze	Hillary@redcaranalytics.com	Red Car Analytics
David	Springer	Dspringer@frontierenergy.com	Frontier Energy
Jeff	Stein	Jstein@taylor-engineering.com	Taylor Engineering
Jon	McHugh	jon@mchughenergy.com	McHugh Energy Consultants
John	Bade	Johnbade@2050partners.com	2050 partners
Rahul	Athlaye	Rathalye@noresco.com	NORESCO
Erica	DiLello	Edilello@noresco.com	NORESCO
Ben	Lalor	Blalor@noresco.com	NORESCO

California Energy Commission:

First Name	Last Name	Email
Payam	Bozorgchami	Payam.Bozorgchami@energy.ca.gov
Haile	Bucaneg	haile.bucaneg@energy.ca.gov
Adrian	Ownby	adrian.ownby@energy.ca.gov
Larry	Froess	Larry.foress@energy.ca.gov

Jeff	Miller	Jeff.miller@energy.ca.gov
Cheng	Moua	Cheng.moua@energy.ca.gov
Judy	Roberson	Jduy.roberson@energy.ca.gov

Stakeholder Attendees:

First Name	Last Name	Affiliation
Sid	Sidel	Sidel Systems
Emaan	Ammar	ARUP
Nate	Baker	Cadeo
Jeff	Boldt	IMEG Corp
Joe	Boros	Rheem
Holly	Brink	ARUP
Joseph	Brook	AMCA
Nick	Brown	Build Smart Group
David	Choo	CalCerts
Abram	Conant	Proctor Engineering
Frank	Cuaderno	Mars Air System
Soph	Davenberry	National Energy Management Institute
Frank	David	Carrier
Darryl	DeAngelis	Ebtron
David	Dias	SMW Local 104
Ben	Dolcich	Vertiv
Roy	Eads	Self-employed
Henry	Ernst	Daikin
Jim	Gatto	Robinson Fans
Robert	Glass	Goodman Mfg
Kenneth	Golovko	HED
Keith	Goshia	Veritv
Peter	Grant	Beyond Efficiency
Aaron	Gunzer	AMCA
Joe	Hale	2020 Engineering
Tasha	Harvey	ARUP
Armin	Hauer	EBM-Papst
Jeff	Herring	Vertiv
Jill	Hootman	Trane
Marshall	Hunt	Self-employed
Peachie	Hytowitz	Raypak
Abhishek	Jain	Air Flow Pvt
Dan	Johnson	Beyond Efficiency
Dave	Kelley	Vertiv/Liebert
Russ	King	CalCerts
Jeff	Kleiss	Lochinvar
Joey	Krueger	Raypak

Jared	Landsman	Integral Group
William	LeBlanc	Sytemair
Brendan	McGovern	Trane
Nazme	Mohsina	AMCA
Peter	Mustacich	2050 Partners
George	Nesbitt	Environmental Design/Build
Dillion	OConnor	Comefri USA
Randy	Oshiro	Nortiz America
Laura	Petrillo-Groh	AHRI
Neil	Placer	EnerNex
Chris	Quinones	AcoustiFLO
Patrick	Riley	Carrier
Luis	Salcedo	Carrier
Lisa	Saponaro	Vertiv
Patrick	Smith	Air Treament
Bruce	Severance	Mitsubishi Electric
Philip	Stephens	Weil-McLain
Cassandra	Trester	Ei Companies
Joe	Vadder	Evapco
Robert	Valbracht	Loren Cook Company
Patrick	Villaume	Patterson-Kelley
Andy	Wahl	Zehnder America
Meg	Waltner	Energy 350
Ola	Wettergren	Systemair
Jeff	Whitelaw	Mitsubishi Electric
David	Winningham	Lennox International
Mike	Wolf	Greenheck
Curt	Yaeger	Yaeger Services
James	York	Rinnai America

Meeting Resources

1. Agenda
2. Presentation Slides
3. Submeasure Summaries
    a. Fan Power Budget
    b. Fan Energy Index
    c. Duct Leakage Testing
    d. Computer Room Efficiency
    e. Nonresidential High Efficiency Boilers and Service Water Heating
    f. Single Family Variable Capacity HVAC Compliance Software Revisions

Meeting Notes

1.1 CASE Presentation I: Nonresidential Air Distribution

1.1.1 Air Distribution (Chad Worth and Benny Zank, Energy Solutions)

1. George Nesbitt (Environment Design/Build): Duct leakage is air that does not come or go from where it is supposed to go. Do leaky ducts mask duct resistance? I have done small commercial duct testing and has shown that ducts leak, is this similar to residential?
    a. John Bade (2050 Partners): No, they make it worse. More air has to be moved through the ducts.
2. Kenneth Golovko (HED): Regarding mixed-air design, how was 2022 design layout external static pressure (ESP) calculated?
    a. John Bade (2050 Partners): We used the values that the original The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1 fan team used to create the current limits. Then we calculated how much pressure had to be removed from that to achieve all of the power savings by only changing duct design. To be clear, the proposal does not limit the permitted external static pressure (ESP).
3. Kenneth Golovko (HED): For the first cost, was a HVAC contractor engaged for pricing, or was it a cost consultant?
    a. John Bade (2050 Partners): That was part of the low-pressure design from ARUP.
4. George Nesbitt (Environment Design/Build): How is this field verified for compliance? If it is not verified, it likely does not achieve savings.
5. Bruce Severance (Mitsubishi Electric): A recent article from Alison Bailes indicates significant flow and ESP improvements with longer sweeping elbows.
6. Kenneth Golovko (HED): When will there be third party analysis from an industry expert (HVAC contractor) concerning first costs? It is concerning that the same firm providing analysis is confirming their design.
    a. Chad Worth (Energy Solutions): There are easier ways to achieve this. We tried to give ourselves the most expensive way to design this duct work.
    b. Jeff Whitelaw (Mitsubishi Electric): Agree with Kenneth, a third-party analysis is needed to verify costs.
    c. John Bade (2050 Partners): We are going to be doing more cost analysis with industry experts. Though we have high confidence in ARUP's work, as their costing department has a lot of experience. Further, they had no incentive to show a lower cost.
7. George Nesbitt (Environment Design/Build): Flow resistance has never been a mystery. It is industries resistance to designing and installing low resistance systems.
    a. Jeff Whitelaw (Mitsubishi Electric): Improving product efficiency is understandable; however, if you do not verify ductwork in the field, the expected savings will not be met.

i. John Bade (2050 Partners): When you say verify ductwork in the field, are you referring to compliance or costing? We would be happy to hear suggestions for compliance requirements that are not overly onerous or costly. We would appreciate it if you would submit comments.

8. Jeff Boldt (IMEG Corp): The fan power reduction proposal seems reasonable. I have not had trouble meeting the ASHRAE 90.1 fan power limits even on laboratories.

9. Armin Hauer (EBM Papst): Are the files (resources) still the same as the originally posted ones, when they were announced by email? Or do we need to download a fresh set of copies?

    a. John Bade (2050 Partners): We made some updates.

10. Jeff Boldt (IMEG Corp): In my opinion, fan efficiency index (FEI) is a great improvement over fan efficiency grades (FEG).

    a. Chad Worth (Energy Solutions): We agree. This is where the nation is moving.

11. Jeff Boldt (IMEG Corp): I agree with eliminating (ASHRAE FEI) exemption 4 (embedded fans included in equipment bearing a third-party-certified seal for air or energy performance of the equipment package). Return fans are the worst offenders in my experience of poor efficiency. (Slide 68)

12. Mike Wolf: Other equipment impacted could be energy recovery ventilation (ERV), make-up air units (MUA).

    a. John Bade (2050 Partners): I am not aware of ERV having a seal. We agree MUA would be affected. On ERV, please keep in mind that the lower limit is 5 horsepower, so only large ERV would be affected. Does MUA have any package certification program today?

    b. Mike Wolf (Greenheck): I am not sure what you mean by "package certification." I suggest we discuss later.

13. Meg Waltner (Energy 350): I support removing that exemption.

1.2 Duct Leakage (Benny Zank, Energy Solution)

14. Jeff Boldt (IMEG Corp): I did the economic analysis for the seal Class A requirement in ASHRAE 90.1, and it was very clear that it met our economic requirements. Gus Farris may have information for you. He is working on individual component leakage rating certification.

15. George Nesbitt (Environment Design/Build): It is recommended to test the first install, identify issues, and test often to assure compliance. There are the low leakage air handlers in the low-rise residential section of the code.

16. Jeff Boldt (IMEG Corp): ASHRAE 90.1 gives the owner the choice of which duct sections are tested. I think it makes it as fair as the owner thinks needed.

    a. Benny Zank (Energy Solutions): Our concern is that we are then dependent on the interest and the knowledge of the building owner. We want to ensure consistency independent of who the owner is.

17. David Dias (SMW Local 104): Mechanical acceptance test technicians should perform VAV testing in the field.

a. Benny Zank (Energy Solutions): Do you have thoughts on how many would need to be tested in the field to get an accurate leakage? At this time, we are recommending 20 percent of each type or at least three.

b. Benny Zank (Energy Solutions): Do you think the testing language needs to be adjusted?

c. David Dias (SMW Local 104): 20 percent might work. I will ask around and see what our balancers think.

d. David Dias (SMW Local 104): An ANSI certified air balancer could do it as well.

1.3 CASE Presentation II: Computer Room Efficiency (Hillary Weitze, Red Car)

18. Ben Dolcich (Vertiv): In the California energy modeling program, would the defined cold and hot aisle temperatures change with the proposed change to only 65°F outside air dry-bulb temperature (ODA) for all economizer types?

    a. Jeff Stein (Taylor Engineering): The baseline modeling assumptions for supply air temperature (SAT) and return air temperature (RAT) in the Alternative Calculation Method (ACM) Reference Manual will likely increase from current values of 60/80 to 70/90.

19. Laura Petrillo-Groh (AHRI): This change in economizer temperature eliminates the opportunity to use water economizers, including dry coolers, which use little or no water.

    a. Jeff Stein (Taylor Engineering): Water economizers can still meet the 50 wet bulb condition. Dry coolers will be problematic but note that dry coolers are much less efficient than other economizer options.

20. Lisa Saponaro (Vertiv): What analysis has been done to justify raising the economizer outside air (OA) condition temperature on fluid economizer technologies other than airside economizer?

21. Ben Dolcich (Vertiv): Utilization of wet bulb conditions suggest massive amounts of water use. Are California water utilities ready for that?

22. Joe Hale (2020 Engineering): What if there are site restrictions on water consumption yet chilled water is still preferred due to building configuration?

    a. Jeff Stein (Taylor Engineering): There is no point to energy codes if any option is allowed in every case. Some changes in current practice may be required. All measures have been shown to be cost-effective. Note that many options still exist in your case such as refrigerant economizers, liquid cooling with dry coolers, etc.

    b. Jeff Stein (Taylor Engineering): Water use is more likely to go down. Many data centers use air economizers. Many use water-cooled chilled water. A water economizer uses less water than a water-cooled plant.

23. Ben Dolcich (Vertiv): ASHRAE Standards were referenced several times earlier in this meeting. ASHRAE has developed ASHRAE 90.4 Energy Standard for Data Centers that is aligned with ASHRAE 90.1-2019. It establishes design efficiency metrics for data centers. The California approach is different, much more prescriptive and minimizes design professional creativity. Why is ASHRAE 90.4 not considered?

a. Hillary Weitze (Red Car): The biggest issue is that it is a performance metric that is not enforceable.

24. Laura Petrillo-Groh (AHRI): AHRI recommends harmonization with ASHRAE 90.4-2019, including definitions (ex. Title 24, Part 6 computer room is data center in ASHRAE 90.4) and information technology equipment (ITE) design load breaks (ex. Table 140.9-A).

25. Dave Kelley (Liebert): Why is there not an incremental cost for a large computer room to provide containment? Also, how does a colocation data center address containment when they may have numerous customers with many different rack configurations?

26. Laura Petrillo-Groh (AHRI): Coefficient of performance (COP) is a common term used for HVAC equipment. Applying this term to heat transfer in the building, as computer room heat recovery COP, may be confusing to users of Title 24, Part 6. Has the Statewide CASE Team considered other terms for this?

    a. Jeff Stein (Taylor Engineering): COP definition is the ratio of heat transferred from the computer room to the rate of energy input of the computer room heat recovery system, calculated under design conditions and expressed in consistent units.

    b. Laura Petrillo-Groh (AHRI): Yes, I see that is the proposed definition. My comment is that applying COP to building heat transfer, rather than equipment where it is currently an industry standard term, is confusing.

27. Laura Petrillo-Groh (AHRI): How are building total ITE design load breaks selected?

28. Ben Dolcich (Vertiv): ASHRAE 90.4-2019 defines data center and computer room differently than California. For consistency, why not use the same definitions?

    a. Jeff Stein (Taylor Engineering): The Title 24, Part 6 computer room definition has not changed since 2013.

29. Jeff Whitelaw (Mitsubishi Electric): Why is this more prescriptive than a new ASHRAE 90.4 Standard? Definitions should be aligned at a minimum.

30. Laura Petrillo-Groh (AHRI): Regarding EXCEPTION 5 to Section 140.9(a)1- Why was a computer room heat recovery COP of 4.0 selected? Please provide justification for this proposal. Likewise, in 140.9(a)4.A, why was a computer room heat recovery COP of 3.0 selected?

    a. Jeff Stein (Taylor Engineering): Regarding COP for exceptions, these are exceptions for different requirements; one is for economizer, the other is for heat recovery so the savings required to omit the requirement are different, but we will revisit to see if we can harmonize them.

31. Ben Dolcich (Vertiv): Does this heat recovery proposal consider losses incurred on the cooling system when heat is not being recovered? If not, it should. ASHRAE 90.4 has addendum ‘a’ regarding heat recovery in data centers. It aligns with ASHRAE 90.4 data center metrics. It considers cooling system losses. This month it will be made available for public review. The (sic: CASE team) proposal is very different. Why not consider the ASHRAE 90.4 approach?

    a. Jeff Stein (Taylor Engineering): Regarding ASHRAE 90.4, there are many examples where Title 24, Part 6 is more strict than ASHRAE 90.1 or 90.4.

32. Jeff Boldt (IMEG Corp): Tim Peglow did the economics for ASHRAE 90.1 related to HR chillers. They met our economic criteria.

33. Jeff Stein (Taylor Engineering): The ASHRAE 90.4 proposal for heat recovery is not a heat recovery requirement but rather an exception/relaxation of the mechanical load component (MLC)/power usage effectiveness requirement if heat recovery is included in the design. The proposed heat recovery prescriptive requirement is based on a lifecycle cost analysis (LCCA) that has shown that adding heat recovery is cost effective in select cases.

34. Ben Dolcich (Vertiv): For California, more stringent code than ASHRAE 90.4 may make sense. Why not use the same approach as ASHRAE 90.4?

    a. Jeff Stein (Taylor Engineering): What approach are you referring to?

    b. Ben Dolcich (Vertiv): The MLC defined in ASHRAE 90.4.

    c. Jeff Stein (Taylor Engineering): Title 24, Part 6 has an equivalent approach to the MLC, which is the performance compliance approach. The proposal described today are prescriptive, not mandatory.

35. Kenneth Golovko (HED): How many mega-watts (MW) are we considering when we say "large"?

    a. Jeff Stein (Taylor Engineering): The PUE requirement is for 2 MW and above.

36. Jeff Boldt (IMEG Corp): Dewpoint of 55°F is probably okay for most of California. In more humid climates, that is a big energy penalty if applied to all space types.

    a. Jeff Stein (Taylor Engineering): I am not following your point. Is this related to the economizer requirement of 65 drybulb, 50 wet-bulb?

1.4 Nonresidential High Efficiency Boilers and Service Water Heating

37. George Nesbitt (Environment Design/Build): It is more resilient to install multiple (smaller capacity) boilers than to install one large one so you could stay with lower efficiency equipment.

    a. George Chapman (Energy Solutions): This is a system-level efficiency requirement.

38. Joey Krueger (Raypak): Can you please repeat when the proposed 90 percent boiler system efficiency will take effect?

    a. Simon Silverberg (Energy Solutions): This proposed code change proposal impacts gas boiler systems with capacities between 1 and 10 million British thermal unit per hour (Btu/h). The minimum size of a boiler to count towards the system level input is 300,000 Btu/h. So, four 300,000 Btu/h gas boilers would trigger the requirement.

39. Jeff Boldt (IMEG Corp): I do not think ASHRAE 90.1 has done the economics, but could we go above 10 million Btu (MMBtu) for condensing boilers? For example, economizers on big steam hospital boilers. I would like to look at that.

    a. George Chapman (Energy Solutions): We cannot go beyond because of federal preemption.

40. Laura Petrillo-Groh (AHRI): The oxygen trim should be technology neutral to achieve the combustion efficiency. There are multiple alternative technologies which can achieve the same objective.

a. George Chapman (Energy Solutions): We are not prescribing oxygen trim, just the oxygen concentration.

41. Sid Abma (Sidel Systems): Condensing economizers are developed for boilers from 50 horsepower to 1000 horsepower.
42. Patrick Villaume (Patterson-Kelley): The incremental cost of the design change is a bit low. I have calculated that at being around an $8 difference.
43. George Nesbitt (Environment Design/Build): I do not think the draft code language reflects that if 300,000 or larger boilers with a total system capacity of 1 million to 10 million fall under this requirement.
44. Phillip Stephens (Weil-McLain): Were maintenance costs of the combustion monitoring included in the analysis?
    a. George Chapman (Energy Solutions): We'll talk about that when we get to oxygen concentration section.
45. Patrick Villaume (Patterson-Kelley): Again, we are about 50 percent low on the incremental cost at roughly $6/MMBtu/h.
46. Jeff Boldt (IMEG Corp): My experience has been that condensing boilers have a very short payback, partially because you do not need to buy a new boiler every few years because the water temperature was set low to save energy. I doubt that this is in any energy analyses.
47. George Nesbitt (Environment Design/Build): If you have multiple boiler systems on a building serving different areas (isolated loops), does the 1 million to 10 million threshold apply to each individual system or the building as a whole?
    a. George Chapman (Energy Solutions): I want to make sure we take a close look before providing an answer, and I will be happy to follow up offline.
48. Jon McHugh (McHugh Energy): With lower oxygen concentrations there is a lower excess air fraction, and there is a longer residence time. My expectation is that the rise temperature should be lower when you drop your excess air?
    a. Jeff Boldt (IMEG Corp): 200°F seems quite high for condensing boilers.
    b. Phillip Stephens (Weil-McLain): Can we have more explanation of the temperature difference calculation?
    c. George Chapman (Energy Solutions): The difference is based on a United States (U.S.) Department of Energy (DOE) chart that is available in our Draft CASE Report that shows difference in flue gas and combustion temperature.
    d. Patrick Villaume (Patterson-Kelley): Depending on the condensing operation that is high.
    e. Jon McHugh (McHugh Energy): For process boilers, are we assuming hot water or steam boiler?
    f. George Chapman (Energy Solutions): That's a good question. If we need to break that out, we can. Steam and hot water boilers may have different temperatures differences, if so, we need to tweak it.
    g. Phillip Stephens (Weil-McLain): The title of that is "Steam" and we are working on hot water.

i. Shaojie Wang (Energy Solutions): Yes, you are correct. However, this table is very similar to thermal efficiency in 2013 CASE Report. We are conducting a literature review. Do you know any other resources for hot water boiler?

h. Jon McHugh (McHugh Energy): If relative humidity of air changes, that mapping does not work. If air has more vapor, it gets lighter. I am not aware of other technologies besides measuring the oxygen concentration in the combustion air. Laura mentioned other technologies, what are those?

i. Jon McHugh (McHugh Energy): Is there an increase in maintenance costs due to more adjustment of air to fuel ratio? Is there more manual adjustment of air to fuel ratio in oxygen trim than parallel positioning?

i. George Chapman (Energy Solutions): This is our goal to find out.

ii. Jeff Kleiss (Lochinvar): I doubt that the maintenance cost will be significantly different. Current modulating systems will be adjusting fuel and air rations. Incremental cost is dependent on input rates.

iii. Shaojie Wang (Energy Solutions): We are using U.S. General Services Administration (GSA) and Pacific Northwest National Labs (PNNL) research papers to determine the incremental cost data.

j. George Nesbitt (Environment Design/Build): Condensing equipment is either stainless steel or plastic.

k. George Nesbitt (Environment Design/Build): There are tons of boilers less than 300,000 input that are high efficiency.

i. John Bade (2050 Partners): If you are asking why boilers less than 300 thousand Btu/h (kBtu/h) are not included, it is because of federal preemption. States cannot set higher than federal minimum efficiencies for these products.

ii. George Nesbitt (Environment Design/Build): We prescriptively require a 0.8 energy factor tankless water heater in (sic: low-rise residential) despite federal preemption.

iii. John Bade (2050 Partners): That is allowed through a tradeoff. Users have the option to use federal minimum hot water heaters if they use the compact piping layout. There could be a tradeoff proposed for small boilers, but the analysis for tradeoffs is very detailed.

iv. George Nesbitt (Environment Design/Build): You can trade off the tankless water heater in the performance path too.

1.5 Single Family Variable Capacity HVAC Compliance Software Revisions (David Springer (Frontier Energy), Curtis Harrington (WCEC))

49. George Nesbitt (Environment Design/Build): You also have two-stage equipment as well, and heating losses would be increased too.

50. George Nesbitt (Environment Design/Build): Two-stage and variable are installed in change outs, replacements, new systems in existing homes, as well as in small commercial.

51. Bruce Severance (Mitsubishi Electric): Were any of these tests or assumptions done with R-49 to R-60 with deeply buried ducts?
    a. Curtis Harrington (WCEC): All of the tests were done with the prescriptive duct R-value in each climate zone.
    b. George Nesbitt (Environment Design/Build): Buried ducts or greater duct insulation would reduce the effect of the losses.
    c. Curtis Harrington (WCEC): That is correct, increased R-value would impact the result. WCEC has performed that analysis and published those results.
52. Curt Yaeger (Yaeger Services): What duct R-value was used?
    a. Curtis Harrington (WCEC): The R-value was 8 in most cases.
    b. George Nesbitt (Environment Design/Build): R-8 was used in Climate Zone 1, 2, 4, 8-16; R-6 was used in Climate Zone 3, 5-7.
53. Curtis Harrington (WCEC): You could still put very high R values in the California Simulation Engine (CSE) and the improved duct model would simulate the impact appropriately.
54. Bruce Severance (Mitsubishi Electric): I have just performed a cost trade-off analysis on deeply buried ducts and R-60 in all climate zones and the reduced duct losses and improved ceiling R-value were cost effective in all climate zones. With R-60 blown fiberglass over R-8 ducts over 2x4 truss chords, R-value is increased to about R-20.
55. Jeff Whitelaw (Mitsubishi Electric): The list of companies does not appear to show complete options.
    a. George Nesbitt (Environment Design/Build): Bryant, and other brand names have the same equipment available as the "parent" company.
56. George Nesbitt (Environment Design/Build): The buried duct charts are wrong because they use the same depth per R-value for fiberglass and cellulose.
57. Bruce Severance (Mitsubishi Electric): Agreed. The buried duct charts in the ACM Reference Manual Section 150.1 appear to be incorrect.
58. George Nesbitt (Environment Design/Build): The quality insulation installation (QII) requirements for buried ducts mean that nobody would take credit.
59. Jeff Whitelaw (Mitsubishi Electric): What is a "certified zonal control system"? If product allows zoning, such as a multi-split system, is that allowed?
60. George Nesbitt (Environment Design/Build): If increased accuracy of duct losses for two stage/variable equipment means less market uptake, then it is a bad idea.
61. Curt Yaeger (Yaeger Services): Burring ducts is not feasible in most homes, unrealistic and cost prohibitive for most owners.
62. Payam Bozorgchami (Energy Commission): Bruce Severance, please send me the reason why you think the current Residential ACM Reference Manual is incorrect when assuming a buried duct?
    a. Bruce Severance (Mitsubishi Electric): When you look at those charts, the duct diameters plateau with different R-values. In reality it would not work that way.

b. Payam Bozorgchami (Energy Commission): Section 150.1 does not necessary consider buried ducts. The ACM Reference Manual does. We can connect offline.

63. Bruce Severance (Mitsubishi Electric): Were any simulations conducted on buried ducts? Also, charts appear to be messed up?

    a. David Springer (Frontier Energy): We will be sure to review charts.

    b. Curtis Harrington (WCEC): We did not look at buried ducts. We just took the prescriptive code. R-values should be based on ASHRAE 150.

    c. Bruce Severance (Mitsubishi Electric): There are certain variables that need to be addressed such as depth. In the modeling you included cycling losses variable capacity avoids, is there any research on this?

    d. Curtis Harrington (WCEC): We did not have a basis for the reduced cycling. There was little cycling. We wanted to make sure duct model accounts for variable air flow rates.

    e. Bruce Severance (Mitsubishi Electric): Will you include recommendations on controls for variable capacity systems? It would be great to manufacturers if you make those recommendations for manufacturers.

    f. Curtis Harrington (WCEC): Maintain duct velocity at design point. We found that having two zones for variable speed significantly improves duct performance at part-load. We have recommendation for optimal performance. But in this case work, we are just recommending two zones be used.

64. George Nesbitt (Environment Design/Build): I think we will not see a lot of it in new construction, because they buy the cheapest thing they can. This may happen in retrofits. Variable speed is popular when people want to go to zoning. High end systems go through initial set-ups and go through tests. In operation, they automatically open zones as needed to bleed air to maintain air flow. If you're going to zone, you almost have to use the manufacturers' set up.