

Meeting Notes



2022 California Energy Code (Title 24, Part 6)

Notes for the Utility-Sponsored Stakeholder Meeting for:

Nonresidential HVAC and Envelope Part 2: Reduced Infiltration, HVAC Controls (Air Efficiency, DOAS)

Posted May 11, 2020

Meeting Information

Meeting Date: April 14, 2020

Meeting Time: 8:30am – 11:05pm 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 | <i>Live Attendee Poll</i> | |
| 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: HVAC Controls | Tim Minezaki (Energy Solutions) Neil Bulger (Red Car Analytics) |
| 9:55 am | CASE Presentation II: Reduced Infiltration | Benjamin Zank, Alamelu Brooks (Energy Solutions) |
| 11:05 am | Wrap Up and Closing | Statewide CASE Team |

Meeting Attendees

Statewide Utility Codes and Standards Team – Utility Staff:

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| Kelly | Cunningham | KACV@pge.com | Pacific Gas and Electric (PG&E) |
| John | Barbour | jbarbour@sdge.com | San Diego Gas and Electric (SDG&E) |
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| Josh | Rasin | joshua.rasin@smud.org | Sacramento Municipal Utility District (SMUD) |
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| Tom | Abram | Mesa Energy |
| Nick | Agopian | RenewAire |
| Jr | Babineau | Johns Manville |
| Jake | Barker | Airtreatment Coproration |
| Will | Becchina | Energy Wall |
| Craig | Bender | Ventacity |
| Joe | Boros | Rheem |
| Nick | Brown | Build Smart Group |
| John | Bruschi | N/A |
| Liam | Buckley | IES Ltd. |
| Conrad | Carino | Climatec |
| John | Carrieri | Energy Cloud Inc. |
| David | Choo | CalCERTS, Inc. |
| Chadwick | Collins | Kellen Company |
| Kris | Crosby | Arkema |
| Frank | Cuaderno | Mars Air Systems, LLC |
| Laverne | Dalgleish | Air Barrier Association of America |
| Soph | Davenberry | National Energy Management Institute Committee |
| David | Dias | SMW Local 104 |
| Brendan | Dineen | Malarkey |
| Matt | Emberson | MicroMetl |
| Henry | Ernst | Daikin |
| Heather | Estes | GAF |
| Mike | Fischer | Kellen |
| Jeanne | Fricot | Center for Sustainable Energy |
| Scott | Gilchrist | LG Electronics |
| Robert | Glass | Goodman Mfg. Company |
| Chandra | Gollapudi | Samsung |
| Aaron | Gunzner | AMCA International |
| Reid | Hart | Pacific NW National Labs |
| Armin | Hauer | ebm-papst. Inc. |

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| Jill | Hootman | Trane |
| Michael | Hsueh | RDH |
| Michael | Huhtala | Simpson Gumpertz & Heger Inc. |
| Marshall | Hunt | MBH Associates |
| Dan | Johnson | Beyond Efficiency Inc |
| Denali | Jones | RDH Building Science |
| Christopher | Kelly | LG Electronics |
| Jesse | Kinsell | Efficiency First Solutions |
| Conner | Kisiel | Trane |
| Nikola | Kravik | ASHRAE |
| Jared | Landsman | Integral Group |
| Mark | Lessans | Johnson Controls |
| Paul | Lindahl | Cooling Industry Relations LLC |
| Mark | Macdonald | MicroMetl Corporation |
| Victor | Marinich | Danfoss |
| Matt | Matheny | S&P USA Ventilation Systems, LLC |
| Vrushali | Mendon | Resource Refocus LLC |
| Michael | Milliken | MicroMetl Corporation |
| Sean | Morash | EnerNex LLC |
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| George | Nesbitt | Environmental Design / Build |
| Tom | Paine | ConSol |
| Laura | Petrillo-Groh | AHRI |
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| Ericka | Schoen | Acuity Brands |
| Micah | Seierstad | CalBarrier LLC |
| Bruce | Severance | Mitsubishi Electric |
| John | Sheff | Danfoss |
| Miles | Shinneman | LG |
| Lee | Shoemaker | Metal Building Manufacturers Association |
| Patrick | Smith | Air Treatment |
| Jeff | Stein | Taylor Engineering |
| Nehemiah | Stone | Stone Energy Associates |
| Rick | Taipale | DMG North Inc. |
| Dallas | Terry | Sustainable Investment Group |
| Luis | Tovar | Danfoss |
| Doug | Tucker | Mitsubishi Electric US |
| Bob | Valbracht | Loren Cook Company |
| Martha | VanGeem | N/A |
| Andy | Wahl | Zehnder America |
| Meg | Waltner | Energy 350 |

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| David | Ware | Knauf Insulation |
| Jason | Warner | Emerson |
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| Kurt | Wessels | Trane |
| Rich | Williams | Alliance Green Builders |
| David | Winningham | Lennox International |
| John | Woestman | Extruded Polystyrene Foam Association (XPSA) |
| Robert | Yori | EDSL USA |

Meeting Resources

1. [Agenda](#)
2. [Presentation Slides](#)
3. Submeasure Summaries
 - a. [HVAC Controls](#)
 - b. [Reduced Infiltration](#)

Meeting Notes

1.1 CASE Presentation I: HVAC Controls

1.1.1 Dedicated Outdoor Air Systems (DOAS) (Neil Bulger, Red Car Analytics)

1. Meg Waltner (Energy 350): These savings are compared to a baseline DOAS system correct?
 - a. Hillary Weitze (Red Car Analytics): Yes, the baseline consists of multiple 'market reference' (i.e. typical) DOAS systems.
2. Rahul Athalye (NORESO): If the DOAS serves, say, a south-facing zone and a north-facing zone, with one in cooling mode and another in heating mode, how does the DOAS economizer work? Will it be as effective as economizers on every zone system?
 - a. Neil Bulger (Red Car Analytics): The economizer in DOAS is really set to operate within limits of, say 55 to 75, to bring in air in different configurations. With two different facing zones, the DOAS would just react on outside air limits rather than pinging each space.
3. **Poll 1: Do you agree with these incremental costs?**
 - a. Jill Hootman (Trane): Where did you get costs of the units? What source?
 - b. Mike Fischer (Kellen): I believe it is inappropriate to survey competitors about pricing.
 - c. Dan Johnson (Beyond Efficiency Inc): Pricing for DOAS vs. conventional could be similar with integrated design; however, there is a big incremental soft cost to retrain mechanical engineers.
 - i. Hillary Weitze (Red Car Analytics): Dan, thanks for your comment. We will take design time into consideration into the cost-effectiveness analysis.
4. **Poll 2: Do you agree with this forecast for DOAS buildings?**
5. Henry Ernst (Daikin): The requirement for 150 percent of ventilation. Can you explain how that number was chosen?

- a. Neil Bulger (Red Car Analytics): That was chosen based on the link to economizing. The increased ventilation provides more economizing for mild climates. We have seen systems installed at much higher levels than for the same reason, so we determined that this was an appropriate level for projects today.

1.1.2 Exhaust Air Heat Recovery (Tim Minezaki, Energy Solutions)

1. Will Becchina (Energy Wall): Can you reiterate when economizer is required?
2. John Arent (NORESKO): Is the cubic feet per minute (cfm) threshold judged on the system level, or building level?
 - a. Tim Minezaki (Energy Solutions): These are system level requirements.
3. **Poll 3: This measure originally looked to align with ASHRAE 90.1's requirements. However, based on the high benefit to cost ratio for results (above 4.0 for several scenarios), should we investigate more stringent requirements for this measure?**
4. Will Becchina (Energy Wall): Do costs per cfm include installation?
 - a. Tim Minezaki (Energy Solutions): Yes, they do.
5. Jon McHugh (MEC): Are there climate zones not considered that might be cost effective with California's higher energy rates and lower discount rates than the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)?
 - a. Tim Minezaki (Energy Solutions): If we receive a lot of interest in more stringent requirements, we can analyze those in further detail. We are looking for feedback.
6. Craig Bender (Ventacity): A. Why do you assume only 60 percent heat recovery ventilation (HRV) effectiveness when systems are available with 75 percent (or more) effectiveness?
 - a. Tim Minezaki (Energy Solutions): Neil conducted a market analysis. We wanted to align with DOAS requirements.
 - b. Neil Bulger (Red Car Analytics): The challenge is ensuring that supply air and release air match. This can affect the recovery ratio, even bringing it below rated effectiveness due to air stream balance. While there are great opportunities to enhance efficiency, we wanted to start at a level where we see many products already. Exhaust air heat recovery has not been in the code yet, so we think that these energy savings should be achievable. This is good feedback to consider.
7. Jon McHugh (MEC): 75 percent of outdoor air (OA) is on the bubble in terms of exfiltrated air required to pressurize the building. Should this value be lower? This is in regards to Exception 3 in regards to exhaust air being at least 75 percent of OA.
8. Dan Johnson (Beyond Efficiency Inc): A system would need to ventilate 23 hours per day to exceed 8000 hours per year. In my experience ventilation is shut down outside operating hours.
9. Craig Bender (Ventacity): 8,000 hours is nearly 24 hours per day. Why does ASHRAE use such a borderline cutoff?
 - a. John Bade (2050 Partners): The 8,000-hour table is for 24-hour occupancies such as hospitals, hotels, multifamily.
 - b. Heidi Werner (Energy Solutions): Should we (Statewide CASE Team) consider diverging from ASHRAE's hours of operation thresholds?
 - i. Meg Waltner (Energy 350): Yes, I think you should consider diverging from the ASHRAE hours of operation thresholds if different thresholds appear that they might be cost effective (seems likely based on analysis presented).

- c. Jon McHugh (MEC): Areas greater than 8,000 hours include: hospital, grocery, hotel lobby, hallways in high-rise multifamily, manufacturing, distribution warehouse, airports train stations, police/fire station, mini-mart etc.
- d. John Arent (NORESKO): Similar question on how hours of operation are documented for compliance, for facilities that are not 24/7 operation.
 - i. Heidi Werner (Energy Solutions): We will need to work through the details for compliance verification based on hours of operation. This is a step that needs to occur to translate ASHRAE requirements based on hours of operation to the Title 24, Part 6 compliance verification process. One idea is to apply the requirements to space types that typically operate over 8,000 hours (i.e., see Jon McHugh's list above).
 - ii. John Arent (NORESKO): Over 8,000 is well understood. The table flashed by quickly, but if this is potentially to apply to office or retail, you would have to determine a "typical" operating hours, which may not be easy to define. Even for some 24-hour buildings (hotel, multifamily), there are some spaces that may not have 24 hour occupancy.
 - iii. Heidi Werner (Energy Solutions): Good point on applying exhaust air heat recovery to retail or offices. We will look into this further.

1.1.3 VAV Deadband Airflow (Tim Minezaki)

1. **Poll 4: We believe this to be a no cost measure. Do you agree?**
2. Dan Johnson (Beyond Efficiency Inc): Would DOAS measures apply as an overlay on top of ASHRAE 62.2 (residential) spaces, or just 62.1 spaces?
 - a. Neil Bulger (Red Car Analytics): Just 62.1 spaces though California has their own set of space types. In 2019, the space types did get updated to align by name with those in 62.1.
3. Nehemiah Stone (Stone Energy Associates): Why are savings shown for multifamily but in the next slide - about buildings to which the measure would apply - multifamily is not listed? Referring to last few slides of Submeasure C.
 - a. Shaojie Wang (Energy Solutions): For the VAV measure, ApartmentHighRise belongs to California Energy Commission (Energy Commission) building type colleges.
 - b. Heidi Werner (Energy Solutions): Nehemiah, we used a modified version of the high-rise apartment prototype to evaluate impacts on dorms. We would not be recommending for multifamily. Just using the high-rise prototype to approximate impacts on dorms.

1.1.4 Expand Economizer Requirements (Tim Minezaki)

1. Laura Petrillo-Groh (AHRI): Have you spoken with manufacturers about potential oil management issues with such low compressor displacement (15 percent)?
 - a. Tim Minezaki (Energy Solutions): We have reached out to a number of manufacturers and would like to hear from more. We have not heard of that particular issue so would be interested in meeting to discuss.
2. Laura Petrillo-Groh (AHRI): Regarding cost for economizing on smaller units: cost analysis and impact to California consumer expanding fault detection diagnostics (FDD) and

- economizer requirement from 54,000 to 33,000? Cost should include variable refrigerant flow (VRF)/ductless/geothermal systems.
- a. Tim Minezaki (Energy Solutions): Can you clarify this question? It might make sense to follow up later.
 - b. Laura Petrillo-Groh (AHRI): I wanted to ask what you considered for those costs. Is it simply unitary package equipment?
 - c. Tim Minezaki (Energy Solutions): The costs only include the economizer and maintenance for the package unit. This does not include FDD.
 - d. Laura Petrillo-Groh (AHRI): The proposal impacts these other systems, however, so those costs should be included.
 - e. Tim Minezaki (Energy Solutions): We will follow up later.
3. John Sheff (Danfoss): We have some concerns about requiring 15 percent minimum compressor replacement. Laura also mentioned return on system reliability including low mass flow and low velocity. There are technical issues with turning compressors down that low.
- a. Luis Tovar (Danfoss): As John and Laura mentioned, when we go down to 15 percent there can be quality issues. Especially when the conditions are not proper. We have to address this with development – right now we cannot secure that part of the application at 15 percent.
 - b. Tim Minezaki (Energy Solutions): The code language and ASHRAE use the term “Minimum Compressor Displacement.” Our intention is integrating economizer hours here. If there are two compressors with 30 percent minimum compressor displacement, that would satisfy the requirements. Let us follow up for an offline discussion.
 - c. Jeff Stein (Taylor Engineering): The 15 percent is not per compressor, it refers to the turn-down of the units. Usually there would be four compressors on a unit of that size, so 15 percent would be 60 percent turndown on one of the compressors. Most manufacturers meet these requirements with some of their products already.
 - d. Luis Tovar (Danfoss): When you can go down to 30 percent, that does not work equally when you turn only one compressor down. We need to have a better discussion on these issues.
4. Henry Ernst (Daikin): It is more challenging for most products to meet this than you think. There are other ways to avoid losing integrated economizer hours – with direct digital control (DDC), you do not need to disable the economizer when reducing compressors. This is too prescriptive. Whatever percent cut-off you pick, there will be winners and losers. If you allow other ways to avoid losing integrated economizers you can still be efficient. This might lock out some very efficient equipment that would save more energy than what you are requiring.
- a. Jeff Stein (Taylor Engineering): This is a prescriptive requirement, so it is still possible to follow the performance path. This is the path that ASHRAE and manufacturers went down 10 years ago when this was first introduced. This is simply updating the numbers after 10 years of advancement in the industry.
 - b. Henry Ernst (Daikin): Well, this is significant. I do not know how your energy savings work, but if you are afraid of losing integrated economizer hours there are other ways to do this.

- c. Jeff Stein (Taylor Engineering): Certainly, there could be other ways. If you have any ideas or input please let us know.
- 5. Laura Petrillo-Groh (AHRI): We assume that saving energy is the driving factor behind this proposal, but is there something else you are trying to accomplish? Is there another option that could satisfy your needs while still allowing more design options?
 - a. Tim Minezaki (Energy Solutions): I would be interested to hear from you and other manufacturers what your particular concerns are so that we can address those.
- 6. Heidi Werner (Energy Solutions): The Statewide CASE Team is happy to continue the dialogue with individuals and organization. It sounds like we need to continue working on the economizer recommendations, and we look forward to doing so. This includes exploring alternatives that would achieve similar energy performance.
- 7. Jill Hootman (Trane): As a manufacturer you need to consider the entire picture. Amongst these design changes you are suggesting, we have to redesign units for the California Air Resources Board (CARB) alternate refrigerant and United States (U.S.) Department of Energy (DOE) standard levels, I think you need to consider major product development in compressors staging has to be considered amongst all of these changes
 - a. Laura Petrillo-Groh (AHRI): To build on Jill's comment, please be aware that manufacturers are impacted by COVID-19. Labs are closed, production and design resources necessary to implement this proposal have been impacted. Has the Statewide CASE team considered this?
 - b. Heidi Werner (Energy Solutions): Thank you, Jill. Good point. We aware that COVID-19 is impacting manufacturers and all stakeholders. We are collecting information on impacts so we can help enable informed decision making.
 - c. Laura Petrillo-Groh (AHRI): Heidi, thank you. We are also collecting information to provide to regulators regarding the COVID-19 impact.
- 8. Laura Petrillo-Groh (AHRI): Also, it was implied that there are many products that can meet this proposal, this is not the case. Compressor capacity displacement down to 50 percent is essentially only possible with a variable speed compressor, which is not common under 10 tons.
- 9. Jill Hootman (Trane): Compressor staging would also affect existing buildings, correct? Prescriptive I realize but consideration that in many cases more stages of compressors or more compressors on the whole will drive ampacity of the system up, causing fusing, breakers and wire size to increase required changes to properly protect the building electrically. These increased costs need to be considered, since the market is over half replacement systems.

1.2 CASE Presentation II: Reduced Infiltration (Benjamin Zank, Energy Solutions)

- 1. Dan Johnson (Beyond Efficiency Inc): How is this different from the Section 110.7 mandatory requirement to limit air leakage? "All joints, penetrations and other openings" must be sealed.
 - a. George Nesbitt (Environmental Design/Build): Dan, just because Section 110.7 says that you will do something, does not mean that you will. Testing will prove that.
 - b. Dan Johnson (Beyond Efficiency Inc): Why test in only some climate zones, when Section 110.7 requires this for every building? Statewide CASE Team: current code

- does not allow leakage testing as a credit; we are jumping in one cycle to a prescriptive requirement?
- c. George Nesbitt (Environmental Design/Build): Washington state has no requirement for retesting or fixing when a building does not meet code. I have been trying to get air leakage testing in nonresidential for a decade now!
 - d. Emile Wang (Morrison Hershfield): George - the repairs are required per code, the language may show up later, but contractors are required to make repairs
 - e. George Nesbitt (Environmental Design/Build): If you cannot do better than twice as bad as code, then you need to try harder. And it should not be that hard.
2. Lee Shoemaker (Metal Building Manufacturers Association): I do not understand why the proposed has an "and" for requirements one and two - if you have to do a test, why do the prescriptive material/assembly requirements apply?
 3. Denali Jones (RDH Building Science): For your information, the material/assembly leakage requirements were taken out of the Washington state energy code in the 2015 cycle.
 - a. Benjamin Zank (Energy Solutions): Thank you.
 4. **Poll 5: What should happen if a building retests and has an infiltration rate above 0.60 cfm/ft²?**
 5. Martha VanGeem: ASHRAE 90.1 still allows verification of air barrier.
 6. George Nesbitt (Environmental Design/Build): Whole building leakage testing needs to include the ability to test by floor(s) or sample. The Washington code does not address this. But with tall buildings it's hard to test all at once.
 - a. Martha VanGeem: George ASHRAE 90.1 allows this.
 - b. Emile Wang (Morrison Hershfield): George we agree – we have included allowance for code modification requests.
 - c. Reid Hart (Pacific NW National Labs): The International Energy Conservation Code (IECC) has an allowance for sample testing in buildings more than 50,000 square feet (ft²).
 - d. Benjamin Zank (Energy Solutions): ASHRAE 90.1 also has this exception. We will talk about sampling further along.
 - e. Denali Jones (RDH Building Science): George, this can be done by a code alternate request in Washington. It only applies in very tall buildings which is a small percentage of overall construction.
 7. **Poll 6: Should Title 24, Part 6 offer a continuous air barrier verification alternative? Please explain.**
 - a. Dan Johnson (Beyond Efficiency Inc): Current code prescriptive air barrier requirement (no testing) is not tradable in the California Building Energy Code Compliance (CBECC) software; will this be tradable in 2020 proposal?
 - i. Alamelu Brooks (Energy Solutions): Dan, it is a good question. We are looking into both pros and cons of it.
 8. Lee Durston (Morrison Hershfield): Is building size the envelope area or floor area?
 - a. Benjamin Zank (Energy Solutions): When Pacific Northwest National Laboratory (PNNL) created this formula, they were looking at floor area, but the code is actually looking at wall area enclosing the space.
 9. George Nesbitt (Environmental Design/Build): It is mostly tall buildings that are hard to test as "one" and they are in different phases of construction.

- a. Alamelu Brooks (Energy Solutions): George, the testing will be done after the construction is complete.
 - b. George Nesbitt (Environmental Design/Build): Alamelu; tall buildings are never completed at the same time and sometimes occupied in part while construction continues. Air leakage testing needs to be a credit in the performance method.
 - c. Alamelu Brooks (Energy Solutions): George, we agree tall buildings will be done in phases. We will add a language. Regarding performance credit, we are working on it.
10. Javier Perez (California Energy Commission): Is third party verification being proposed for this measure?
- a. Benjamin Zank (Energy Solutions): Do you mean as alternative or in addition to testing?
11. **Poll 7: Should sampling be allowed for whole building air leakage testing?**
12. Dan Johnson (Beyond Efficiency Inc): Alamelu, I thought anything prescriptive is tradable by definition, thanks.
13. George Nesbitt (Environmental Design/Build): The air leakage tester (independent third party) is probably the best person to determine how to test a given builder.
- a. Javier Perez (California Energy Commission): Who is conducting the testing?
 - b. Benjamin Zank (Energy Solutions): The testing would be conducted by an independent third party.
14. Rahul Athalye (NORESO): The 1.8 cfm/ft² was based on little data and it also depended on what the “with air barrier” level was, mainly intended to capture the difference for savings analysis.
15. Heidi Werner (Energy Solutions): ASHRAE Appendix G uses a leakage rate of 1.0 cfm/ft² for baseline building performance. The economizer control board (ECB) uses the values shown in the slides.
- a. Benjamin Zank (Energy Solutions): We are using a conservative estimate, and a single rate across all climate zones. We are still considering multiple baselines based on climate zones where this might not be a requirement.
16. Rahul Athalye (NORESO): My recollection is that buildings with air barrier requirements but no testing requirements fell somewhere in the 0.40 to 0.80 cfm/ft² when tested. So, the assumption of 0.80 cfm/ft² for a baseline seems appropriate.
17. Michael Hsueh (RDH): I am curious to see what the energy impacts would look like in a scenario where more buildings move towards electrification, including heat.
- a. Benjamin Zank (Energy Solutions): This is something that would be interesting to look at.
 - b. Alamelu Brooks (Energy Solutions): Michael, we anticipate an increase in savings.
18. George Nesbitt (Environmental Design/Build): Meeting the 0.25 cfm/ft² in Washington state has not been much of a problem.
- a. Benjamin Zank (Energy Solutions): Are you suggesting that we reduce below 0.30 cfm/ft² for this proposal?
 - b. George Nesbitt (Environmental Design/Build): I think 0.30 cfm/ft² is okay.
 - c. Reid Hart (Pacific NW National Labs): The U.S. Army Corps of Engineers (U.S. ACE) limit is 0.25 cfm/ft² and is easily met.
19. Reid Hart (Pacific NW National Labs): Note that buildings under 5,000 square feet have a much lower cost, similar to a house.
- a. Lee Durston (Morrison Hershfield): Large building tests do cost more but are a smaller percentage of the overall construction cost.

- b. Kelvin Liu (Morrison Hershfield): Reid, although it is true that 0.25 cfm/ft² is easy to meet for certain building types, it can be challenging for others.
20. Micah Seierstad (CalBarrier LLC): Is the 0.3 cfm/ft² based on conditioned floor area or on area of envelope surfaces?
- a. Kelvin Liu (Morrison Hershfield): Micah, it is based on area of envelope.
21. Michael Hsueh (RDH): Savings for warehouses may be inflated if there are not provisions that account for air leakage through loading docks.
- a. Benjamin Zank (Energy Solutions): You are recommending that we should mandate requirement around loading dock to achieve these savings?
- b. Heidi Werner (Energy Solutions): Good point. Thank you for this recommendation. We will account for leakage through docks in our next iteration of the analysis.
22. Javier Perez (California Energy Commission): Do your incremental costs include hiring a third party to conduct this test?
- a. Benjamin Zank (Energy Solutions): These costs come from those third-party testing agencies.
23. Jesse Kinsell (Efficiency First Solutions): I would support the U.S. ACE standard. They have a very clear, comprehensive standard.
- a. Benjamin Zank (Energy Solutions): This is good to know – they recommend leakage rate of 0.25 cfm/ft².
24. Rich Williams (Alliance Green Builders): Is the building envelope all six sides or five when area adjacent to ground contact?
- a. Lee Durston (Morrison Hershfield): Five sides.
25. Nick Brown: How did cost effectiveness look (energy savings versus cost of testing and improved leakage measures)?
- a. Benjamin Zank (Energy Solutions): We are still developing this. Cost effectiveness is dependent on climate zone and building type, so results have varied. We are still determining which to require testing for.
26. Laverne Dalglish (Air Barrier Association of America): The U.S. ACE has a protocol document which was turned into the American Society for Testing and Materials (ASTM) E 3158 test method.
27. John Arent (NORESKO): Loading docks, even with seals, have a much higher leakage rate than the building envelope as a whole.
- a. Benjamin Zank (Energy Solutions): Thank you, we will follow up with you later.
28. Lee Durston (Morrison Hershfield): ASTM E3158 incorporates the U.S. ACE air leakage test protocol (ALTP).
29. Meg Waltner (Energy 350): Sorry if I missed it earlier, but did you address why the vestibules requirement was removed?
- a. Benjamin Zank (Energy Solutions): We have seen that a vestibule requirement by itself has much lower savings potential than looking at the building as a whole, so we chose to focus on this measure.
30. Mike Fischer (Kellen): Loading docks require a completely different discussion. The question is whether the measurements are evaluated when all doors are closed. It is unrealistic to presume air tightness of dock seals around vehicles. Correct?
- a. John Arent (NORESKO): Correct. The seals help quite a bit but there is still leakage. I have a study with limited testing when trucks are at the docks.

- b. Heidi Werner (Energy Solutions): The Statewide CASE Team investigated potential code requirements for loading dock seals during the 2019 code cycle. The CASE Report is available here: http://title24stakeholders.com/wp-content/uploads/2019/01/T24-2019-CASE-Study-Results-Report_Dock-Seals_Final_with_Attachments.pdf
31. Rich Williams (Alliance Green Builders): Can you discuss feasible technologies for air sealing of buildings?
- a. Lee Durston (Morrison Hershfield): Rich, look up a white paper titled: *Air Tightness in New and Retrofitted US Army Buildings*. The Air Barrier Association of America (ABAA) has a lot of evaluated assemblies: <http://www.airbarrier.org/technical-information/evaluated-assemblies-2/>
32. Reid Hart (Pacific NW National Labs): Seems you should require air curtains where vestibules are removed.
- a. Benjamin Zank (Energy Solutions): Thanks, we will take a look at that.
33. Benjamin Zank (Energy Solutions): From what we have looked at, we have not seen a need to change the materials. This measure would look more closely at how the envelope is put together and focus on education and coordination in the field. Often the air barrier is not included in construction requirements, so construction teams are not aware of penetrations that they are making through this.
34. Jesse Kinsell (Efficiency First Solutions): Lots of exterior products are available, some interior products like Aerobarrier or Ecosseal.

Poll Data

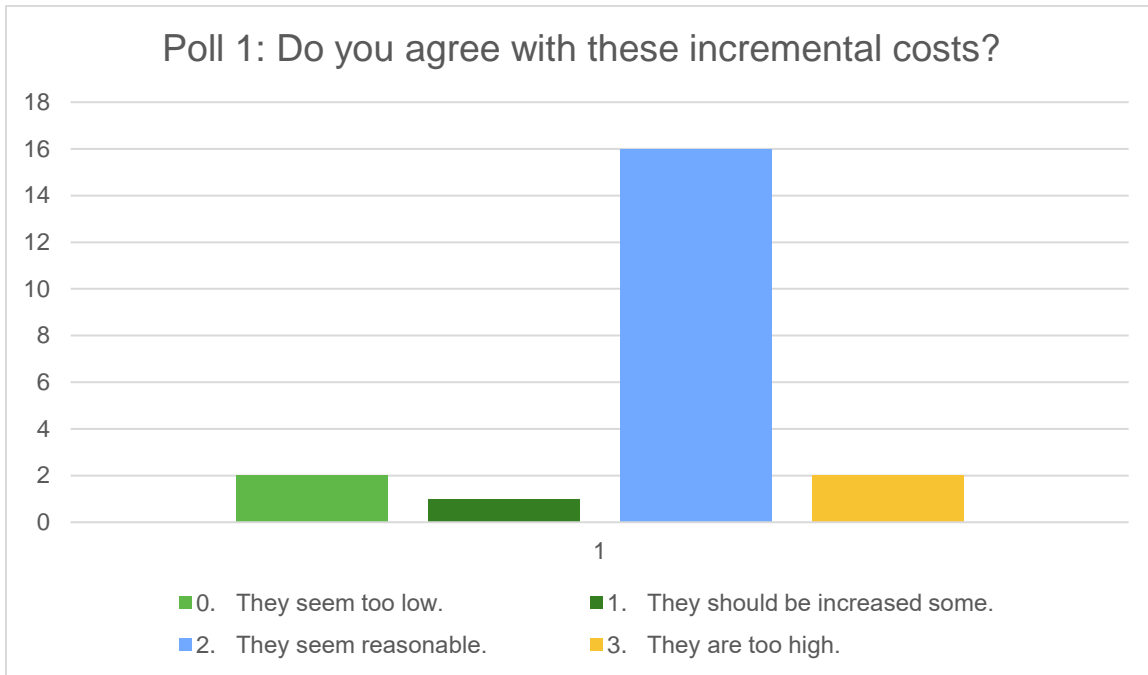


Figure 1: Results of Poll 1, Single Answer

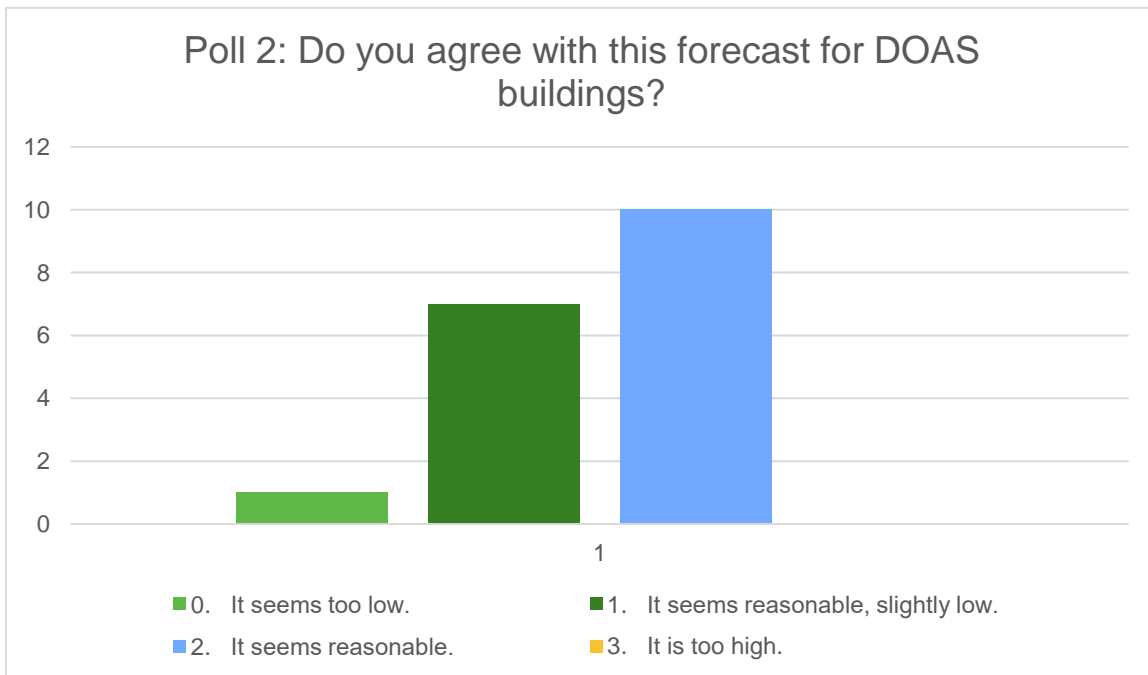


Figure 2: Results of Poll 2, Single Answer