TRANSCRIPT OF PROCEEDINGS

IN THE MATTER OF:)
)
ASRAC FANS AND BLOWERS)
WORKING GROUP MEETING)

Pages: 216 through 421

Place: Washington, D.C.

Date: May 19, 2015

HERITAGE REPORTING CORPORATION

Official Reporters

1220 L Street, N.W., Suite 206

Washington, D.C. 20005-4018

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BEFORE THE U.S. DEPARTMENT OF ENERGY
OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

IN THE MATTER OF:)
)
ASRAC FANS AND BLOWERS)
WORKING GROUP MEETING)

Room 8E-089
Forrestal Building
1000 Independence Avenue, S.W.
Washington, D.C.

Tuesday,
May 19, 2015

The parties met, pursuant to the notice, at 8:15 a.m.

Department of Energy:

STEVE FINE
ASHLEY ARMSTRONG
WADE BOSWELL
PETE COCHRAN
JOHN CYMBALSKI

PARTICIPANTS:

KARIM AMRANE
AHRI

CHRISTOPHER AUTH
Baltimore Aircoil Co.

MARK BUBLITZ
New York Blower Company

LARRY BURDICK
SPX Cooling Technologies

PETER BUSHNELL (Via Webinar)
Carrier

PARTICIPANTS: (Cont'd)

TOM CATANIA
AMCA

STEVE DIKEMAN
AcoustiFLO

GARY FERNSTROM
California IOUs

MARK FLY
AAON, Inc.

DAN HARTLEIN
Twin City Fan Companies

ARMIN HAUER
ebm-papst Inc.

NICHOLAS HOWE
Carnes Co.

SANAEE IYAMA
Lawrence Berkeley National Laboratory

DIANE JAKOBS
Rheem

SAM JASINSKI
Navigant Consulting

TIM MATHSON
Greenheck

JOANNA MAUER (Via Webinar)
Appliance Standards Awareness Project

MICHAEL MCCABE
Ingersoll Rand Corp.

DONALD MCNEIL
Buffalo Air Handling Co.

TRINITY PERSFUL
Clarage Fan Company

ELAINA PRESENT
Navigant Consulting

PARTICIPANTS: (Cont'd)

ANIRUDDH ROY
Goodman

WILLIAM SMILEY
Trane

WADE SMITH
AMCA, International

LOUIS STARR
Northwest Energy Efficiency Alliance

PHILIP THOMAS
Berner Inc.

GREG WAGNER
Morrison Products

MEG WALTNER
Natural Resources Defense Council

ROBERT WHITWELL
Carrier

STEPHEN WIGGINS
Newcomb & Boyd

CHRIS WISEMAN
Nidec

MICHAEL WOLF
Greenheck

P R O C E E D I N G S

(8:15 a.m.)

MR. BOSWELL: Good morning. Welcome to the fourth meeting of the ASRAC Fan Working Group. My name is Wade Boswell and I'm from DOE's Office of Hearings & Appeals and I'm one of the facilitators. For the record, we'll start off as we normally do just going around the room, and if everyone could introduce themselves and identify their organization.

MR. BURDICK: Larry Burdick, SPX Cooling Technologies, representing Cooling Tower Institute.

MR. THOMAS: Phil Thomas, Berner International.

MR. DIKEMAN: Steve Dikeman, AcoustiFLO.

MS. JAKOBS: Diane Jakobs, Rheem.

MR. WAGNER: Greg Wagner, Morrison Products.

MR. HOWE: Nick Howe, Carnes Company.

MR. HAUER: Armin Hauer, ebm-papst.

MR. BUBLITZ: Mark Bublitz, New York Blower Company.

MR. HARTLEIN: Dan Hartlein, TCF.

MR. WOLF: Mike Wolf, Greenheck.

MR. STARR: Louis Starr, Northwest Energy Efficiency Alliance.

MR. FERNSTROM: Gary Fernstrom representing the California Investor-Owned Utilities, who are the Pacific Gas & Electric Company, the Southern California Edison Company, the San Diego Gas & Electric Company, and the Southern California Gas Company.

MS. WALTNER: Meg Waltner, Natural Resources Defense Council.

MR. GOODMAN: My name is Roy Goodman.

MR. WHITWELL: Bob Whitwell, Carrier.

MR. FLY: Mark Fly, AAON.

MR. SMILEY: Bill Smiley, Trane.

MR. JASINSKI: Sam Jasinski, Navigant Consulting.

MR. CYMBALSKY: John Cymbalsky, DOE.

MR. FINE: Steve Fine, Office of Hearings & Appeals.

MS. IYAMA: Sanaee Iyama, Lawrence Berkeley National Lab.

MR. WIGGINS: Steve Wiggins, Newcomb & Boyd.

MR. SMITH: Wade Smith representing AMCA.

MR. MCNEIL: Don McNeil, Buffalo Air Handling.

MR. MATHSON: Tim Mathson, Greenheck Fan.

MR. PERSFUL: Trinity Persful, Clarage.

MR. WISEMAN: Chris Wiseman, Nidec U.S.

Motors.

MR. CATANIA: Tom Catania, AMCA.

MS. PRESENT: Elaina Present, Navigant Consulting.

MR. AMRANE: Karim Amrane, AHRI.

MR. MCCABE: Michael McCabe, supporting Trane.

MR. AUTH: Chris Auth, Baltimore Aircoil.

MR. BOSWELL: Great. Thank you. Unless there are any specific issues people wanted to pick up from yesterday, my understanding is that we're going to start with a presentation by Tim Mathson from AMCA, and I think he's set to go on that.

MR. FERNSTROM: So this is Gary for the California IOUs. Before the presentation I have a question that goes back to yesterday. We had that big Trane rooftop unit on the screen and we were talking about the expense and difficulty of testing the air handlers. It literally was about the size of a train car I guess. And I was curious how the manufacturer specifies the performance of the air handler for architects and engineers if it isn't tested. And I was wondering if maybe Wade could speak to how AMCA, you know, may or may not test fans and blowers of that size.

MR. BOSWELL: And again, if people could identify themselves with their organizations, especially, you know, often -- I thought we did a really good job yesterday of staying more conversational as opposed to, you know, jumping from one topic to the other based on tent cards, but at some point people stopped identifying themselves.

And for the sake of the transcript that needs to be made, it would be really helpful if people remember that. And I'll try to remind people, which I failed to do yesterday.

MR. SMITH: This is Wade Smith with the Air Movement & Control Association. So AMCA owns and operates several labs, two, one in Singapore, one in the United States. And we do, in the U.S., we do over 2,000 tests a year. These are rating tests. So it's not a research lab, it's a performance testing lab.

And the question, I'll sort of break it into two chunks to provide an answer. If we were testing the fan, in other words, if the fan assembly were pulled out of the casing and we were to set it up in one of our chambers and test it, typically what's done is that the manufacturer chooses several representative fan diameters and tests them themselves in order to rate an infinite number of operating points on many different fan sizes. They don't have to test each fan size.

And then if the fan is being certified through AMCA, then if those tests are done in an accredited lab, then there's just a check test that's done, but if not, then basically the entire rating of the product line has to be based on AMCA, tests done in the AMCA lab.

So that's how a fan is rated. I should add that we charge our member companies our cost to do these tests. Trane is a member of AMCA. And, you know, a test like that runs around $3,000. Probably my guess is two or three tests would be necessary to rate the entire fan product line, okay?

We also do tests of air handler fan sections or air handlers, air handling units essentially, and we do those tests under contract from AHRI as part of their certification program. They have a standard called, I believe it's AHRI 430. Isn't that right?

And so, in 430, it's defined what is tested, so I'll just defer to what AHRI 430 says, but nominally, it is the fan section of the unit. It includes some of the components that are inside the air handler but not all. And we test the air performance of that box, which is the fan section, and the ratings for air handling units then are published in accordance with AHRI 430.

And some of the losses, including the system effects associated with the box around the fan, are implicit in the fan performance tables, and losses which are not implicit and integrated into that performance table are considered external to the fan. In other words, you add the static pressure losses of those components. Am I doing this right, Bill?

MR. SMILEY: Yep.

MR. SMITH: So far. Okay.

MR. SMILEY: Good job.

MR. SMITH: Okay. Rooftop units are a little bit different because there's no certification of the air performance of a rooftop unit, so we don't actually test air performance of rooftop units today. If one were to test the air performance of a rooftop unit, you would do something similar to what is done with air handlers. You'd depopulate the unit of its optional devices, right, and then you'd test it without those devices and then the added pressure drop associated with those devices would be included as static pressure losses external to the fan rating, not external to the unit but external to the fan's rating.

MR. STARR: So this is Louis. I've got a

quick question. Louis Starr with NEEA. So by depopulate, you mean things like taking out the --

MR. SMITH: Filters.

MR. STARR: -- cooling coils, the heat --

MR. SMITH: Typically not.

MR. STARR: Okay.

MR. SMITH: But, you know, if they have a two row cooling coil as the minimum, then normally the two row coil would be in the unit, and then if they have a option for a three row coil or a four row coil, the added pressure loss associated with that would be tabled.

MR. STARR: Okay. So you try to find the base unit is essentially what you're trying to do.

MR. SMITH: Right.

MR. STARR: Okay.

MR. SMITH: Right. So I think the comment made yesterday about the difficulty of testing the air performance of the unit is valid. However, the air performance of the unit has to be tested in order for Trane to catalog the air performance of their product, and they do catalog the air performance of their product.

So the risk to Trane in terms of added testing cost is the need to -- if the regulation is written such that there is a dotted line box around the fan, and since Trane, since that fan is not sold as a standalone fan, if the box is drawn around the fan, then the fan has to be -- the performance of the fan has to be determined, and how it's determined is I think a question that's open to discussion, but one way is to remove the fan assembly and its structure and test it in a testing lab. And if we were to do that testing, you know, it would cost a member company around $3,000. We charge more for non-member testing, but for member testing it would be about a $3,000 test.

MR. FERNSTROM: So this is Gary. Thank you, Wade. The energy efficiency performance of the air handlers constitutes a significant end use use of energy and it's important to us, so I wanted the record to be clear about just what the actual cost and difficulty of determining that parameter is. Thank you.

MR. FLY: Wade, this is Mark Fly with AAON. What's the capacity of your chamber or your --

MR. SMITH: I don't know exactly.

You know, Steve?

MR. DIKEMAN: This is Steve Dikeman. I believe it's 55,000 CFM.

MR. SMITH: Yeah.

MR. DIKEMAN: But that's not anything more than, you know, vague memory.

MR. SMITH: It depends on whether the flow measurement is done on the discharge or the inlet of the fan.

MALE VOICE: Right.

MR. SMITH: But I think it's 55 or greater.

MR. FLY: I mean, it depends on the pressure you're testing at obviously.

MR. SMITH: Not so much. We can go up to 20 inches of pressure differential.

MR. DIKEMAN: That's 55,000 CFMs.

MR. SMITH: No, because that's a smaller chamber. Right. So I would add, though, however, you know, our members rate and certify the performance of products that are much larger than we can test and they do that using the fan laws, testing a smaller unit and using the results to rate a larger unit. It's a common practice and well-accepted.

MR. FLY: And that's kind of where I was going, that a lot of this stuff is projected up from smaller units. And even air handlers a lot of times are rated kind of by an AEDM type process, whereas we have a model that fits a smaller unit well, then we'll project it on up to larger units.

MR. SMILEY: So this is Bill Smiley, Trane.

MR. BOSWELL: Actually, if I could turn to Larry. He's been waiting to make a comment.

MR. BURDICK: Yeah. Wade, thanks. I'd like a couple more questions on your test. You said it was $3,000 for a member, one of your members for a test. What is the up charge for a nonmember?

MR. SMITH: This is Wade Smith. I think it's double.

MR. BURDICK: Okay.

MR. SMITH: It's not more than double, so --

MR. BURDICK: Uh-huh. And then the other question is how much more capacity do you have, you know, with your facilities on being able to perform testing? Can you do three times more tests than you do now? Can you do nine times more tests than you do now?

MR. SMITH: Right.

MR. BURDICK: How much capacity do you have?

MR. SMITH: Right. We run one shift, with an occasional second with a reduced crew. Once in a while we'll have one or two guys on second shift. And so the answer is we could double our testing load with no problem.

Look, understand, however, that we're in the business of testing and if, you know, the demand exceeded our capacity to supply, we'd make capital investments to increase our capacity. But we're running at about 50, 60 percent of what we could do at the present time. We have, you know, three air test chambers. We can run many tests simultaneously.

Dan?

MR. HARTLEIN: Sorry. Dan Hartlein, Twin City. I think additional comment to that too is that there is a tremendous testing capacity in the membership of AMCA that is certified lab. I don't know what that count -- I think I saw a number, 50 labs.

MR. SMITH: Yeah. We accredit laboratories outside of AMCA, and we have 50. Actually, I think the total number is 53. But we have 50 member company laboratories which are accredited to do this kind of testing. We have a lab in Singapore which of course is accredited. We own it. And we have two independent, not manufacturer-owned, two independent testing labs, one in Korea and one in France, that are accredited also. So all of those, all the independent testing labs are available to test people's product as well.

MR. HARTLEIN: Yeah. Thank you. And I was going to add, Dan, again that most of us have invested in our own labs because it's more cost-effective to do it ourselves as opposed to having AMCA do that, so that would be why we have our own labs. So the number that Wade gave you is somehow kind of a retail number as opposed to an internal cost to a fan manufacturer.

MR. SMITH: Right.

MR. HARTLEIN: Just to get the numbers right, I would say that test can probably be run for under $1,000 if it's done by a fan manufacturer in an existing lab.

MR. SMILEY: This is Bill Smiley, Trane. Just one comment to what Dan just said. I believe that the laboratories that my company has were not built because we can test cheaper than AMCA or somebody else. It's because we do research and development and it's hard to do that on a schedule in an outside lab with all the other pressures on an outside lab.

MR. SMITH: Yeah. Very true.

MR. SMILEY: So I don't know that we do it cheaper. It might cost more.

MR. BOSWELL: Okay. Okay. So what I'm going to ask is if we can put this conversation on hold slightly. My impression is that Tim's presentation might be useful for the conversation we're having, so I'd like to move into his conversation and then we can pick up after that, okay?

MR. STARR: Well, this is Louis. You know, I think this conversation's actually one of the best ones we've had to date, so I would say we should continue on it just a little bit more. I think what Tim's going to produce, I think most of us already know that on a technical side of things.

But one thing, I do have a question I would like to ask Wade that is pretty important for when they drew the box around the fan, and that's can they project -- my understanding is is sometimes you can just test the fan outside of the air handler and project the performance such that you don't necessarily need to actually test the fan inside of the enclosed -- so you're predicting the performance of the fan just with the fan separately, so you reduce your testing burden down even further, but you can project what the performance of the air handler.

And that's typically maybe even how they do it. They don't actually bring the whole box in there, but they take the fan and they know how the fan's going to perform in the box. But if you could talk about that, that would be pretty helpful I think.

MR. SMITH: Right. This is Wade Smith. So the fan laws are a gift from the good Lord himself that gave us the physics, right, that allows us to rate larger products from testing smaller products, but there are limitations. And some of the components which impact the rating of a fan as applied don't scale using fan laws, but that doesn't mean they don't scale. So a manufacturer who rates a product based on the test of a smaller unit has to figure out mathematically, affirmed by testing, you know, how they're going to -- what that relationship is.

And such relationships are oftentimes proprietary and unique to a particular product line, and, you know, AMCA is not in the business of affirming, at least we haven't been in the past, affirming people's rating schemes unless they're, you know, in the public domain. Now what we do, however, do is we affirm that their ratings are correct.

Even when an accredited lab, like Dan Hartlein was talking about their lab is, and many others have accredited labs, when they bring a product line to market, we still affirm the testing that they did by testing one of the fans that they tested and making sure that the results in our lab are identical to the results in their lab so we know that the rating tests that they did at the time that they did it are, you know, affirmed by third-party oversight basically.

MR. BURDICK: Larry Burdick with SPX. Wade, it was mentioned here too about certain manufacturers have certified labs. Could you go through that process? What's the cost of the certification, and is there annual licensing, or how does that process work?

MR. SMITH: This is Wade Smith. I'm going to correct your semantics just a little bit. When we accredit labs, it's called an accredited lab, okay? So the accreditation process has a cost that, you know, depends on how many trips we make to the lab, depends how well the laboratory is prepared for our visit and whether or not they meet our requirements. It can be as cheap as, you know, 5- or $6,000, it can be as expensive as 20- or $30,000, in that range, to accredit a lab. It depends how many times we go back. And I should add that there are some labs that we've been back to on four or five occasions and they aren't accredited because they just, they don't meet our standards.

Certification, right, is a term internal to the AMCA family which refers to ratings, and the certification of ratings is essentially AMCA saying as a third-party oversight that we've affirmed that what the cust -- what the customer -- what the member company is publishing for air performance is correct within certain limits. I mean, it's not precisely correct, but the imprecision is defined in a standard, the allowable imprecision. So that's called certification.

And if the member has an accredited lab, the certification of a new product line involves one test to affirm the many tests that they did in their lab. They do, however, submit those test results so that we can look at them and assure that they're linked to the tests that we did correctly.

If the member company doesn't have an accredited lab, they're going to rate their product line based on tests that we do in our lab. And, you know, how many fans do they choose to test, that's always an open question and it's a question that the member company decides. The more tests that they do, the more fans that they test, the more precise is their rating.

However, the imprecision, when you're scaling from a smaller fan to a larger fan, the imprecision is always on the conservative side. So why would you pick more fans? So that your fan ratings are better, right? If you pick fewer fans to rate your product line, as you extrapolate to larger units, the resulting ratings that are certified are less than the actual fan will produce.

I should just put one caveat in here. The ability to scale these ratings is founded on dimensional similarity, and in this case, I use the word similarity as the technical definition, which is to say that they're dimensionally similar. So that means that the gap between the fan wheel and the housing grows proportional to the size of the fan.

Fans aren't exactly dimensionally similar, but they're sufficiently dimensionally similar so that this rating scheme has been proven in many, many, many, many check tests. When we rate a product line or when the member rates a product line, they do it based on testing a few sizes, but then when we do check tests, which we do every three years, okay -- so we pull a fan on certified products every three years to test in our lab and we never pull the same size we tested previously. We try to pull an untested side, size. So, when we pull an untested size, it is in part an affirmation of the fan laws that were used to rate that size. Is that okay?

MR. WHITWELL: This is Bob from Carrier.

Just wanted to add one other thing to the -- you talked about the costs of the tests being 3- to $6,000 or something like that, which is in many cases much, many times less cost than the equipment itself would be. So, you know, let's just not think that we've got the test expense. There's also the expense of the equipment under test --

MR. SMITH: Right.

MR. WHITWELL: -- which can be substantial.

MALE VOICE: And shipping.

MR. WHITWELL: Shipping. I mean, we could be talking about approaching $100,000 for some of this stuff.

MR. STARR: You could get your lab -- this is Louis Starr. Although like if you're a big enough company you can probably just get your lab certified. You won't need to ship it anywhere, right?

MR. WHITWELL: Although I'm wondering, if we're talking about lab certification, I don't know if that's really a requirement, to have a certified lab, right? I mean, we test, do a lot of testing for other energy efficiency metrics, right?

MR. STARR: Well, what I meant was is that for AMCA's purposes, they could come and certify your lab, it sounds like, if you had a sufficient thing.

So you would need to -- if -- so obviously I would say someone the size of Carrier it's probably not going to be a problem for. I would envision that you would certify your lab to AMCA standards.

Now it would be a question of what ends up getting negotiated as far as, you know, the ultimate --

MR. WHITWELL: I mean, we've got to see what the test procedure's going to be and everything, right? And again, I haven't heard anything or seen anything in any of the publications talking about anything as far as certification of labs as a requirement, so --

MALE VOICE: It's coming next I think, right?

MR. WHITWELL: Thank you. I don't think so. I mean, I don't know.

MR. STARR: Well, I was thinking it would be a similar -- well, you know, actually DOE would be the better ones to comment on that.

MR. WHITWELL: So I guess, you know, let's see what we -- because you mentioned that you already know about it. So some of us have not seen this material yet, right? So --

MR. STARR: Yeah. Well, I meant this is

more about systems. It was less about what we're talking about. But it's more about fans and the opportunity to save energy, but yeah.

MR. AUTH: I just have one comment. Chris Auth, Baltimore Aircoil. I don't disagree with the geometrically scaling and the rating of fans. This is just a comment regarding the costs associated with testing fans.

You know, what we deal with is much larger fans usually and they have special manufacturing processes that aren't typical to, you know, the fans that are tested, that AMCA tests, typically sheet metal or cast type of fans. We're, you know, hand laid fiberglass or extruded aluminum. And to be able to build a fan to be in the say 55,000 CFM limit, that would not be in the product line of our suppliers or even if we made them ourselves. So we would have to go to a modeling shop, make a special fan, and the associated costs to that, I'm not sure, but I would expect it would exceed probably the test cost.

MR. FERNSTROM: So this is Gary. Thanks for giving us the opportunity to talk this through.

MR. BOSWELL: Okay. So I think we're up to Tim's presentation. And I realize I neglected when I was asking people to identify themselves for the record, I think we have at least one working group member that's participating by the web with an open mic, so if I could ask any working group members participating via the web to identify themselves by name and company.

MS. MAUER: Hi. This is Joanna Mauer with the Appliance Standards Awareness Project.

MR. BOSWELL: Thank you. Any other?

(No response.)

MR. BOSWELL: Great. Okay. Thank you.

Tim?

MR. MATHSON: Okay. Tim Mathson from Greenheck Fan. As mentioned, I guess a lot of you have been exposed to this metric that we're proposing, that AMCA's proposing to use for this ruling, but there are some that haven't and especially some of the AHRI folks, and I want to make sure that everybody at least has a view of that and hopefully you can understand how we can use this in your products.

This slide is not quantitative at all. It's just what we recognized as the issues that go into saving energy in air systems and just to get them out on the table. And why this is important, kind of the background, we understood going into this that if we simply look at one of these pieces of the pie, like fan efficiency, we probably won't have the impact that we want to have, because if we just look at peak efficiency of a fan curve and we increase that, there is a great dependence on this fan selection pie. The size is significant there.

Somebody mentioned yesterday that we don't sell fans to building owners who pay electric bills, so there's not a lot of motivation in that fan selection part of the pie. The people who are buying fans, let's say mechanical contractors, are concerned with price and cost, those two things, not efficiency. And so those kind of fight the battle with efficiency.

So if we in our effort to increase fan efficiency add cost to the product, we're likely to have people selecting smaller fans yet or less expensive fans yet further away from that peak and ultimately not saving energy. So that's just the background of this.

MS. JAKOBS: This is Diane Jakobs. Could I just ask a question about the pie chart?

MR. MATHSON: Yes.

MS. JAKOBS: You said it wasn't quantitative. Does that mean system design potential is not equal to system effect and system leakage potential?

MR. MATHSON: We don't have any data to back this up.

MS. JAKOBS: Okay. So you just drew it.

MR. MATHSON: We know that they are somewhat proportional to their impact.

MS. JAKOBS: Okay.

MR. SMILEY: Bill Smiley, Trane. I have a follow-up question to that.

MR. MATHSON: Yeah.

MR. SMILEY: So, if you said there 100 percent equals the potential savings, is that representative of what you believe each of those pie sections is worth?

MR. MATHSON: Yeah. Yeah.

MR. BURDICK: This is Larry Burdick.

MR. SMILEY: So, and --

MR. BURDICK: I -- go ahead.

MR. SMILEY: No, go ahead.

MR. BURDICK: This is Larry and I would disagree with that. You know, one of the points that I brought up yesterday is that system design's much more of interest for the heat exchanger, or what the heat exchanger can contribute to the system dwarfs any of the other sections or items that you have listed there. And I think this slide's real dangerous to present to the public, you know, without the caveat that you've identified there, you know, that it's just a representation of maybe the possible effects of a fan system but should not be construed as percentages or capabilities of each particular section.

MR. MATHSON: Okay.

MR. SMILEY: Yeah. I would suggest just a list rather than a pie chart because the implication of that is that fan efficiency isn't very critical and system, you know --

MR. WHITWELL: I mean, it also says that fan selection is the biggest opportunity and I think that while that may be true in some cases, I think in the case of the HVAC equipment, I don't think that there's that much that can be done across the board to change the fans, the fan types used and improve the efficiency a lot.

MR. STARR: So I think what he's referring to is systems that --

MR. BOSWELL: Again, please remember to identify yourself.

MR. STARR: Oh. Louis Starr with NEEA. The system he's referring to is the air system, so I don't think he's talking about system in the sense of the air handler, right? Or the --

MR. MATHSON: No. Yes. Yes, air system. Yeah.

MR. STARR: So this is the ductwork and everything. So it's not -- you're thinking of design as in your air handler and actually what he's talking about is design of the air systems downstream of a fan and not so much really a -- he's not thinking -- this was really not about air handlers. It's more about fan and fan systems that are not --

MS. JAKOBS: So this is Diane Jakobs. So you're only talking about ducted systems?

MR. STARR: That's what -- I think that's what you're referring to essentially. And, well, and also, you know --

MR. WHITWELL: But --

MR. STARR: -- warehouses and things like that.

MR. MATHSON: Well, for that part, yes. System design? Yeah, that would be ducted systems. Yes.

MR. FERNSTROM: This is Gary. So I think the point of confusion here is the fan folks are talking about the air distribution system in buildings, you know, be it what it is, and the heating and refrigeration folks are talking about the fan selection and performance within the unit.

MR. WHITWELL: Yeah, but I would still say that I still question fan selection being the largest element here. So even applied in the building, I'm not sure that you're going to make much energy savings by changing the types of fans that are used.

MR. FERNSTROM: Well, this is Gary again. Our perception is that the energy use associated with ventilation, air movement within the building, is just about equal to the energy use associated with the heating and cooling equipment, so the fan selection as it relates to air distribution within the building is a very important factor with respect to energy use and savings.

MR. WHITWELL: No question there's a lot of energy used to move the air around the building. I think -- let's back up. This chart, we should get rid of this chart and list the things that --

MR. MATHSON: Okay. Let me -- okay. Let me just --

MR. WHITWELL: I agree with the list, but I question whether changing the fan selection in doing it is going to --

MR. SMITH: Can I, Tim --

MR. MATHSON: Why don't you go ahead.

MR. SMITH: -- just one, for a second? This is Wade Smith. Okay. So I'm the guy that made the chart, okay? So this is a perception, the consensus of AMCA members, about where the gold is to be mined for energy efficiency in air systems. The fan selection matters much more than the air dynamic shape of the fan. So just to not be confused by what we're saying here is fan efficiency, meaning changing the aerodynamic shape of the fan, is a small piece of the puzzle. Drive efficiency is another small piece of the puzzle not to be overlooked. It's a significant chunk.

Fan selection matters a lot and we can, did actually, when we presented this, demonstrate exactly what the difference is by looking at the fan selection output of any of our members' selection programs which for a given flow and pressure differential will pump out five, six, seven fan selections. And the power consumed by those, to pick a number, five fan selections varies by a factor of two, which is to say that the least efficient fan will use twice as much energy as the most efficient fan.

And then we look where does the market actually select these fans. We created a database representing 46 percent of the American market to test that question, and they are selected generally very close to the least efficient of those five selections. So the potential for savings by altering selections absolutely overwhelms the potential for saving by changing the aerodynamic shape of the fan.

And if you think about aerodynamics, if you're a molecule of air running through the fan, if you go through the fan at half the speed, there's much less turbulence created, and that's the consequence of selecting a larger fan. So it's not wrong. It's not wrong.

Now, in the context of an air handling unit or a rooftop unit, when you put a larger fan inside a given casing, what you gain in fan efficiency you might lose in casing losses. But why is the casing size fixed?

So again, fan selection matters a lot, system design -- this means the air system design, the size of the components, the pressure drops through the system -- matters a lot, system effects not just in and around the fan, but system effects within the duct system matter a lot.

And the point of this chart is not to say that we shouldn't tackle fan efficiency or drive efficiency or fan selection. It's to remind ourselves that the goal is not to boost fan efficiency, the goal is to save energy, and there's a lot of energy to be saved from all of these one, two, three, four, five, six areas.

System leakage. What percentage of the air sent into the ductwork doesn't arrive at the diffuser?

MR. WOLF: So, guys, this is Mike Wolf. If I could for just a second. You know, one thing I think we're all in agreement is this regulation is not going to regulate the building.

So, you know, to kind of get back on topic here, Ashley sent me a request last night asking if Tim would, you know, do this presentation this morning. I volunteered him to do so without consulting him ahead of time, so kind of putting him on the spot here.

And with that said, you know, the intent, I think, of what Ashley was looking for, probably due to some of my feedback to her, was in participating in the various discussions, you know, the last NODA that just came out introduced a new, relatively new metric to some of us, this FEI. AMCA refers to it as FER. Previously it was referred to as PBER.

So anyway, I think what Ashley was hoping to accomplish this morning and have Tim do is just kind of give an overview of the FER metric that's in the latest NODA so that we're all at some kind of baseline foundation of understanding what that metric is.

Relative to this chart, we could probably debate this forever, you know, and not have any hard data to back it up. You know, it's good discussion, I think. I don't think it's that far off with regard to air systems personally, but I guess I would agree, you know, we probably should just set this pie chart aside for the moment.

And, Tim, if you could maybe --

MR. MATHSON: Yeah.

MR WOLF: -- just get into the FER, you know --

MR. MATHSON: Okay.

MR. WOLF: -- technicalities of the rating, I think, or the metric, that would be good.

MR. MATHSON: Okay. And one last comment. I guess when we started looking at an efficiency regulation we started talking about fan efficiency grades, FEGs, which address this one part of the pie, fan efficiency. They don't address the drive efficiency. They don't address fan selection. And what we think we have ended up with is something that addresses each of these three, however big they may be, addresses each of the three.

MR. HARTLEIN: Tim, Dan Hartlein, Twin City. I also wanted to add that that left half of that chart is more than a thumb in the wind analysis because we did look at a lot of membership data in getting to the assumption of what was happening from a selection practice in the industry overall in looking at the potential savings, looking at that large data set that we were able to compile for a year of shipment.

So I think that I would believe that that left half of that chart is probably pretty good. It's pretty representative. Better than, and databased better than perhaps the right half, which was more of where the, you know, the data just doesn't exist in the industry. So we did our best, but --

MR. MATHSON: And it may not be for certain products. Dan, you mentioned --

MR. HARTLEIN: Right.

MR. MATHSON: -- process fans where you're building fans to the peak efficiency and they're running at that point.

MR. HARTLEIN: We actually have an issue in the larger fans, and we do fans that, you know, will go to 15,000 horsepower in some of our division, one of our divisions. And in the larger fans you have the exact opposite problem. What happens here is that conservative design, on top of conservative design, on top of conservative design. Nobody wants a power plant or boiler system to miss its guarantee points because they were short fan.

What they end up doing is buying way too much fan to be sure and closing dampers. And we know that's a lot like driving your car with the foot on the brake, right? It doesn't help from an energy perspective.

Variable speed and variable frequency drives cures a lot of those ills, so that's a place where we can go in that end of the industry for gains. But, yeah, you're right, on the other end of the business it's the exact opposite problem from a selection perspective. So, but that would be in that selection chart as well. Thank you.

MR. WOLF: So, Tim, if I may. Mike Wolf, Greenheck. Just, I can't resist now because Dan opened the door. On that other end of the spectrum, we've done a lot of research in our company as well with regard to fan selection. And as Tim kind of alluded to, you know, the metric that he's going to be sharing with us is really an eloquent way of working fan selection into the metric because what we found is that in many cases -- in fact, Tim, you presented, I think you did a forum at an ASHRAE in Dallas, was it, on this subject?

MR. MATHSON: Yeah.

MR. WOLF: And you did a scatter diagram of all the fans that we had sold for a year over the various ranges of operation, and the number of times that there was a more efficient fan available for a given selection was a large percentage of the time.

And, you know, I don't know if any of you are familiar with the ASHRAE forum process, but it's basically an open mic. I mean, people can come up and say whatever they want to without any, you know, substantiation. So Tim does his presentation and this engineer comes up and he goes, so help me understand why all these engineers are making such stupid selections. And I found it kind of amusing because apparently the guy has never heard of something called bid day. You know, I think I had to just hold myself in the chair to not get up and comment.

But, you know, the reason it's happening is the engineer will specify, he'll put a schedule together, specify his fan and then put it out for bid, and every contractor, every manufacturer, you know, they're scrapping to get that job, and largely what happens to get that job is you need to be the low bidder, and to be the low bidder you select the smaller fan. And I think Tim will probably have some slides in here that show the difference in size --

MR. MATHSON: Yeah.

MR. WOLF: -- how it affects efficiency, you know, and what we found, if you just would bump the fan up a size or two, you know, the fan will run very efficiently, but that fan's going to cost more, so the guy, you know, at bid day selects as small a fan as he can.

And a lot of times it'll probably be outside of the engineer's specification, but he worries about that later, you know, and he'll a lot of times be able to get that smaller fan approved because, you know, the time constraints on the schedule of the building. Well, you know, I've already got, you know, we're three-fourths done, or, you know, with design drawings and I can't go back and change it now, so, okay, good enough. It's such a small element in the overall construction process that, you know, it ends up we end up getting very poor selections and very minimally optimized fan selections on a lot of our projects.

So, anyway, sorry, Tim. I'm done now. Go.

MR. MATHSON: Okay. Fan efficiency ratios.

Now FER in this presentation that AMCA has presented is not the same as FER in the NODA that just came out. They switched the terms around a little bit. So just so everybody understands that. This would be closely related to the FEI that's mentioned in the NODA. FEI.

And in this whole presentation, I'm going to talk about power in terms of horsepower, shaft power. Eventually this will get into an overall efficiency metric, in other words, wire to air, but it's much easier to talk about in terms of shaft power, so that's what this is going to show.

So it's a ratio of fan efficiency to a baseline efficiency, and this is a value that is calculated at every flow and pressure point. The fan efficiency, everybody knows how that's calculated at a certain flow and pressure. The baseline efficiency is also calculated at that same flow and pressure. It's a function of airflow and pressure. So it varies along a fan curve, the FER does, the value of FER. It's independent of the fan type or category. We talked about fan categories here. There are only two test, two different I'll say categories, test configurations, ducted and nonducted.

And like, Bill, you said yesterday, we're talking about the discharge. It doesn't matter whether it's ducted or not on the inlet side. So whenever we write this we should write it ducted on the outlet, but when we talk about it it's easier just to say ducted and nonducted.

And if you think about this baseline efficiency as a minimum allowable efficiency, which it is going to be most of the time -- there may be exceptions to that -- then the value of 1.0 means that you meet the efficiency. Anything greater than 1.0 is you would exceed the baseline efficiency.

Okay. So here's a fan curve, pressure curve, power curve. We can plot an efficiency curve. And the whole reason that we're talking about this is the shape of that efficiency curve and how it goes anywhere from zero to a peak value, and where you are on that efficiency curve really determines how much energy is going to be consumed by the fan.

So, but with these same variables, pressure, airflow, and power, we can calculate the fan efficiency ratio, and it is a curve, like I said, that varies along the fan curve. Should rise up to some peak and drop off some. And what we want to do is identify the area of that curve that is greater than 1, and that becomes the allowable selection range, okay? So we want to define a range on this fan curve where manufacturers can actually sell the product or portray the product, its performance. Yes?

MALE VOICE: This based on total efficiency? Because you don't have zero efficiency at --

MR. MATHSON: Both. It's based on total efficiency for ducted fans and static efficiency for nonducted fans. So I'm just using it in a generic sense right now. Oh, okay. That's the next slide.

So ducted fans -- and this may be a whole separate topic to discuss because this is different from the NODA -- ducted fans can use both the static and velocity pressure to overcome system losses and should be selected using total pressure, and total efficiency then would be the correct measure. Should be selected using total pressure. Most of the time that does not happen, but should be.

With nonducted fans, any of the velocity pressure at the fan discharge is dissipated, making it unusable for further work, so nonducted fans must be selected using static pressure, and therefore, static efficiency is the more appropriate measure. Again, that could be a whole separate discussion.

So the baseline efficiency, the bottom of that ratio, so a baseline or minimum efficiency varies with airflow and pressure. These are lines of constant efficiency, increasing as you go up in airflow and up in pressure. So this is one way to look at it.

At reduced or at -- airflow is proportional to fan size essentially, so larger systems are to the right. And pressure can be thought about as increasing fan complexity. You know, to develop higher pressures you need to add things to fans, like scrolls or straightening vanes or different things. Those increase the efficiency at higher pressures, but they decrease the efficiency at lower pressures. So this pressure component here is really to get rid of fan categories so that we can use the same metric to talk about prop panel fans that we do for centrifugal blowers.

Another way to look at this same thing is a 3D plot here, airflow and pressure. And this baseline efficiency again takes on some shape here. And anything above this surface would be FER greater than 1, anything below it would be less than 1.

MS. JAKOBS: Excuse me. This is Diane Jakobs from Rheem. And just, it's probably a dumb question, but where does this relationship come from? So you're drawing curves. Is it something tested? Is it fan laws?

MR. MATHSON: Yeah. This baseline -- so this baseline is a function of airflow and pressure. The airflow part of it --

MS. JAKOBS: No, I can see it's a function of it.

MR. MATHSON: Yeah.

MS. JAKOBS: But where do you get it? Where did --

MR. MATHSON: Where did it come from?

MALE VOICE: It's a derivation.

MR. MATHSON: Well, the airflow relationship is exactly the same as the original FEG curves, and that reflects how fan efficiency drops off with smaller fans.

MS. JAKOBS: So did you test 1,000 fans and this is the result or?

MR. MATHSON: Yeah. Essentially, yes. Yeah. It's based on what's available on the market.

MS. JAKOBS: And how it performed on the AMCA 210 test?

MR. MATHSON: Yes. Yeah.

MS. JAKOBS: So just a straight duct or a straight -- the airflow is straight, right?

MR. MATHSON: No. Any different type of fan. There were many fans that we plotted the peak efficiency versus the fan size or the airflow and that took on that shape.

MR. STARR: So this is Louis with NEEA. The basis is the brake horsepower equation is what it is. And essentially they've added some scalers by looking at their fan selection. So they take the brake horsepower equation and put a scaler in for the flow and put a scaler in for the static pressure, and then the ratio of a baseline fan is one to the other. So it's really just using the brake horsepower with some scalers added in is the basis of the FER.

MR. SMILEY: Bill Smiley, Trane. Just a quick question, Tim. So you had a significant amount of data that you used to develop the numerical values of all this stuff and that significant amount of data was based on using every fan type you had data on, which would have been airfoil, BI, BC, radial, axial.

MR. MATHSON: Yes.

MR. SMILEY: And that's probably about it for AMCA. So it doesn't really have FC fans in there, it doesn't really have panel --

MR. MATHSON: FC fans, yeah.

MR. SMILEY: It does?

MR. MATHSON: Yeah.

MALE VOICE: Everything.

MR. SMILEY: So, so, and then the result of that would be a huge, wide curve of data.

MR. MATHSON: Right. Right. Right.

MR. SMILEY: And what you did there is you took this wide curve of data and you said here's the curve we're going to assign to all fans and make it the same for everything.

MR. MATHSON: That's right. That's right.

MR. SMILEY: Is that basically what you did?

MR. MATHSON: Yeah.

MR. SMILEY: Do you have that scatter chart that shows here's the range, or do you get into that a little bit later?

MR. MATHSON: No.

Go ahead, Wade. I'm having a hard time. It's not as simple as that.

MR. SMITH: Right. So it all started with FEG. When the committee was working on what the FEG formula should be, there was a recognition that smaller fans are less efficient than larger fans, right? And so the fan committee, the fan engineering committee did scatter plots of different fan types to determine what that relationship was and then reflected it in the family of curves which define the fan efficiency grade.

And what you do is you take the fan efficiency and diameter and you go into that chart and then you figure out what the FEG is. And the shape of those banana curves, so to speak, is reflective of those scatter diagrams. Those scatter diagrams are all fan types on the same diagram with a curve fit, okay?

MR. SMILEY: So a least squares fit?

MR. SMITH: Well, yeah, essentially. So there's two -- this was FEG and the FEG curves were much debated for years, yeah, and adopted. So, when Tim crafted this approach, he used those curves to deal with flow. And the shape of this curve, if you were to make a slice through it -- he's got it on the screen right now -- and just look at baseline efficiency versus flow, you'd see it's the FEG curve.

He did the same thing with pressure, okay, and the idea of creating a diminished requirement for smaller pressures, that's how the constant is added into the formula. The idea of creating a reduction in the required efficiency for fans operating at lower pressures was an accommodation for the lower efficiency that's implicit in low pressure operation. And the types of fans optimized to minimize the power consumption at low pressures also diminishes the peak efficiency of that fan.

So there's a pressure constant of 0.4 in this equation and there's a flow constant of 250. The flow constant mimics the FEG curves. The pressure constant is a recognition and an accommodation to fans designed specifically for operating at low pressures to reduce their efficiency requirement. And there's a tradeoff. As you reduce the efficiency requirement for fans operating at low pressure, in order to generate the savings from any particular regulatory level, you've got to boost the efficiency requirement at the higher pressures, right? And so the membership debated at length what accommodation should exist, okay? And so they did this with the benefit of a lot of data in front of them.

But to say it's a curved fit is not correct. It's the consequence of a debate which intended to diminish the efficiency requirement of low pressure applications vis-à-vis high. The other one is, after years of debate about FEGs, is simply an extraction of that relationship. So now we have a three-dimensional curve, right, that has both of these things at work.

MR. AUTH: Chris Auth, Baltimore Aircoil. I have two comments.

One is, it goes back to yesterday with the whole discussion with the embedded fans. So this whole database as I understand it is an AMCA database. So I don't have a clear understanding of that database, how many embedded fans would be represented in it. I know our products, the percentage is probably close to zero. I would suspect it's maybe higher than that for smaller fans, but I would suspect it's a pretty low number. You know, I'm not doubting, you know, the fan types we use are similar. I'm just saying that database doesn't represent a good sample of embedded fan types that are used today in the market.

And the second point I have is it goes back to -- you know, it's the thought that sometimes people would select a less efficient fan to save money, to lower costs. That's not always the case. There's some -- you know, engineering, you know, it's not just about efficiency. There's also like one -- one big example would be sound. We use fans that are less efficient that, you know, cost us several times more than the most efficient fan, but we use it because of sound for our customers. They have a sound limit that they have to have. So that's just one point I want to bring up.

MR. MATHSON: Steve.

MR. DIKEMAN: Steve Dikeman. I'm going to argue with Tim, but I'm saying it with a smile on my face. This graph right here illustrates a particular set of inputs illustrating where FER is greater than 1 or less than 1.

MR. MATHSON: That's right.

MR. DIKEMAN: Right? And so now, as we look at different fan categories, classes, the target efficiency might be different, probably will be different. So, if you were to go draw another graph with a different target efficiency, it would move up and down in the vertical axis where you meet 1.0, exceed 1.0, or fall below. So this isn't -- it was compared against our database, but this is just one individual set of inputs. Your target efficiency in this graph is a single number, correct?

MR. MATHSON: Yes. Yeah.

MR. DIKEMAN: And so, if you had a different target efficiency for a different fan category, that graph would change.

MR. MATHSON: That's correct.

MR. DIKEMAN: That's the simplicity and the subtlety of FER. If this fan category has this target efficiency and if you took the baseline efficiency off your graph, now it would apply to the conversation we're having. You've made an individual input to create this graph. You know what I'm saying?

MR. MATHSON: Yes. Yeah.

MR. DIKEMAN: So, for a different fan class with a different target efficiency, it wouldn't go up to 63 percent baseline. It would be higher or lower. Target efficiency changes with fan class, category, whatever the correct moniker is for that.

MR. MATHSON: Okay.

MR. DIKEMAN: 1.0 and higher is a compliant product.

MR. MATHSON: I want to say something else to maybe help lighten the -- so that maybe you're not quite as afraid of this as you are.

If you are personally looking at fan selections, you're probably exceeding this significantly, okay? If you are a mechanical contractor, you may not be exceeding this, okay? And Wade talked about the database. We looked at all the different fan types that were in the database and if we put this surface here let's say, we get let's say 20 percent of the fan selections were below this surface for this fan type and for this fan type and for this fan type. We tried to match up so that, you know, the same percentage would be below this curve that would be above, and like I said, it's a small number and if you're paying any attention to the fan selection, you're probably well above this surface.

MR. JASINSKI: So, Tim, I'm just going to interrupt for a second. I think this is a good conversation and it's important to understand what assumptions and ultimately what data went into the approach that's being presented, but I think maybe what we should try to do is get a little bit further into this approach because I'm worried that even though they're related that we might be debating FEG, and that's not what we are here to do. We want to talk about the merits of the approach later on.

I think the message being sent here is that there is a relationship with efficiency and airflow and pressure. You can't just set one efficiency target at all airflows and all pressures because the way fans work, there are -- you know, it's inherently -- fans are inherently less efficient across a range of airflows and a range of pressures.

So, if everybody is in general agreement about that, not the quantitative aspect but maybe just the qualitative aspect, I think that's going to play into how the metric is structured, and then once we get to the actual metric being discussed then we can say okay, well, for the mechanisms in the metric, in the FER or the FEI metric being discussed, let's look at the data that goes into that and we can tweak those factors or those aspects of that metric as opposed to all the stuff leading up to it.

So let's get to the end and then work our way back maybe a little bit. I think that would be a better way to approach this.

MR. MATHSON: Wade, you have something to add.

MR. SMITH: This is Wade Smith. I just want to respond to the question about embedded fans. No, there are many embedded fans in the database. And the other point that you asked about I think also deserves mention, and that is that we did not focus on nor seek to include forward-curved fans that were in regulated unitary equipment because at the time that we pulled the database together we were of the belief that they weren't, you know, part of the rulemaking. So there are a lot of embedded fans missing, right, because we didn't look at that group, but we did go back to our membership and affirm that there are lots of fans that they sell OEM which become embedded that are included in the database.

With respect to cooling tower axial fans, the answer is that we've got lots of axial fans in here, lots of prop fans, lots of panel fans, but I don't think too many of them truthfully went into cooling towers. So I think to the extent that we acknowledge, I think it's important to acknowledge that we don't have a lot of cooling tower fans in here and we don't have a lot of fans that are embedded in regulated equipment in the database, but we do have lots of embedded fans.

MR. MATHSON: Okay. So the FER can be, as I said before, the ratio of fan efficiency to baseline efficiency. It can also be flipped over and talked about in terms of power because they're the same variables here. So the same fan efficiency ratio is a baseline power or in this case it would be a maximum power, allowable power, divided by fan input power. That's a little bit easier to work with.

So here's the form of the equations. Like Sam said, this is just to get us going here to understand them. For fans tested with a ducted outlet, the total efficiency, the baseline total efficiency is some target value, and Steve mentioned this determines the height of that surface curve. There's an airflow factor and a pressure factor, and the Q-naught and the P-naught are constants that are in these equations. And then for nonducted the whole thing is done in static pressure and static efficiency, same form.

So that's the form of the equation. Again, the values in blue are constants, and these are some of the constants that we think are real good. The target efficiencies, again, have yet to be established, and --

MR. DIKEMAN: That's what this meeting is about.

MR. MATHSON: Yup.

MS. JAKOBS: So this is Diane Jakobs from Rheem again. So, just to be clear, 250 and .4 are constants selected by the AMCA committee members? Okay.

MR. MATHSON: Yes. So this is just a little --

MR. WOLF: Tim, this is Mike. I've sort of waited. It wasn't just AMCA, right? We did this with the energy advocates. Were they part of that process as well or no?

MR. SMITH: This is Wade. Yeah. I mean, the big debate was amongst AMCA members to decide what to recommend, and then we had to explain why and what the impact was and why the numbers should be higher or shouldn't be lower. So I'm not sure. Did the consensus comment that we made to the NODA, did it include these constants? I believe it did.

MS. MAUER: This is Joanna. I don't think it did. I think we said that -- we had open discussions about it, but not an agreement.

MR. SMITH: Open to question, yeah.

MR. FERNSTROM: So this is Gary. The efficiency advocates were part of the discussion where this concept was presented, and to the extent that it addresses a little broader system approach toward application we were in support of it, and it follows the same line of thinking that the Hydraulics Institute utilized for pumps based on the European pump standards work.

MR. ROY: Aniruddh Roy, Goodman. I have a question for either Tim or Wade. If you can just go back to the previous slide on the constant. Just following up on Diane's question. So since the sample size did not include forward-curved impellers, would the constant change if they were included in the data set to determine the equation?

MR. SMITH: This is Wade. It did include forward-curved. It did not -- we made no effort to try and include forward-curved fans that are embedded inside regulated unitary equipment. So your question then would be if those were included, yeah, would the numbers change. I really doubt it.

MR. MATHSON: I don't think so.

MR. SMITH: But, you know, if we ever get the data, we'd be happy to analyze it.

MR. MATHSON: And this graph just shows where each of those constants affects/impacts the shape of this. The target efficiency on top again raises or lowers this whole surface. The curvature on the sides are impacted by the Q-naught and the P-naught.

So, if this is what the metric looks like, what would the regulation look like? So we've got a metric here, FER, and the ways, different ways that we could use this. The federal regulation could require fans to be sold greater than 1.0 at both its peak and at its design point. You know, peak is kind of obvious there, but at its design point if that information is give to the manufacturer.

ASHRAE 90.1 could require FER greater than 1.0 at the design points. Same concept. 189.1 could require a greater number, a 10 percent increase in efficiency over 90.1.

And then rebates, if we have utility

rebates, we can use this as a basis for those rebates. So we've established a baseline at 1.0. If you've got a fan for a particular operation at 1.2, you know you're going to use 20 percent less power, and then you go through the calculations on what that rebate might be for that purpose.

So this is how it can be used, you know, in a regulation sense, but to a person who is selecting a fan, I think it's much more powerful to see this value.

MS. JAKOBS: So this is Diane Jakobs from Rheem again. So your design point, it would be defined as a pressure?

MR. MATHSON: Pressure and an airflow.

MS. JAKOBS: And an airflow.

MR. MATHSON: Yeah.

MALE VOICE: It needs efficiency of power too, doesn't it?

MR. MATHSON: Well, the customer would come to the manufacturer and say I need an airflow and a pressure. So, yeah, to calculate the FER, you need power and the efficiencies.

MR. WHITWELL: So one of the things that we have to talk about in that case is how do we define the pressure and the airflow on a product where that gets determined by the application, right? So our customers tell us what they -- they determine what the pressure requirements are for the product, the external static pressure requirement. They tell us what the airflow is.

MR. DIKEMAN: For every curve.

MR. WHITWELL: Right.

MR. DIKEMAN: It's the duty of the FER.

MR. WHITWELL: But this is in a product that's already designed and available for sale, and they can vary it, right?

MR. BOSWELL: So, again, please remember to identify yourself.

MR. WHITWELL: Bob Whitwell from Carrier. Thank you. Sorry.

So, I mean, we just need to understand how this would be applied in a situation like that, right?

MR. MATHSON: Yes.

MR. SMITH: This is Wade. You just described every sale of every fan, right? Yeah.

MR. SMILEY: Bill Smiley, Trane.

MR. MATHSON: Yeah. Go ahead.

MR. SMILEY: But with an OEM type product the customer or user defines the external static requirement. He doesn't know or probably doesn't even care what the total pressure requirement for the fan is. He's looking at his system needs to match up to a unit that outputs pressure to overcome his system requirement.

MR. SMITH: That's true, Bill, of every --

MR. SMILEY: So, I mean, that's where we get into a sticky spot here.

MR. SMITH: That's true, Bill, of every fan. A fan sold standalone, the statement you just made would apply.

MR. SMILEY: Mm-hmm.

MR. SMITH: So the question is at the customer's flow and pressure what is the maximum horsepower allowed, and that's the question that we hope to answer in the regulation. So, for the given flow and given pressure, what is the maximum horsepower that the DOE will authorize?

MR. MATHSON: Let me answer that in a little different way. If a custom air handler manufacturer goes to a fan manufacturer and orders a fan at a certain airflow and pressure, it includes both the external pressures and the internal losses in the air handler, right? So the customer is the air handler manufacturer.

In the case of a packaged unit, the customer is specifying external static pressure, and so what you're saying is, yes, somehow we have to correlate. They don't know what the internal pressure drop is, so we have to work on that. So that's in the administration of this I guess.

MR. JASINSKI: Tim, I just want to make sure if what you're describing is accurate. I mean, what I'm hearing is that even though the end user of maybe a rooftop unit who's specifying the external static pressure and the flow, that the manufacturer of that RTU can take that and translate it into what does one of my fans internally need to produce in terms of flow and pressure, because the RTU manufacturer will know what those internal losses are and they'll be able to translate that and give that to the fan manufacturer who is supplying the fan in general.

MR. MATHSON: Well, they don't have to run that test. They don't have to. They could run the test of the air handler with the fan in it.

MR. JASINSKI: Right.

MR. MATHSON: And just measure the external performance.

MR. HAUER: It's Armin Hauer speaking. I would assume that the fan static pressure cannot be known inside of the unit because inlet affects and outlet system affects and you cannot distinguish it to an embedded equipment. So what you really know for that fan in that application is only the flow. The static pressure, fan static pressure you cannot know.

MR. MATHSON: Okay. These are the right questions and they get to how would this look in an OEM product.

MR. WHITWELL: So just one more comment. Bob Whitwell from Carrier. So you talked about having to understand the end customer's requirements and then selecting the fan based upon that. So what really happens is we might have a couple different fans selected and qualified in the product. So it's not a situation where a customer tells us they have this sort of requirement there, out there as far as static and flow, so we go look and see, okay, where does it fall on the third number, and say, okay, we go to a fan manufacturer, we need a new fan to put in this unit because they're running at a condition where it drops below the one.

So, in that case then, we would have to go back in and requalify that fan in our equipment. If it's got gas heat, we've got to put that fan in. We've got to make sure that the airflows are all still good and the safeties all work, and this is months of stuff that would have to be done. So it does create some difficulties that we have to work around and understand. Either that or we're going to have to say we can't sell you that unit. We can't sell you that unit. I don't know if that's what we want to do.

MR. SMITH: This is Wade Smith. No, that's not the situation that we're describing here. The air performance of a unit under this scheme would have a compliant range of operation, and I think if you look at the data and look at the curves and look at the proposed efficiency levels, I think the outcome of that analysis is that what you just described would not happen, all right?

So I just think you have to be patient and get through the analysis and do the comparison with your own product line to appreciate that, but that's the analysis that our members went through, and what we did was we compared different regulatory schemes, different curve shapes, and different regulatory levels against the database of actual sales, and then begged the question how many selections were noncompliant relative to any level or shape that you might want to ask about, and how would the customer cure the noncompliance? How would the rep basically cure it? And then the follow-on question is, is that an undue burden? And the other follow-on question is, how much energy do we save?

And that analysis has all been done for many of the products, and the recommendation that we came up with is a reasonable burden to fan manufacturers and produces a lot of savings. So it works. Does it work for your product? You need to analyze it.

MR. WHITWELL: Okay. So --

MR. SMITH: What you described is something that doesn't work.

MR. WHITWELL: Yes.

MR. SMITH: And if it didn't work, it wouldn't be acceptable.

MR. WHITWELL: Yeah. So I was just responding to the comment that was made that -- my understanding, maybe I misunderstood what he said, but it sounds like that could happen. So I'll be patient now and listen to the rest.

MR. MATHSON: Okay. So this metric will serve not just to regulate fans but also to teach or to encourage good fan selection. So what we envision is that the FER value will be shown in catalogs where performance is shown. So, in this case, the green highlighted area is all greater than FER 1.0, and whatever we do with that, obviously we would not be able to sell fans down in that white area that's not highlighted, but it also, you know, tells you how far you are away from the peak.

If you'll notice, the numbers are lower here as you get up into higher pressures. They're up in the 1.2s at six inches, but at one inch they're up as high as greater than 2, and you'll see that a little bit more with the fan curves why that is. The efficiency requirement, the baseline efficiency is lower at lower pressures, so the FER becomes -- well, I guess they're not over 2. They're about 1.4, 1.5.

But in electronic fan selection software, a customer will put in a design point of operation, in this case 10,000 CFM at three inches of pressure, and they will get a list. In this case, this was centrifugal fans with eight different selections, and again, like Wade mentioned, the smallest fan is 12 horsepower, the largest fan is six horsepower. The lowest number is the 33, size 33. So we're showing the power and the baseline power, so, again, baseline power would be maximum power allowed. That would equate to an FER of 1, and then the FER value on the right-hand side.

MR. SMILEY: Tim, Bill Smiley, Trane.

MR. MATHSON: Yeah.

MR. SMILEY: A quick question. The largest fan, 36, you're saying is an acceptable selection is implied here, but the peak efficiency, your actual total efficiency dropped off a little bit.

MR. MATHSON: Yeah.

MR. SMILEY: That's to the left of the peak efficiency point?

MR. MATHSON: It's to the left of the peak, yes, so it's right next to the --

MR. SMILEY: But it's not in stall.

MR. MATHSON: Right next to it.

MR. SMILEY: Not in stall yet.

MR. MATHSON: Yup, not in stall yet.

MR. SMILEY: Okay.

MR. MATHSON: Right on the edge.

MR. SMILEY: But damn close.

MR. MATHSON: Not a good selection.

MS. JAKOBS: So this is Diane Jakobs from Rheem. So, if you had a space-constrained application and you needed a 20-inch fan size, there's just no solution?

MR. MATHSON: Well, there is, there is. You need to get a more efficient fan.

MR. SMILEY: There's not one --

MR. MATHSON: Different model, different

model.

MR. BURDICK: How do you propose to raise the efficiency from a .8 FER to over 1? That's 20 percent efficiency.

MR. MATHSON: Well, if this wasn't scrolled centrifugal to start with, I would say go to a more efficient fan. But this is an efficient fan to start with. You won't get there, to answer your question.

MR. FLY: This is Mark Fly at AAON. One of the things that I'm a little concerned at, maybe you're going to get to it, but I have yet to see a system curve plotted on any of these fan curves. You know, the trend and what we've been driving to in many of our regulations is to try to go to variable speed fans. In a multi-zone VAV system, the system curve does not start at zero-zero. It starts at some operating pressure that it takes to run the boxes.

MR. MATHSON: Right.

MR. FLY: So, as you turn the fan speed down, you go into stall at some point. As you pick the fan selection at design where it runs 1 percent of the time or less, at the very peak of the curve, which this is all driving you up to, then you have less turndown in that fan.

MR. MATHSON: That's right.

MR. FLY: So I'm really concerned that we're going to encourage -- I mean, we don't always select smaller fans because they're cheaper. Sometimes we select them to have more turndown in a VAV application.

MR. MATHSON: Yeah. Yeah. The way I would recommend personally addressing that is to have a lower FER requirement for VAV systems.

MR. JASINSKI: Yeah, Tim, I'm just going to -- so I think a lot of --

MR. MATHSON: But we haven't gotten into that yet.

MR. JASINSKI: Right. I think a lot of the questions we're hearing are going to be good questions and things that need to be addressed and considered once we start selecting levels in that we don't -- what I'm hearing from the working group is that we don't want to select levels that may completely eliminate certain fan types, certain operating points, and trigger a lot of these costs that, Bob, you brought up, correct?

But I don't think that we can -- to Wade's point -- I don't think that the working group can really assess or evaluate those things until we are talking about an actual proposed level, which we're not doing here right now. Right now we are simply talking about a metric, not a specific -- you know, not a baseline total efficiency. You know, for instance, for this particular product maybe the correct baseline efficiency is below 59.4 and all of these would still be viable selections, but that's not commenting on the appropriateness of the metric itself.

So I think for now, you know, maybe that's because everybody is on board and in agreement that this is a good metric and we're ready to start talking about what appropriate levels should be, I don't know, but I think for the working group's sake and for the sake of doing future analysis what we're trying to accomplish today is establish a baseline understanding of the metric that was proposed by AMCA, a very similar metric that was used in the NODA by the Department of Energy, and get comment on whether or not we think that's a workable solution, regardless of where the levels might end up.

MR. WHITWELL: Yeah, Bob Whitwell, Carrier. So good comments. I think, though, that the questions still -- we need to get the questions out there, right, and it's part of the discussion to understand what some of the implications of this metric could be, right?

MR. JASINSKI: Absolutely.

MR. WHITWELL: So I think we need to ask them now, understanding that there will be more -- we'll have to talk about them some more when we get to that level.

MR. JASINSKI: No, absolutely useful. I'm not suggesting that we shouldn't have had that conversation. I'm just saying in addition to those questions we also do want to get some feedback on the approach itself, understanding that there are those concerns and, you know, it's part of understanding this to understand the impacts. Point well taken.

MR. MATHSON: Yeah, I would say if your -- that question, that particular question from Mark, that means you understand what we're talking about here.

MR. SMITH: Mark, there's a lot of debate inside AMCA members about how to deal with VAV, and there needs to be an accommodation, so it's a recognized need that you described, and so, you know, at some point we should put it on the table and talk about it.

MR. FLY: This is Mark Fly with AAON. I just bring it up because I have seen hundreds of fans, maybe thousands of fans, running in stall in my career from people trying to do the right thing and fans in stall -- I mean, FC fans, you can run in stall all day. You start running BI fans in stall and things start flying apart.

So I think it's very important that we not only just look at the design point selection, but, you know, if you look at the IEER weightings, which is basically looking at building loads, it's been well vetted over time, that's telling you that these systems are running between 50 and 75 percent the vast majority of hours that they're operating in a VAV system, so we have to make sure that it works across that range.

MR. WHITWELL: Right, and it's not just the VAV, but, I mean, in the other working group where we're looking at commercial unitary air conditioning efficiency, I mean, the IEER metric is driving us to fan staging, so varying fan speeds, even without having it go all the way down to a full VAV type situation. So we can't put a metric here on a fan that will not allow us to get to the overall system efficiency levels, or else we're just going to shut the whole industry down.

MR. FLY: Right.

MR. MATHSON: Okay. Let's look at some more pictures. Here's a multi-speed fan curve with a very efficient fan. There will be a large portion of that map that is greater than FER 1.0, and this is not actual data. This is just an artist's rendering here. This is what it will look like. The more efficient the fan is the larger percentage of this performance map will be highlighted or allowable to sell.

But what I wanted you to notice about this is remember the baseline efficiency increases with increasing airflow and pressure. So, at low airflows and pressures, in other words, low speeds, you can use the whole fan curve. The whole curve is green. The whole curve is allowable. As you get up into higher pressures and flows, the baseline is increasing and so the allowable range of operation has shrunk.

MR. SMILEY: Tim, Bill Smiley, Trane. I have a quick question on this. So what this is telling me is that the base efficiency varies along the system curve.

MR. MATHSON: Yes.

MR. SMILEY: Okay. And that's why the FER varies.

MR. MATHSON: Yes.

MR. SMILEY: And does not follow a system curve.

MR. MATHSON: The fan efficiency would be constant, but the baseline is changing.

MR. SMILEY: Okay.

MR. MATHSON: That's right.

MR. SMILEY: See, that's why I was confused yesterday. It would have been a simple response. Then I read your stuff last night and I go, oh, well, hell, that's how it is. Thanks.

MR. MATHSON: Let's talk about an inefficient fan. Okay, it may have a range of operation that is much smaller. Again, this is just an artist's rendering here. I just changed the numbers. Today this product might be catalogued beyond its allowable range, okay? And so a change -- a regulation like this may restrict this fan from being sold at these higher powers or higher pressures and flows.

MS. JAKOBS: This is Diane Jakobs. Another dumb question. So, when you say it restricts the sale, so that would mean the manufacturer's literature would say its application was only within a certain range?

MR. MATHSON: Mm-hmm.

MS. JAKOBS: And then there would be no

enforcement. People buy stuff and do whatever they want, right? I mean, I don't --

MR. MATHSON: We can't control where exactly the fan is going to operate in the field. We can control where it's designed to operate, where it's sold or intended to operate. So you can talk about labeling and things, Sam.

MR. JASINSKI: Yeah, I'll jump in. I think naturally where this conversation is going to go are compliance enforcement labeling questions. Ashley is on her way and I think she should be in the room for that discussion. So I think --

(Laughter.)

MR. JASINSKI: Oh, there she is. Well, I was going to suggest maybe -- yeah, I was going to suggest maybe we take a break if everybody is ready to take a break, and be prepared after maybe a 15-minute break to comment on whether or not this is the metric we should be using going forward in the analysis, and if the answer is no, why not and what should we be using.

MR. HAUER: Can I just tag on a question about Slide 17, the relatively efficient fan? Right. Okay. Now let's assume your black curve, the very far to the right, this is a direct drive fan with, I don't know, four pole motor, right? But now your customer needs a performance point between the curve to the right and then the next one down. Right, right smack in between. How do you accomplish that?

MR. JASINSKI: Between here?

MR. HAUER: And what type of an FER would you declare there?

MS. JAKOBS: Between 1 and .9?

MR. MATHSON: Right where the arrow is?

MR. HAUER: Yeah, between -- yeah, exactly there. How would you arrive there, you know, if you have a direct drive fan?

MR. MATHSON: With a VFD.

MR. HAUER: Okay. So where is the --

MR. MATHSON: Is that what you're asking? Is that your question?

MR. HAUER: Okay. So where is then the efficiency impact of the VFD or maybe the belt reflected? There are some losses associated with varying the speed to that point.

MR. SMILEY: Well, you could pick the next size smaller down if that was the correct increment.

MR. HAUER: Yeah, but there is a likelihood that you will never exactly measure design points. So basically I'm leading to the question where do you reflect the losses in the belts and in the variable speed drive and the motor impact from a variable speed drive?

MR. WOLF: This is Mike Wolf with Greenheck. So I think we're going to get into somewhere down the line here, Tim, the discussion of how we get from wire to air?

MR. MATHSON: Yeah.

MR. WOLF: Right?

MR. MATHSON: Yeah.

MR. WOLF: I guess, Sam, I'll just ask him. How many slides do you have left?

MR. MATHSON: Maybe 10; not important ones.

MR. WOLF: Do you get into the --

(Laughter.)

MR. MATHSON: They're all pictures.

MR. WOLF: Do you get into the 207?

MR. MATHSON: No.

MR. WOLF: You don't?

MR. JASINSKI: We have some slides that --

MR. WOLF: Okay.

MR. JASINSKI: -- reflect the wire-to-air aspects which I think will address your questions.

MR. BOSWELL: I was going to say there is a proposal to take like a 15-minute break. We've been going for almost two hours. So unless there's an objection why don't we do that.

(Whereupon, a short recess was taken.)

MR. BOSWELL: Okay. If we could all come back to our seats. So we're going to pick up with the balance of Tim's presentation and then continue the discussion.

MR. MATHSON: Okay. So here's -- we talked about a -- I'm going back up. This is what an efficient fan might look like in its performance map, what an inefficient fan might look like in its performance map. We talked about -- we've talked about at AMCA what we do when we don't know the actual design point. So, if a fan is sold through a distributor or something like that, the regulation may say that the FER must be greater than 1.0 at the best efficiency point at the maximum RPM. So, in this case, this fan does not meet that requirement, but it would meet that requirement if the max RPM was just reduced to a certain level. So I kind of think this could be part of the regulation as well.

MR. SMILEY: Tim, Bill Smiley, Trane. Quick question. When you say "max RPM," you mean max design capability like the fan, the next fan up?

MR. MATHSON: Well --

MR. SMILEY: No. It says FER must be 1 or greater at best efficiency point at maximum RPM.

MR. MATHSON: Yeah.

MR. SMILEY: You mean the fan capability RPM or what?

MR. MATHSON: Well, that would be part of the regulation. I would say it could be the range that the fan is able to be advertised at.

MR. SMILEY: Okay. So you would say your max allowed usage RPM.

MR. MATHSON: Yes.

MR. SMILEY: Not necessarily design limit or anything like that?

MR. MATHSON: Right, right.

MR. SMILEY: Okay. Thank you.

MR. MATHSON: So, you know, in this little sort of made up example here, today let's say we published beyond that speed. If there was a regulation tomorrow and we could only go up to a lower speed, that would probably take away some of the motor horsepowers for that fan, so we might redesign it smaller, you know, a little bit differently, or we may take it off the market, you know, and just replace it with something else.

And if this regulation was the only

regulation, then we would just change the maximum RPM to meet that. If there is something else, like let's say the regulation said for safety fans you can use an FER of 0.9 or if we wanted to use this fan overseas somewhere, you know, those are all really fine details about how it could be administered.

But one example here as we end up, this is just to illustrate what we want to accomplish with this, with this metric. Here's a square in-line fan that we sell a lot of that is not very efficient. It's just a centrifugal fan inside of a box, and it's ducted inlet, ducted outlet. Sometimes you see them a lot as a return fan or an exhaust fan. It's inexpensive, easy to install, easy to maintain. It's all about the contractor. It's made for the contractor to install, but it's low efficiency.

If we look at the performance map for this fan, this is a 30-inch wheel in a square in-line fan, and now because it's ducted I'm showing total pressure here. This is the range that we catalogue today, and so it's got a best efficiency point, a maximum total pressure 53 percent, which is really up high on the fan curves. It's kind of unique that way. But you can draw other lines of efficiency. You can see how it dropped, the total efficiency drops as you go down the fan curve.

And we've plotted actual fan selections from the year 2012 on this map to see where people are selecting these fans. And so, as you look at this and where the efficiencies are, I think it becomes obvious that these customers don't care very much about efficiency. It's all over the place. There's no grouping here anywhere near high efficiency. There's a lot of selections down towards the end.

And if, if we were going to have this regulation of FER greater than 1, that allowable selection range would be as I have shown here. So about 40 percent of these fan selections for this model fell within this, and this is just what we had proposed as some base efficiency levels, target efficiency levels. So about 40 percent of the selections met the requirement.

So the purpose of this is, what do you do with the other 60 percent? Well, if I look at one size larger, size 36, that covers more of that range, so that covers 70 percent now of the fan selection. So 40 percent of them could have been done with the 30, the next 30 percent I guess of selections could be covered by one size larger, and then about 90 percent of them could have been covered by the next size larger. So some of the fans had to go one size up, some of the fans had to go two sizes up. There are some of the fans that are higher pressure there that are not covered by any of those bubbles. Those would have to be covered by a different fan type. This fan doesn't cover that.

But if you look at this. So I looked at one point out here and said well, what's the customer going to do; 15,000 CFM at a half-inch of total pressure. So his option here is to use a larger fan size, a size 42, but that's pretty big. So here's that design point, 15,000 CFM at .5 inches. The size 30 was -- here's the details on that: 5.3 brake horsepower; FER .62, so that was not an acceptable selection there, the size 30, and some of the other details, operating cost, budget cost.

So, because of that, they can replace that with a size 42, so 42-inch wheel. Quite a bit larger in size to get that FER above 1.0. So it moved up to 1.12, and you see the FER is proportional to the power. The FER went up by almost a factor of 2. The power was almost cut in half. But it's a heavy fan, 735 pounds. It's more expensive. You could, and I put on there the housing widths, so the original was 46 inches wide, this was 48 inches wide. So the customer may say, well, that's too large, I can't fit it into the space that I want.

So you can replace that with a mixed flow fan, a size 27 will do this, with an FER greater than 1. So its horsepower again is 2.77, about half of what the original selection was. But if you look at the cost, it's twice the cost of that original selection, and that's why we didn't sell this fan in this application.

So this is the customer's choice, but what we're trying to do here is to get the customer to come back to the fan manufacturer and say, hey, I need a new square in-line fan with better efficiency, okay? I can't accept this 58-inch square. I need something smaller, so redesign this. We want our customers to say redesign this fan to get a better efficiency or come out with a new mixed flow fan that's less expensive that competes with that. And either one would be a good answer for that situation.

So, again, the point of this illustration is we don't want to -- you know, if we're just -- if the regulation is just concerned with efficiency and not the fan selection, we'll design a more efficient square in-line fan, but they'll still pick the size 30, so we're trying to capture all of that together here.

What is this? Oh, this is something else. Extended products, I won't talk about this.

MS. ARMSTRONG: Why don't we move --

MR. MATHSON: Yeah, you can talk about that. Okay. That's all I have.

MR. SMITH: This is Wade Smith. While Sanaee's team get up I thought I would just add a comment. It was mentioned that when we started working on this question of how to measure fan efficiency we started down the path of peak efficiency, our FEG, which was an accommodation to smaller fans that have lower peak efficiency, and the membership of AMCA got quite far down the road with FEG, wrote standards, recommended FEG nomenclature for 90.1, et cetera.

And then we switched, and the reason we switched is because we had the assignment to calculate the savings associated with different FEG levels, pushing assimilation basically or a query into the database and asking for, hey, what is the savings, what is the impact, how many fans are going to have to be redesigned, et cetera.

And then a debate ensued about the method of calculating the savings, and out of that discussion grew a realization that our calculation of savings was highly speculative and that the savings that we did calculate was at risk over customer behavior, responding to a higher priced fan, like what was just shown, by instead purchasing a smaller size.

And so the question of what savings would we generate from a peak-based efficiency metric became -- you know, turned into a big question mark, and the common expression was that the change in peak efficiency was not deterministically linked to a change in energy use. This is a statement which is more true for some fan categories than others. It depends on how broadly across the spectrum fans are selected, and we looked very carefully at scatter diagrams where fan selections actually occurred, and another way to look at is this: that if the fan selection varies from 5 percent to 85 percent and you raise the peak efficiency by two or three percentage points, you know, what have you really done?

In other words, you've got two things working to drive energy use. One has tremendous leverage and the other one has very little leverage. The one that has tremendous leverage needs attention. And so that's when we went back to the drawing board and Tim Mathson and the folks at Greenheck made this recommendation and suggested that there was a deterministic link between the efficiency rating at the design point and the actual energy consumed, and we went on from there.

So the suggestion and the proposal that grew out of that was to have DOE regulate the efficiency of the fan at its design point, not at peak efficiency, and that's kind of where we are and why, in terms of the recommendation that we made, why we ended up there, just so everybody understands.

MS. ARMSTRONG: Yeah, so that's a pretty good segue into what Sanaee is about to present to you. Before we start, Peter online wants to comment about the last example. Before we move on we might as well. Unmute him.

Peter, you should be unmuted.

MR. BUSHNELL: Yeah, hi.

MS. ARMSTRONG: Hi.

MR. BUSHNELL: Thanks. It's Peter Bushnell at Carrier. Just on the last example, I found that one interesting because as we look at operating point 15,000 CFM, 0.5 inches of water gauge duty pressure, if we look at all of the fan classes and types for that duty point and kind of look at a specific speed-based approach across all fan types, you'll find that the optimal choice of fan is the axial fan, and I found it interesting that that didn't come out of the analysis that was done. So was I wondering if you could comment on that a little bit, Tim.

MR. MATHSON: This is Tim Mathson. Yes, I would agree that it looks like more of a tubeaxial application, but why wasn't a tubeaxial on that slide, I can't answer that question.

MR. WAGNER: This is Greg. I would say that was a selection thing.

MR. BUSHNELL: The reason I bring that up is that --

MR. WAGNER: Sorry. This is Greg Wagner.

MR. BUSHNELL: The reason I brought that up was that if you follow simply kind of looking through catalogs and databases you'll come up with one solution, but if you use kind of a systematic approach using specific speed approach, which I think was what was used in the DOE pump regulation for efficiency, then there's kind of a more systematic way to find what's the right type of fan for a given duty point, and this is the most critical point in choosing a given fan.

And, Ashley, I'm having a lot of feedback, by the way, so this is very challenging for me to actually speak here.

MR. HARTLEIN: So, Peter, this is Dan Hartlein from Twin City Fan. We would agree. There's actually theoretically a range where the specific speed would indicate a typical axial selection, that as specific speed changes things like hub ratio and blade solidity change in the design of the product. There is obviously as well a specific speed where a centrifugal fan tends to rule the day. And then there's products where the customers in the market want to buy something that is different than both because it's cheap and easy and it works for them in the field, and I think that that centrifugal fan in the box is an outcome of that.

That is absolutely correct that that's operating at a specific speed which would typically and technically be an axial fan, and it's a duty point that should be there, but the market is buying a product or demanding a product that is not -- I think Tim rightfully showed a peak efficiency of that product line at 53 percent. That is not a product that's being designed and sold for its energy efficiency. That's clear, and I think you're 100 percent right that that would be a, from a specific speed question, that would be a axial fan. You're absolutely right.

MR. BUSHNELL: And I think that the example also brings up another interesting point, is that there may be for that example other constraints like stall margin performance or extended range of pressurized; you know, going down, down to lower flow rates, and with those kinds of constraints, you know, it might be that, hey, the mixed flow fan is really required, but if you're strictly looking at .5 at 15,000 CFM, you know, without those extended requirements, axial fan is probably the right choice.

MR. HARTLEIN: Yeah, I think we agree. I think you had your hand up.

MR. BUSHNELL: So this discussion on design point, I think those are the kind of factors that come into play on design point. You know, it's what are the extended range requirements, stall margin, things like that.

MR. WIGGINS: This is Steve Wiggins from Newcomb Boyd. I think the other thing we need to realize too when we start talking about the customer or the -- and I'm going to step across the line and say the designer who is specifying the product, specific speed means nothing to him in his world currently, okay? And so, when you start looking at how do we get to the point where we're making the fan selection, I think we have to realize too that if we go certain directions we're talking about potentially training an industry to do their business in a different manner than what they're currently doing, and that may be a bag of worms we don't want to go play with too hard.

MR. BUSHNELL: Yeah, it's a challenging area because in a perfect situation you would have tools and selection processes and a regulation that somehow is consistent with that specific speed methodology because that would drive the optimal selection, and I think the problem is the industry doesn't really have that completely formalized for fans. We don't have universal specific speed charts that are used throughout the industry, so it makes it difficult.

MR. HARTLEIN: Yeah. Steve, just one other comment to that. That world that you describe on specific speed is a driver for selection actually happens in the heavy-duty industry, so our Clarage division will select a fan and design a fan optimized to the specific speed, the duty point, but that's a custom fan. We start to see that happen in higher horsepowers. Some markets will demand that fan at 150 horsepower, so we do get into the 200 horsepower range that we seem to be talking about here. But it's driven by the fact that you can have a million dollars of energy consumption a year on a 10,000 horsepower fan, and in that industry, it does in fact function in the way that you're describing, but the HVAC industry clearly does not at this point.

MS. ARMSTRONG: Okay. So I'm going to make a suggestion at this point that we're going to walk through our metric. It is more or less the AMCA? Advocates' metric that they represented in the NODA. At least we are going to explain it and what this is translated to look like in kind of the DOE world and how this would work. We've highlighted some points for discussion that we would like some feedback. We're hoping, though, that at least some of the stuff we can think about voting on this afternoon in terms of high-level metric and some of the test procedure type issues. So, Sanaee, why don't you start walking us through some of the metric slides and we can have some discussion.

MS. IYAMA: So I'm going to go by the first slides because I think Tim went over this already. Fan efficiency varies greatly depending on the fan's operating point. Here it's just illustrating the fan efficiency distribution amongst different fan selections from the fan data we got from AMCA. And so, to address this issue, DOE used a metric evaluated at each operating point as declared by the manufacturer, so it's an approach similar to the one presented in AMCA's white paper, and it's based here on the wire-to-air approach, so that's the difference with what Tim presented earlier, and it's based on determining the electrical input power of the fan at a given operating point, what we called FER in the NODA.

So the FER would include the fan shaft input power, which is the first part of that equation, flow times pressure divided by fan efficiency. If there's a transmission, like a belt, that would be also incorporated in the electrical input power to the fan, as well as driver losses and control losses if controls are used.

I'm just going to go through the slides, or do you want to stop?

MS. ARMSTRONG: So, yeah, hang on. So before you go through -- so what do we think about this?

MR. SMILEY: Bill Smiley, Trane. The FER you're referring to really is a horsepower or watts? It's not a ratio of any kind. It's a value.

MS. IYAMA: It's just electrical input

power, so you could express it in watts or horsepower.

MR. SMILEY: Well, the term FER is a little misleading then. I mean, you ought to just call it watts.

MS. ARMSTRONG: So we've teed that up. Probably unknownst to the fan industry, DOE does have an FER metric already for residential furnace fans. So what do you propose it be called?

MR. SMILEY: Well, call it watts. That's what it is.

MS. ARMSTRONG: How about fan electrical power?

MR. SMILEY: I don't care.

MS. ARMSTRONG: FEP? Can you deal with that? Great. I mean, it's either that or Ashley. I don't know.

MR. SMILEY: I think I'll vote for Ashley.

MR. FINE: While you're at it, you could add a C to the transmission units.

MR. SMILEY: We don't care about spelling.

MS. ARMSTRONG: Yeah, we don't. That's really not --

MR. SMILEY: We're engineers.

MS. ARMSTRONG: Exactly. That's not important to engineers. The lawyers will take care of that during the months of review.

MALE VOICE: I don't know if I should have caught that.

MALE VOICE: These aren't going to turn into -- these aren't going to be words in any way.

MS. ARMSTRONG: Yeah, exactly.

MR. HAUER: It's Armin Hauer speaking. I was terribly confused about the horsepower, that we called it -- it's electrical power, but we call it horsepower. And horsepower I think is like mostly in the United States. It's a mechanical power. Okay. Can we please --

MALE VOICE: It's brake horsepower.

MR. HAUER: I've never seen electrical power expressed in the unit horsepower.

MS. IYAMA: So I think in the NODA it doesn't really come up because we ended up doing the ratio. So it has no dimension.

MR. HAUER: But in the spreadsheet --

MALE VOICE: Where do you see horsepower here?

MR. HAUER: In the spreadsheet, it's calibrated back to horsepower.

MALE VOICE: So you're suggesting working in watts when using electricity?

MS. ARMSTRONG: So would you prefer using watts always? Okay. No. Well, you guys figure it out in that corner.

MR. HAUER: But when it's electrical power, it's watts, right?

MALE VOICE: Yeah.

MS. WALTNER: This is Meg. If we changed the term to fan input power, would that --

MALE VOICE: It's not fan power.

MALE VOICE: Let's just change the noun.

MS. ARMSTRONG: Right. I would suggest changing the acronym in that case, but --

MR. SMILEY: Bill Smiley, Trane. It's not really fan input power. It's power into the upstream device that connects to the fan through a drive and a motor and on and on and on and on. So the fan power is always in the industry referred to as the actual brake horsepower or the power that's consumed by the rotating device.

MS. ARMSTRONG: So why is it that you want to use horsepower?

MR. SMILEY: Let's be confused here.

MR. HARTLEIN: Because it's -- I think everybody -- excuse me. Dan Hartlein. I think everybody that's in here that doesn't have European origins is comfortable with horsepower as that expression. It's no offense, but that's a metric issue. We use it there. We all know what it means.

MR. BUBLITZ: Well, Mark Bublitz here.

MR. HARTLEIN: Technically he's right.

MR. BUBLITZ: But when we talk horsepower, we talk at the shaft --

MS. ARMSTRONG: Yeah.

MR. BUBLITZ: -- so that you can size the motor.

MR. HARTLEIN: Not all of us. We don't.

MR. FERNSTROM: So this is Gary. I think the Europeans have this figured out, but we haven't quite figured it out yet. And generally horsepower here is deemed to be mechanical, and electrical would be watts or KW, and that's what I would prefer. And we're talking about the electrical input power to the motor controller system that drives the mechanical.

MALE VOICE: Yeah.

MR. BURDICK: This is Larry with SPX. I have a comment about each operating point. There are so many operating points associated with a fan. You know, is it at the design point for that particular cooling, you know, for the design cooling duty? You know, then there are all the stream of points that are associated with when you're running on VFD, you know, or off-duty situations, different motor loadings, you know, different heat rates and so on. You know, I think a broader term or a consistent term might be peak fan efficiency.

MS. ARMSTRONG: It's not peak.

MR. BURDICK: No?

MS. IYAMA: So here it would be at each operating point as declared by the manufacturer.

MS. ARMSTRONG: So it wouldn't just be peak. It would be all.

MR. BURDICK: So this is an operating point declared by the manufacturer as to which point it is I'm talking about.

MR. SMITH: It's the point of sale. Somebody comes to -- this is Wade Smith. When somebody comes to buy a fan, they say, I need a fan that will do the following duty. So we're selling the fan for operation at that duty at a certain efficiency level. Now where does the customer operate the fan?

MS. ARMSTRONG: Kind of. Kind of that.

MR. JASINSKI: Wade, I think, I think the answer is --

MR. SMITH: Kind of that? Okay, kind of that.

MR. JASINSKI: -- everybody is right.

MR. SMITH: Okay.

MR. JASINSKI: What we're talking about here is that it's a -- everybody here is right, but what we're talking about here is the metric allows for these things to be calculated at any operating point. This is not a declaration of which ones we're talking about. We're just saying we are using a metric that regardless of who determines it, whether it's the consumer, the manufacturer, the regulation, that you can determine compliance with this metric regardless of what that operating point is. There are no operating points at which you operate a fan that you can't calculate the FEP as it's written right now.

MR. BURDICK: So the each should be an any? Any I mean.

MR. JASINSKI: Any.

MR. BURDICK: Rather than each?

MS. ARMSTRONG: Correct.

MR. JASINSKI: At any operating point is probably better.

MR. BURDICK: Okay, yeah.

MR. JASINSKI: And then we will get into the discussion about what those operating points are and how they're determined later. What we're just trying to do is make sure that we have a metric that allows for FEP to be calculated at any operating point.

MALE VOICE: So any specific operating point?

MS. ARMSTRONG: Any is fine.

MR. FLY: Yeah. This is Mark Fly. This is not the point of regulation. This is just something to get there.

MS. ARMSTRONG: This is just a metric.

MR. FLY: Just a metric to get there.

MS. ARMSTRONG: Do we agree with the components of the metric?

MALE VOICE: Well, let's see.

MS. ARMSTRONG: So, I mean, just generally speaking, this is similar to the approach you guys have worked on. We'll change the name, FEP.

MALE VOICE: To AER?

MS. ARMSTRONG: You can come up with a better name next week or in two weeks or in August. That's fine. But generally these are the main components that are included in an overall metric.

MR. WHITWELL: So the motor efficiency is included in the transmission?

MALE VOICE: No. Driver losses.

MS. ARMSTRONG: Driver.

MR. WHITWELL: It's in the driver losses? So that's driver and motor losses I guess. Is that yes?

MS. ARMSTRONG: Yes. Okay. Moving on. I think we have a thumbs up.

MR. DIKEMAN: Ashley? Ashley, Steve Dikeman. Before you go, your discussion point on bearings, they're included in AMCA fan ratings if that fan has a fan shaft through it. So you've already got them.

MS. ARMSTRONG: But if they don't, they are not.

MR. DIKEMAN: It's a direct drive. You have no bearing losses.

MS. ARMSTRONG: Right, okay.

MALE VOICE: It's part of the motor efficiency.

MS. ARMSTRONG: Right.

MS. IYAMA: So here fan electrical input power, so for any operating point it could be determined based either on measuring the fan shaft input power and then combining that with default values to represent the motor, the transmission or controls, if any. So that's the first option. We called it the calculation-based method. Or it could be directly measured at the input of the electric motor controls, if any. So that would be the testing-based method.

MR. SMITH: This is Wade Smith. Would you then also allow a test that includes the transmission but not the motor, for example, and use default values for the motor and controls? In other words, is there a continuum between those two extremes, or is it just the two extremes?

MS. ARMSTRONG: I mean, I think we could. Do we need to?

MALE VOICE: Do it anyway.

MR. SMITH: I don't know. I just wanted to know where your stand was, and then I guess we can ask our members what they want.

MS. ARMSTRONG: Yeah. I think it's more a question of what do you want.

MR. SMITH: Okay.

MS. ARMSTRONG: I don't think we have a --

MR. SMITH: So you would have no problem if we step through that as an option.

MS. ARMSTRONG: Not necessarily, no.

MR. SMITH: Okay, good.

MS. ARMSTRONG: I mean, such that they provide equitable ratings.

MR. SMITH: No, no, I understand.

MS. ARMSTRONG: But no.

MS. IYAMA: Okay. So then this metric would be compared to what Tim has presented this morning, but he presented it in terms of maximum allowable shaft input power. Here we're talking about maximum fan electrical input power. So same thing. It would be based on an equation of efficiency as a function of flow and pressure, and then we would combine that with default values for motor, transmission. And here, for that determination, we wouldn't consider controls.

One thing that was in the AMCA white paper was the issue of how to evaluate fans with controls. I think AMCA had presented in that white paper the possible inclusion of sort of a multiplier to the FER standard here as it's called when evaluating fans with controls.

MR. SMILEY: This is Bill Smiley, Trane. A comment there. If, for example, you -- oh, I pushed twice. Sorry. Bill Smiley, Trane. For example, if you had a motor with a VFD on it, variable speed control device controlling the speed of the motor, the motor efficiency changes depending on the output and the type of controller you're using to control the motor. So how would you accommodate or account for that inefficiency? Would that be on the motor, and then it varies at every load point on the motor and setting point from the controller? Or would you account for that in the controls? How would you account for that?

MS. IYAMA: For the losses of the VFD?

MR. SMILEY: There are two things here, losses through the VFD and the effect on the motor of the VFD signal going to the motor that changes the motor's efficiency relationship with speed and frequency and the wave form, the type of motor and the type of VFD, and the list is very long of those variables.

MS. IYAMA: So here we're in that scenario where we're trying to establish the input power of the fan, and it has controls. And so the first option is you could do a wire-to-air test. That's the second bullet on that slide. Or the first option is you establish sort of a default model that allows you to calculate the losses of your motor and VFD, the combined motor and VFD. AMCA has a draft 207 where they have one recommendation on how to do that. We're working also trying to develop a similar or just evaluating their approach, and I think that's probably something that we'll have to discuss.

MR. FLY: This is Mark Fly at AAON. I realize that, you know, what you're talking about changes -- is changeable by punching the buttons on the keypad of the VFD. If you change the switching frequency, if you change the load profile curve on that, it changes the motor efficiency. And that's something that happens in the field all the time.

MS. IYAMA: Okay. So before going into sort of the more detailed stuff, just one slide here about using an index. So, in the NODA, we kind of followed what was in the AMCA white paper and took, you know, the baseline electric -- or the maximum allowable electrical input power, divided that by the electrical input power of the actual fan, and called that the FEI. And that's exactly what Tim has presented this morning, except that here it's a wire-to-air-based index.

Now there might be issues with using an index. One of them could be the number of significant digits. Maybe two significant digits may not be enough to differentiate between higher variation in fan efficiency. So, if you're trying to compare fan A and fan B, you know, they might have the same FEI if you use two significant digits, but they may not have the same electrical input power usage. So that's one example of the issues that could come up with using an index.

From a standard level-setting perspective, if the maximum allowable electrical input power changes, so let's say you change that target to a new higher target, then, you know, that index doesn't really mean anything anymore. You could have fans on the market that are calculated with a different baseline because the regulation has been updated.

MS. JAKOBS: This is Diane Jakobs from Rheem. So I don't know if really the issue is multiple digits. It's more like multiple operating points. And, you know, are you averaging operating points, or are you having multiple indexes? The thing is --

MS. IYAMA: So you'd have a separate value of the index or of the metric for each of the operating points. So that table that Tim had up on his slide, that was the same fan, the performance table of one fan with different ratings at each of the represented operating points.

MS. ARMSTRONG: Yeah. So something that's a little unique to what -- for those that aren't that familiar with what the AMCA white paper -- kind of approach they took. Something that's unique in what they've done and is a little different from most typical DOE regulations is instead of picking a rating point, which you guys are all accustomed to, even though you recognize your equipment operates over a range of different points and a few operating points in the field, they're rating at every operating point. And so they're defining an operating range. I'm sorry. And that whole range is what ultimately they are -- I mean, as the approach would get administered, that range would be certified to the department.

So instead of it being a single point for a fan, they're going to be defining what this range of conditions would be. Now there will be some bounds around that range that we'll get into as we talk through the test procedure and how you come up with ratings, but I think the scheme is completely different in something that's -- it's different in terms of regulatory approach than the department typically takes. And it's not just a single rating point. It is a range reflective of the entire operation range that the manufacturer wants to self-declare and sell its fans to be used in.

I saw some puzzled faces. It's different.

MR. SMILEY: It's normal for the industry -- this is Bill Smiley, Trane. It's just normal for the industry that we operate in.

MS. ARMSTRONG: Correct, which is why we've kind of embraced that.

MR. SMILEY: It's not an issue for us.

MS. ARMSTRONG: Right.

MR. SMILEY: It's a DOE problem or change.

(Laughter.)

MS. ARMSTRONG: We implemented it in the NODA, yeah. So, if you read the second NODA, we implement it. We ran analysis on that exact regulatory approach.

MALE VOICE: Well, I haven't had four years to study all this stuff.

MS. ARMSTRONG: You're a fan manufacturer.

Anyhow, so that's that. I just wanted to -- for those that may not be familiar, it's different, but it's not something DOE is I would say embracing.

MS. JAKOBS: So this is Diane Jakobs. That chart that we just looked at, it kind of looks like an airflow chart for --

MS. ARMSTRONG: Correct.

MS. JAKOBS: So we would have an FEI at every --

MS. ARMSTRONG: Point.

MS. JAKOBS: -- point.

MS. ARMSTRONG: So your table, your cert table would look like this.

MS. IYAMA: We have pressure also in there.

MS. ARMSTRONG: Right.

MR. SMILEY: Yeah, statics -- Bill Smiley, Trane. Statics across the top, CFMs down the sides, like our normal. It's just instead of just having RPM and brake horsepower like the industry has always done, they've added a third column, which says or whatever the metric is or -- I'm probably getting my terminology screwed up here. But whatever the measurement is, the ratio, FER, FEI, XYZ, whatever it is, there would be an extra column for that. And the methodology you're proposing or presenting here is that I think you're suggesting it would need to be one or above to be allowed legally to be used.

MS. ARMSTRONG: We haven't gotten there.

MR. SMILEY: Or something like that.

MS. ARMSTRONG: I mean, that's going to be for like -- hopefully we get there in June, though.

MR. WHITWELL: Bob Whitwell from Carrier. I think there is an important difference here, and that is that what we publish today is based on what the entire unit internal static pressure plus external static pressure is. So it's an operating map for the application in the building.

I think what this is talking about is for the fan itself. So we don't have that data today. We don't publish that today. So that's something that's completely different than what we provide today.

MR. SMILEY: Yeah. Bill Smiley, Trane. That's because the customer doesn't directly care what the internal pressure losses of the unit are. He only cares about what the external pressure capability is for his application, what the cost, what the motor size, the power, and all that are. So, if you base a regulation on total fan static pressure or total fan total pressure, we don't know what that is a lot of times.

MR. SMITH: Well, this is Wade. The fan that goes into your unit will under a regulated scheme have a compliant operating range, and your unit, since you don't catalog the fan performance, you catalog the unit's air performance, the unit will have a corresponding compliant operating range. And you do catalog and you do know what the air performance of the unit is. You catalog it. So now you just have to impose upon what you catalog the compliant operating range of the fan and the corresponding FER.

If you have the performance of the fan and you have the performance, the air performance of the unit, which you clearly do have, then you can translate from one to the other.

MR. FLY: This is Mark Fly at AAON. So just trying to get my head around this. As we looked at say a unit performance chart, I would have the same CFM because the CFM doesn't change. But the static pressure available external would be less than the static pressure of the raw fan and the minimum testable configuration. And so you couldn't directly look -- the table for the fan and the table for the unit would not line up on the static pressure side.

MR. SMITH: Right.

MR. FLY: It would be incorporated, but the FEI would be of the fan in the minimum testable configuration.

MS. IYAMA: All right. So, in the next few slides, I'm just going to go into a little bit more details in the fan efficiency equation that's used to establish the maximum allowable shaft input power and then, based on that, the maximum allowable electrical input power to the fan. So we went over what those constants mean, so I'm just going to go through this really quickly.

And there were some questions about, you know, how did you get to the value of Q-zero and P-zero by matching the diameter effect of the FEG curves, kind of mimicking flow and diameter. This is just what those functions look like, like if you plot a function that's P divided by P plus P-zero. And then just to illustrate how that shape would change if we increased P-zero a little bit or decreased P-zero a little bit. So that's on the left graph. And then we did the same for Q-zero.

Also, based on the data that AMCA had provided to us, we did our own kind of curve fitting to see how far or how close we'd get to those 215 0.4 values. We ended up pretty close, with a 234 and 0.4, but looking at how sensitive the curves are to those values, you know.

Also, if we get to presenting the NODA results at some point, we could show you kind of the impact of using a slightly higher or slightly lower value for those constants.

MS. ARMSTRONG: Right. So I think just the moral of this slide is that those constants are representative of the data set we used to come up with the NODA. We did a similar analysis that AMCA did just for purposes of a) due diligence, but b) to see how sensitive changes would be and changes in data sets would be to those constants. And I think what Sanaee is trying to say is that we didn't find that the constants were overly sensitive, but I don't think we're asking you to say these are the right constants right now because, you know, as we move along in this process and we add data to the data set and we revise analyses, those constants may very well change.

We just want you to understand that the constants didn't seem overly sensitive to data sets. We are committed to updating them as we go through the process, and we include more data, and the general form of the equation on the next slide is going to look something like this. We're there. Right.

MS. IYAMA: So another --

MS. ARMSTRONG: So, in other words, don't worry about the numbers quite yet. What we're trying to talk through at a high level is the form of the equation and the different components that it is accounting for to get people onboard with the concepts before we talk details of the -- when we get into details of the analysis and how the actual data and what the results say, that's when we need to worry about the specifics.

So you can keep going.

MS. IYAMA: Yeah. So one point where the

NODA was different from the AMCA white paper is using static efficiency -- well, an equation expressing static efficiency as a function of static pressure and flow to calculate the maximum allowable BHP for unducted fans. And here I just have two slides to kind of illustrate what the difference is if we use one option or the other. It's just to kind of trigger a discussion.

So for the ducted fans, where AMCA is using an expression of total efficiency as a function of flow and total pressure, we end up being able to calculate the shaft input power based on flow and total pressure. So that's your input data to the function, which means that if two fans have the same total pressure and same flow, they would get the same sort of baseline maximum allowable shaft input power. And then if you go on to the proposal or recommendation that they have for the unducted fans, where it's a metric based on static pressure, then you'd have maximum shaft input power expressed as a function of flow and static pressure, which means that if two fans have the same static pressure and the same flow, then they would be given the same sort of allowance.

So what it looks for two theoretical fans, fan A, fan B. Here it's just an example. They have the same static pressure. So, if we're using option 1, these -- I just used a target of 62. It's just for purely illustrative purposes, and then a slightly lower target if we're talking about static efficiency, so 0.58.

And the two other bullet points are sort of a summary of the comments we got on that issue from the first NODA, you know, concerns about using total pressure because that would require defining the outlet area, and that's not always straightforward for unducted fans. And then other stakeholders saying that, you know, when you use static efficiency, you may be able to slightly change the way you define your outlet areas also and sort of manipulate that to kind of show that you have a higher efficiency than the actual.

So, again, these are just to trigger some discussions. I don't have any further slides on that issue.

MS. ARMSTRONG: You guys have been waiting to talk static/total, so here would be your chance. I'm not sure who wants to take the lead here.

MR. SMITH: Well, let me just introduce it. This is Wade Smith from AMCA. Most of the time, not all, but most of the time, when a fan has no duct on its discharge, the velocity pressure doesn't matter. The velocity -- the energy that is imparted to the air to speed it up, so to speak, is lost and of no consequence. In other words, if you made it go faster, you wouldn't bring the customer any benefit.

So there are real exceptions to this, and that's why I said most of the time, because you have jet fans where velocity is the only thing that matters, induced flow fans, where it matters. There are other examples where velocity matters. But generally speaking, fans that have a free discharge to the atmosphere, velocity pressure is of no consequence to the application and of no value to the application. And there's sort of a theoretical argument that says therefore it doesn't belong in the efficiency equation as a value add. It is not a value add. It's a waste.

But then there's the practical side of static versus total, and the practical side is that if you use static efficiency as the metric, then the manufacturer can extract benefit from a -- what do you call it, diffuser? What do you call those things? Ellipse, evas, évasé -- on the outlet --

MS. ARMSTRONG: Évasé.

MR. SMITH: -- to boost the energy -- to

boost the energy efficiency of the application, and it provides a real benefit.

If you base the regulation on total efficiency, évasé doesn't change the total efficiency, but it does change the static efficiency, which is of benefit.

So there are lots of arguments, and this is another debate that lasted for years literally and has not been -- you know, it isn't over. We still have members who are on both sides of this question. But the consensus is to use static efficiency on fans that don't have ducts on their outlet.

I should just add velocity pressure on a ducted application is of value because between the fan discharge and the ultimate air discharge to the occupied space if it's a ducted system or wherever the duct ends, that velocity pressure is converted to static, and it is used and exploited, knowingly or otherwise, to overcome losses in the duct system. In other words, velocity pressure has real value delivered to the system because it is recovered in the form of static pressure.

So I'll turn it over to folks who are a lot more expert and have been participants in the debate. I've been an observer. So, Tim, do you want to --

MR. MATHSON: Tim Mathson from Greenheck. Sanaee, can we put up a couple of the other slides that were on the desktop there? Yeah.

MS. IYAMA: It's called static versus total.

MR. MATHSON: Static versus total. So just to walk through the discussion a little bit, we insist on using both of these, static for nonducted fans and total for ducted fans, so that the metric correlates to the energy consumed, for one reason, and to encourage the right behavior and obtain the right results.

If you go to the next slide, there is a couple of misconceptions that I think that I know, you know, why they occur. One is that fan static pressure and efficiency is calculated from total pressure and efficiency. And I know that our standard AMCA 210 and 5801 look like that because of the way they're written. But if you look deeper into those standards, the fan static pressure is what is measured during a test, and then the velocity, the average velocity pressure, is added on to that to get fan total pressure. And then at the end, we say in order to get fan static pressure you subtract it off again.

So there's a misconception that total pressure is actually measured, but it's not. It isn't during that test. In the static -- so the fan static pressure and the fan static efficiency can just be calculated directly from the measured values.

Secondly, I think people get twisted around a little bit and think if we're not using total efficiency we'll be ignoring energy that goes into the accelerating of the air. And it's just kind of getting it mixed up a little bit. Actually, the opposite is true. If we use total efficiency for a nonducted fan, we're accrediting fans for energy that doesn't get used, the velocity pressure at the discharge of the fan. And so the difference -- the best example I think is just a sidewall prop fan, small versus large, can develop the same total pressure, can operate at the same total efficiency. But the static pressure would not be as high for that small fan because such a large portion is in velocity pressure.

What's the next one? Oh, arguments. So we've argued about this within AMCA because there are some that I'm going to say didn't understand it. But anyways, we've got a couple of pages about fan velocity pressure in a nonducted fan as being not useful energy. And other people -- Wade Smith has said that if we use total efficiency for fans without outlet ducts, it gives an advantage to smaller fans, and we don't want to do that. We want to save energy.

Mark Steven's words that he -- he talks about the industry is not willing to pay for that velocity pressure in fans. And the European regulation also understand that and uses a dual -- well, use static and total pressure, but it's not, like I say in these notes, it's not a dual metric. It's just a different measurement applied to two different fan types.

And, you know, I think one of the purposes -- we don't talk about a goal, but a goal with any metric is to have a correlation with the energy consumed. In the next slide, and I don't think this is too controversial, but in the next slide, you know, we're proposing a metric based on how the fan is tested. It would be ideal if we knew how the fan was applied, but we don't. And so we're trying to reflect that. And this is just looking at those two different cases, ducted and nonducted, and how well does the testing correlate with how they're applied.

If the fan is tested nonducted and applied nonducted, obviously the two correlate. Or if it's tested ducted and applied ducted, there's correlation there also. The bottom left-hand box, if a fan was tested nonducted, it will never be applied in a ducted situation. So that's kind of, that's a bold term there, never. And the reason I say that is because if we have any means to apply a duct to a fan, we'll test it that way because we get better results. And so the only fans that we test nonducted are those that don't have a flange or a defined outlet where we can put a duct on.

So the bottom left doesn't exist. The top right are the ones where we don't quite match up. So, if we test a fan that's ducted and it's applied nonducted -- and I listed two major ones, double-wide fans and air handlers that are blow-through, so they're not on the end of the air handler. Those would be almost always tested as a ducted outlet because they might be applied as a ducted outlet, and yet they're quite often applied nonducted.

And then utility fans that you may find on a roof that's just an exhaust fan that's fairly common in a -- which would be the responsibility of the contractor to provide an outlet duct, which oftentimes they don't.

So those are two major ones, and we could think of a lot of smaller ones, niches. But I guess that's kind of a point of discussion here is, does that require any more -- any more consideration for that corner, that quadrant, the top-right quadrant there.

MR. FLY: This is Mark Fly with AAON. When you say ducted, you're meaning primarily discharge?

MR. MATHSON: Only discharge, yes.

MR. FLY: Only discharge.

MR. MATHSON: It doesn't --

MR. FLY: Even though the fan performance will change if you duct the inlet or don't duct the inlet.

MR. MATHSON: Right. The fan performance won't change appreciably if you duct the inlet or the outlet. I'm sorry. If you duct the inlet.

MR. WOLF: This is Mike Wolf. Let me maybe phrase that a different way, Mark. For a ducted -- I mean, first of all, I think the answer is yes. It's just for ducted outlet, okay? But for a ducted inlet, for your ducted inlet, you're going to take that into account in your external static pressure calculation for selecting the fan, I think, usually. Am I wrong there? At least that's been my experience.

MR. MATHSON: Well, this is Tim again. As far as an AMCA fan test goes, whether we put a duct on the inlet or we put an inlet bell on the fan on the inlet, we get about the same performance, and the bell just represents a no-loss entry into the duct. Well, different -- yeah, different fans will behave slightly differently.

MR. HARTLEIN: Yeah. This is Dan Hartlein, TCF. I was just commenting that the inlet bell quite often is actually better than the duct, from an inlet configuration perspective. So there may be more loss in the duct than there is actually in the inlet valve as a rule.

Is there any -- a question for me would be is there any controversy to this -- to our -- because we're almost discussing it like we're trying to sell something here, and it sounds to me in the room it feels like everybody agrees that this is good.

MS. JAKOBS: Well, this is Diane from --

MR. HARTLEIN: No, we're not there yet, Diane?

MS. JAKOBS: -- Rheem.

MR. HARTLEIN: Okay.

MS. JAKOBS: So are you saying that upper right-hand box is a loophole so that the --

MR. MATHSON: Well, this is Tim. I would say it's the type of fan where the metric, which would be based on how the fan is tested, wouldn't reflect necessarily the energy consumed as applied. But in those two cases that I put there, they're very close. Those two cases are not a problem. The bigger problem would be is if we tested a fan or had a metric in total efficiency and it was applied nonducted. I mean it was -- I'm sorry. If there was a significant velocity pressure component, like a propeller fan.

MR. HARTLEIN: Diane, if I could. This is Dan, TCF. I think in my experience that square is limited where we've actually tested a ducted fan that's been applied in a nonducted configuration. There are some pretty unique applications when that happens. I'm thinking of a device we build that actually dries the greens for a golf course, for example, okay? So they use a centrifugal fan to do that. They put on a nozzle on it. Then they're trying to blow as much high-velocity air across, so they're converting a fan to be a velocity machine in that case. Perhaps it's not a fan in that case. It's doing something different.

What's that? Yeah, we do also fans -- if anybody in the room is a skier, the fans that you see in the snow machines, those are also high-velocity machines which are undoubtedly rated as a ducted fan because typically that fan would be applied, it's the anomaly that it's applied without a duct.

I had another thought as we went there. Oh, dust suppression in a coal yard, for example, we will use a very, very similar machine in order to blow mist into a dusty environment because the mist will tend to serve as a surfactant and pull the dust out of the air in the industrial market.

So these are all very, very small and unique and special applications. I would be hard-pressed -- maybe somebody else in the room could -- to come up with a large population of fans that are tested ducted and then applied unducted. I think they're the more the exception, not the rule, would be my thinking.

MR. SMILEY: Bill Smiley, Trane. I don't necessarily agree with that because in a lot of applied products, the fan is a housed centrifugal fan, and it is blasted right into a blow-through situation, just like he says on the slide.

MR. HARTLEIN: Yeah. But in that --

MR. SMILEY: So there is no discharge on the fan.

MR. HARTLEIN: In that case, there is a system resistance as well. But you're right, yeah.

MR. SMILEY: But the other point I want to make is if you look at the definition of total pressure per AMCA, which is the measured static pressure plus the velocity pressure calculated from a discharge area, and you said, well, whether it's got a duct or not, if it's unducted, the static pressure is the total pressure based on that definition because the area is infinite.

MR. BUSHNELL: Peter Bushnell with Carrier again. I had a few comments on this. First on the whole -- this chart here that we're looking at. I think this is kind of consistent with what we were talking about yesterday in the EU-327, categories A, B, C, D. So they sort of have this already set, and I think it's kind of fine the way they have it.

If you don't have an outlet duct, you should be using static pressure and static efficiency very, very clear. I don't think -- I mean, this goes way beyond sort of just sort of this industry thing. This is like basic turbo machinery. It's like in the textbooks, you know, very basic stuff.

So there's no doubt that if you don't have an outlet duct you should be talking about the static efficiency and static pressure. And so why is that really important? I think Tim was alluding to this before and some of the other folks that commented. We really want to have high static efficiency when we're driving flow out to free discharge, and one of the ways to achieve that is, as Tim mentioned, you can have a -- just say this is an axial fan. You can have a bigger axial fan. It will have a higher static efficiency because you're basically not blowing all that kinetic energy out through the outlet of the fan. You know, you're reducing the discharged kinetic energy loss.

The other way to deal with that is to put a diffuser on the outlet and recover that kinetic energy and transform it to static pressure. And these are the kinds of things that DOE should be really encouraging, is that, you know, we really want to seek energy efficiency for fans where we have these kinds of abrupt discharge conditions that are necessary in many cases, like free discharge in axial fans on a condensing system. Encouraging means for recovering that energy, that discharged energy, and minimizing the exit loss is a big opportunity.

And the previous comments about centrifugal fans embedded in systems and abruptly discharging, again, there's many cases where we need to do that in equipment due to flow distribution. We need to blow through or draw through heat exchangers that are in close proximity to the fan, and we actually achieve interaction effects that can even be favorable and help the fan and the system net performance and energy draw in those cases. But it's still like the static pressure that matters in those cases, the static efficiency, and when we achieve high static efficiency in those embedded systems where you have abrupt discharge, we're doing the right things when we drive that static efficiency.

So, again, I think it's very clear. If you look at the European regulation, they've got it figured out. I think we can learn from that. I wasn't on earlier. I don't know if you brought that back up. We talked about it a little bit yesterday. But I don't think this should be a controversial area. I think this should be really pretty clear, static efficiency, static pressure whenever we're discharging abruptly and losing the energy at the exit.

MR. HARTLEIN: So can I -- this is Dan from Twin City Fan. I agree 100 percent with what you said. My question back to the DOE, when the NODA came out, it went mostly or predominantly or all I guess to total, didn't it? And so our question is these arguments that have been made here today, it seems to me we've got pretty good consensus around it, with the exception of the NODA. So can you guys give us some insight into what your thinking was? You've had some good technical minds wrapping your heads around this for a while. Where were you with total as opposed to the total/static argument?

MS. ARMSTRONG: We're ready to vote.

MR. HARTLEIN: Ah, okay.

MS. ARMSTRONG: How about that?

MR. HARTLEIN: Great. Thank you.

MR. MATHSON: This is Tim from Greenheck. Just one more comment. As long as it looks like there's pretty good consensus here, the one -- well, Dan mentioned a couple of exceptions, and I'll just mention another one, jet tunnel fans. In the European regulation, they will be -- so that's a fan that's free discharge, but its purpose is to increase the momentum of the air, and so that's not wasted energy in that case. So what they are doing is they're rating that jet tunnel fan in total efficiency for that purpose. So there may be other exceptions to that, like laboratory exhaust fans or something, so just to keep that in mind. As a general rule, we're talking about differentiating into these two different ducted and nonducted categories, but there may be a couple of exceptions.

MS. ARMSTRONG: Okay..

MR. BUSHNELL: It's Peter again. I think even though I was kind of firm about that whole thing with, you know, the delineation, there are systems where even though static pressure is really what we're looking at, static efficiency like for say a condensing or an air-cooled chiller, we do care about the discharged kinetic energy because we need to get the heat away from the system.

And so the optimal design point for the fans in some of those systems may be not exactly right on peak static efficiency or peak total. It's kind of something that's a little bit special to really optimize at the system level. I think there have been some comments made about whether or not heat rejection equipment should be potentially exempt from this, and that's one of the -- that might be a factor, I think, is that heat rejection equipment, you need to move the heat away and use that kinetic energy to do that.

MR. SMILEY: This is Bill Smiley. To add on to that comment, a typical nonducted application of an air conditioning piece of equipment like a fan coil needs to have a certain velocity leaving the unit so that you get the throw and distribution of the cool air or heated air or ventilation air, whichever of those that you're after.

MR. BURDICK: This is Larry Burdick. I would agree with those comments that you want to remove the heated air maybe in our case away from the unit to avoid recirculation, avoid upset situations or severe upset situations in low ambient winds, or those types of conditions.

MS. ARMSTRONG: After the not-so-controversial discussion, here is where we are. What you've heard is the presentation of metric. It's been a broad presentation. We would like to get a vote before lunch, and this will be the first one. So generally speaking, this would be the fan efficiency equation. This is going to show static efficiency for nonducted fans. It's going to show total pressure at the operating point for ducted fans, or static efficiency and total efficiency and then static pressure and total pressure. So are we ready to vote, yes or no?

MR. SMITH: What are we voting on?

MS. ARMSTRONG: That. So the constants have to be determined and will be determined as we move along in the analysis. But you're generally voting on the form of the equation, the components of the equation, and then the allotment of static versus total for ducted versus nonducted, or vice versa I

guess is the way I just said it.
MR. SMILEY: Does it include the electrical portion, this brake horsepower?
MS. ARMSTRONG: Yeah.
MALE VOICE: Use your microphone, please.
MR. SMILEY: Sorry. This is Bill Smiley.
MR. BUSHNELL: Before you vote on this, you might want to be really clear on the definition of static efficiency and total efficiency from a very basic standpoint. These are the definitions of what you're using for your metrics I guess, the standard. But I'm not sure that DOE has a completely clear indication of what the definition of fan static efficiency is and total efficiency based on what I've read.
MS. ARMSTRONG: It's on the slide.
MR. SMILEY: This is Bill Smiley of Trane. It's on the slide. It's flow times pressure divided by horsepower and a conversion factor.
MR. BUSHNELL: That's not the definition of static efficiency --
MR. SMILEY: What?.
MR. BUSHNELL: -- for a fan.
MR. SMILEY: I'm sorry. What is then? Can you enlighten us?

MR. BUSHNELL: There's a definition for static efficiency for a fan is that it's the pressure, the static pressure, the product of the static pressure times the flow rate divided by the shaft input power.

MR. SMILEY: That's just what we said. We said brake horsepower is shaft input power a little bit ago.

MR. BUSHNELL: Okay.

MS. ARMSTRONG: So, Bob, I'm going to ask you, are you in a position to vote, or do you need lunch to talk with him?

MR. WHITWELL: I think I need lunch to talk with Peter.

MS. ARMSTRONG: Because you guys are on the same -- yep.

MS. WALTNER: This is Meg. I just, I have a question probably for Sanaee. I just wanted to understand, you know, did DOE have a different rationale for using total pressure for everything in the -- no.

MS. ARMSTRONG: Not necessarily. We kept the same just for an equitable standpoint, but there wasn't a strong opinion one way or the other, yeah.

Yeah. So we have one person -- Bob, we have one person that's leaving early and needs -- it would be a good idea if he could vote before lunch. Can you resolve it in five minutes or less?

MALE VOICE: We can try.

MS. ARMSTRONG: Can you go try for five minutes, please?

MR. WHITWELL: Hey. Hey, Peter?

MR. BUSHNELL: Yeah.

MR. WHITWELL: This is Bob. Can you just text me quick the phone number that you're at so that we can give you a call? I'll call you along with a couple of the other manufacturers, okay?

MR. BUSHNELL: Sure. Okay.

MR. WHITWELL: Okay, thanks. Yeah. So you can email it to me. I'll get it out of my phone, okay?

MS. ARMSTRONG: So five minutes, we'll reconvene to vote on the slide, yeah.

(Whereupon, a brief recess was taken.)

MS. ARMSTRONG: So, Sam, I'm going to ask you can you provide a 60-second overview of what we're voting on on this slide.

MR. JASINSKI: Sure. So what we're voting on here is just the general form of the equation to determine the target efficiency and based on that target efficiency what the maximum allowable brake horsepower would be at any given operating point. And we've added in red text the modification that for ducted fans P would be total pressure and efficiency would be total efficiency, and for nonducted fans P would be static pressure and the efficiency would be static efficiency.

MS. ARMSTRONG: Okay. Can you guys call a vote?

MR. BOSWELL: Okay. So a vote for, I guess we're doing thumbs up, agreement, can live with; thumbs down, not in agreement.

MS. ARMSTRONG: So, Joanna, you have to tell us your vote because you're unmuted.

MS. MAUER: Do I say that my thumb is up?

MR. BOSWELL: Okay. Okay. So I --

MS. ARMSTRONG: We'll get that. Vote first.

MR. BOSWELL: Okay. So I'm saying counting thumbs down, I'm seeing one, two, three, four. So we do not have a consensus. Our definition of consensus is if we have three negative votes there is no consensus, so I guess what I would --

MS. ARMSTRONG: Four.

MR. BOSWELL: Four.

MR. FINE: And who are the four negative

votes besides that guy?

MR. BOSWELL: Okay. I'm sorry, I'm looking at the wrong one. Somebody left the wrong stack of -- okay. So it is four.

MR. FINE: We do have a rule, but if you vote against you have to explain why. So why don't we start with --

MALE VOICE: I'll ask Bill to start.

MR. SMILEY: The reason I voted --

MALE VOICE: Excuse me. I think you only have three negative votes.

MS. ARMSTRONG: You have AHRI right behind you. Karim? Karim is the alternate for Laura.

MR. BOSWELL: He's the alternate for Laura?

MS. ARMSTRONG: Yeah.

MR. FINE: Why don't we start with you, Bill, and you can say why --

MR. SMILEY: This is Bill Smiley, Trane. There's a couple of issues I have, and I hope I can resolve them. One is I'd like to see a singular definition of what efficiency is, as like a line above that equation, that first equation. What is the definition of efficiency? And the second thing is --

MS. ARMSTRONG: I don't understand that. What are you asking for? Like what is the metric going to be?

MR. SMILEY: I want to see a singular definition of what static efficiency and total efficiency are without that middle stuff in there. I want to see it --

MR. JASINSKI: What's the middle stuff you're talking about?

MR. SMILEY: There's an equation there with a left-hand side of the equal sign, there's a part that's in between the two equal signs, and then there's a third part to the right.

MR. JASINSKI: You want a definition for this term here?

MR. SMILEY: Yes.

MR. JASINSKI: And this is not sufficient? I'm saying you want it in --

MR. SMILEY: I want a singular definition.

MS. ARMSTRONG: He wants either the middle or the right, not both.

MR. SMILEY: Yes.

MR. JASINSKI: I see.

MS. ARMSTRONG: In other words, he's asserting they're not equivalent.

MR. SMILEY: I don't know.

MS. ARMSTRONG: Okay.

MR. SMILEY: I don't know if they're equivalent. I suspect that they may be, but for the definition, I want a singular definition, not a dual definition, okay?

MS. IYAMA: This is Sanaee. Would you be comfortable if we deleted this?

MS. ARMSTRONG: Yeah, just take that out.

MS. IYAMA: And then this?

MR. SMILEY: No. I want to see what the official technical definition of efficiency is. And if you are saying that the definition of efficiency is some bogus or some bogey factor target -- excuse me. I didn't mean to say bogus. Some bogey factor target efficiency times Q over P divided by the quantities of Q+Q times P+P, that is not the industry accepted definition of what efficiency is currently. What I want to see is what that definition is. It's a simple equation you put right above that.

Now it may in the final, a month or two from now, end up being exactly what that is, but I cannot support that form of a definition of efficiency until I understand how it affects the products of the company that I represent.

I have not had four years to do all this analysis and study all this data. I appreciate all the work that's been done to get to this point and I think there's a lot of smart people doing a lot of highly technical stuff to get here, the data to back it. But my industry, my company has not had a chance that I'm aware of to evaluate this, so I cannot in a true sense vote for this until I understand what the implication is. There may be a better way. I don't know. That's why I'm voting no.

MR. JASINSKI: Can I ask a clarifying question? So it sounded like you were trying to evaluate whether efficiency STD is equivalent to the industry accepted efficiency definition.

I think the answer is no, but not because it's not equivalent and it should be, but the target, efficiency target would be equivalent to the industry defined definition of efficiency, static efficiency or total efficiency, and the efficiency STD basically is modified by that second term in that equation to be de-rated with flow and pressure to account for the inherent difficulty in achieving higher efficiencies at lower airflows and lower pressures.

Am I right in that, Wade?

So all I'm trying to clarify is that for your exercise the comparison should be between -- the intent is that efficiency target is equivalent to the industry definitions that you're talking about, not the efficiency STD.

MALE VOICE: Make that clear.

MR. JASINSKI: Okay.

MR. SMILEY: Bill Smiley, Trane. If you would make that clear --

MS. ARMSTRONG: You can suggest stuff.

MR. SMILEY: If you would make that clear, that would be very good.

MR. JASINSKI: Okay.

MR. SMILEY: Ashley, you had a comment?

MS. ARMSTRONG: I said you can make suggestions.

MR. SMILEY: I just did. That's a suggestion. I still cannot vote for that form of the equation that you have up there because I don't understand how that interacts with the products that my company manufactures.

MS. ARMSTRONG: But that's like saying --

MR. SMILEY: I have not had a chance to evaluate it. I don't know if that's the right form. It might be there should be a squared function in there.

MS. ARMSTRONG: So can I ask a question then?

MR. SMILEY: It might be a log function in there. I don't know.

MS. ARMSTRONG: Are you taking the position then at the table that you're not going to vote on anything until you determine if you agree to the standard level at the very end? Because that's what you're saying. Until you can agree to how the standard impacts your company, are you not going to be voting on anything? Because I think the committee should know that, because we can't make progress that way. Is that your position?

MR. SMILEY: This is Bill Smiley, Trane. That is not my position. My position is I need time to evaluate, understand, and analyze what all this is going to do to my company so that I can make an intelligent vote on what I think is right and what we think is right. You're asking for us to --

MS. ARMSTRONG: We're not voting on the targets, right? We're voting on the form of the equation.

MR. SMILEY: I know, I know we're voting on the form of the equation. I just told you I don't know that I would agree that that's the correct and only form the equation could ever be in. I don't know. Maybe there's other function that would be better.

MR. MATHSON: A comment. This is Tim Mathson from Greenheck. I can understand there's some confusion because there's several steps that are included in one line here, and I think if we just separated those out step by step it would be more clear as to what we're voting on.

MR. FINE: Well, at this point, just as sort of a procedural way to end this, I think there should be some more discussion on the point that Bill's raising. It would be valuable to talk about it more. But maybe we could first go and let everybody be heard who had voted against it. Maybe they'll have some of the same common concerns, and then we can deal with the concerns and see if we can't, how do you want to say it --

MS. ARMSTRONG: Okay. That's okay. Do you want to? I mean, I think at this point, you know, we go to lunch. I mean, that's where we are. This is the most simplistic thing we need to wrap our hands around in order to start making progress with metric and then test procedure analysis so you can actually talk about levels and see how things might impact your company. You know, this is how we have to move forward.

We can try to break down this into components. Actually, why don't you guys try and break this down into components as to what you would like to see and bring it back to the group for discussion after lunch so we can move forward. I think that's reasonable.

MR. BOSWELL: The other thing that I would say is, you know, the whole idea with trying to reach consensus as we go along is to kind of build towards a final term sheet. Ultimately there's a vote on the final term sheet so that if other complications come up that people didn't anticipate, I don't think that a vote on any particular matter forecloses that. It's just a way of trying to build towards seeing if we can reach consensus on a term sheet.

MR. FINE: So why don't we take a break for lunch and come back and --

MR. BOSWELL: It is now about 10 after 12. I presume some people are going to want to talk during lunch. And we're breaking at 3:00 today as I recall.

Okay. So we will return at 1:00.

(Whereupon, at 12:09 p.m., the meeting in the above-entitled matter was recessed, to reconvene at 1:00 p.m. this same day, Tuesday, May 19, 2015.)

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A F T E R N O O N   S E S S I O N

(1:14 p.m.)

MR. JASINSKI: Okay. So, to pick up where we left off, I think we want to resume the post-voting discussions. We're going to allow all the "no" votes to provide their explanation for why they're voting no, give them an opportunity to present any alternatives if they have them, and if they don't have an alternative ready to be presented, to explain a path forward in terms of what they're willing to do to get to an alternative and on what time frame.

So we'll just kind of go through that methodically, give each of them a chance to make those statements, and then after that I think what we will do is just continue to show what the department has done in terms of metric, test procedure, et cetera, just so that we can get feedback on those things that have already been done and inform everyone else of what those things are.

So, Bill, I think we left off with you. You just handed me a note to try to clarify some of the changes that you were suggesting. But why don't we start over now that everybody's food coma is starting and we'll just, you know, explain why you voted no, any alternative, and if you don't have an alternative what the path forward to get an alternative would be.

MR. SMILEY: Okay. Bill Smiley, Trane. The addition I asked for to be added to this slide was the singular definition of what efficiency is, and I gave you on a piece of paper what that efficiency would be for both static and total. The difference would just be the pressure.

MR. JASINSKI: Right. I have the static one here, but the changes would be that the fan efficiency would be total fan efficiency and the pressure would be total pressure.

Is this big enough for everyone? I can try to make it a little bit bigger.

MR. SMILEY: Now the second comment. In general, I agree that an equation that compensates for operating a point on a fan and a fan selection that is based on performance with some adjustment for flow and pressure similar to what's shown up there is a good thing. I appreciate all the work that AMCA and DOE and you guys have done to develop this metric. The only problem I have is the form of that equation. I don't know if that's the optimum form of the equation based on the products that my company makes. I was told that somebody from my company participated in this and I will have to check with them and get a data dump from them.

In general, I agree with the concept of having an equation similar to this. What I don't know yet, because I have no data to back it or no knowledge, is should that be exactly the form where you add a little bit of CFM and you add a little bit of pressure to come up with the relationship. That's what I was voting no against. I was understanding that if I voted yes that would be written in stone and could never be changed. If that is not true, then restate what we're voting on, I may change my vote. I don't know. I don't know the procedures and the process here, but that's basically my comment.

MR. JASINSKI: Okay. We were voting on the general form, so what I would -- but it's good to know that you are in general agreement with the concept. So I think in keeping with the ground rules we would just ask what is -- so you don't have an alternative immediately. What can be done to get that alternative? What can you do to get that alternative and what's the time frame to do it?

MR. SMILEY: I would say by the end of the week if he's available I can consult the other person within the company that did a considerable amount of work on this.

MR. JASINSKI: Okay.

MR. SMILEY: And I would defer until I get to that point. I make an assumption now that he considered all products in scope and that his data dump and opinion is valid, but I would reserve that if he did not consider all potential products that I may request a little more time to evaluate that.

MR. JASINSKI: Okay.

MR. SMILEY: But again, in concept, I'm agreeing with this type of methodology. I'm not trying to stall anything. I'm not trying to be a roadblock. And I know some people's perception is we've had a long time to think about this and to look at it and work on it, but to tell you the truth, I haven't.

MR. JASINSKI: Okay. So I think that's a good example of exactly what we want to hear in terms of making progress. So for each of the other "no" votes, I would say if you follow, if you do exactly what Bill just did, I think that's what will be most helpful. So I don't know who wants to go next. Larry, did you want to weigh in?

MR. BURDICK: I have a message that they can't hear on the webinar.

MS. ARMSTRONG: We're working on it.

MR. JASINSKI: Okay.

MS. ARMSTRONG: We have to get our audio folks in here.

MR. BURDICK: Okay. So Larry with SPX. One of the things that I would be interested in is seeing, you know, what the further development of this is. You know, there's been two different NODAs published, have evaluated, you know, the one that's labeled NODA 2, was not, you know, necessarily certain that it was working properly or what all that consisted of. You know, we'd like to see, I think I'd like to see a full explanation of that, you know, as part of this.

In general, I'm in agreement with, you know, this page, but I don't know how it affects, you know, things downstream.

MR. JASINSKI: Okay. So I think we're planning to get into --

MS. ARMSTRONG: I was going to say I think at our next meeting our plan is to walk through the NODA analysis and those spreadsheets, so hopefully that will give you the tools necessary to come to an opinion on this one.

MR. BURDICK: Yeah. And, Ashley, I would request that we have that available to everyone, you know, well before the meeting so that we can perform what if's and other scenarios.

MS. ARMSTRONG: Tools?

MR. BURDICK: Yes.

MS. ARMSTRONG: So they're available now and I've downloaded them out of our docket and I can get them working. So, if you've downloaded a version that's not working, let me know after the meeting so we can fix that.

MR. BURDICK: Fair enough.

MS. ARMSTRONG: Because they should be able to be working now, the same ones that have been in the docket.

MR. JASINSKI: Okay. I think that's two out of the four. Do we have -- go for it.

MR. AMRANE: This is Karim with AHRI. I think I consider the same as Bill. I think with the addition here, I think we're fine with that.

Regarding a vote, I think it would be good if we decide to vote on this slide that at least this vote should be contingent upon having the possibility of modifying this equation. If there's new data that shows that we can modify the equation in the future or if you want to give us more time to come back, you know, at the next meeting with a definite yes or no. It's up to you how you want to proceed.

MR. JASINSKI: Okay. Next meeting. We'll take care of it on the next meeting. There was one more.

MR. ROY: Aniruddh Roy, Goodman. I share some of the same concerns as Bill and Karim mentioned and they've been addressed through the conversation, so no further comments.

MR. JASINSKI: Okay. Thank you.

So I think at this point we will just continue with a little bit more information in terms of the test procedure. I think it's going to come in the form of just kind of a list of some information that we're seeking.

MS. IYAMA: All right. So we've got two sets of slides. The first one is sort of an overview of the default values that were mentioned earlier to get to the wire-to-air metric. Let's see. Okay. So let's see if I can open the previous presentation.

(Pause.)

MS. IYAMA: Okay. So earlier we saw this concept of adding default values to get to wire-to-air metric, although we would be testing for shaft input power, so that's when establishing the consumption of the fan.

And then here, that energy consumption of the fan would be compared to the standard level, so based on that fan efficiency equation that Sam talked about, combined with default values. Default values for the motor, transmissions, and then for the fan, if it's sold with controls, default values for the controls. So that's what we're going to go through here.

So for default values for the motor, when calculating what in the NODA is called FER standard, which would be the maximum allowable electrical input power of the fan, we used motor efficiency values that were at the level of the upcoming standard for medium electric motors. That's sort of a description of what the scope of that regulation is, the medium electric motor's regulation. Basically it's three phase AC induction motors.

Some of the exclusions which are pretty important when we're looking at fan is that this regulation doesn't cover totally enclosed air over motors which are often used to drive fans.

MR. SMILEY: Excuse me. This is Bill Smiley, Trane. What regulation are you talking about that doesn't cover the TEAO motors?

MS. IYAMA: The medium electric motors.

MR. SMILEY: Oh, okay. The NEMA code.

MS. IYAMA: The DOE regulation.

MR. SMILEY: So is this a new DOE standard that's coming out?

MS. IYAMA: So the final rule has been published and I think it's going to be starting in 2016 if I'm not mistaken.

MR. SMILEY: So a new motor efficiency standard covering what motors again?

MS. IYAMA: These motors.

MR. SMILEY: So this is an update to the prior standard?

MS. IYAMA: Yup.

MR. SMILEY: So we'll be having new motors that we'll have to qualify for all our equipment presumably.

MS. IYAMA: If it's motors in the scope of that regulation which are described on here, which basically it's AC induction, three phase motors, with a few exceptions that are listed below. And I think for fans the most significant one is the TEAO motors.

So, you know, the idea is that those default values are going to be representing sort of the conservative side of the efficiency of a motor found today on the market, and so here in the NODA and in the calculation of the metric these are the values we used.

I'm also going to present in the next slide some default values for TEAO motors. These were not used in the NODA. It's just to show one way that we could do this and get feedback from the working group.

MR. HAUER: Sanaee, it's Armin Hauer of ebm-papst. Are you using minimum efficiencies or nominal efficiencies according to the regulation?

MS. IYAMA: So I'm going to go through those values in the next slide. So for motors that are AC three phase and regulated motors, we would be using those default values which are here. And again, that's up for discussion, but what we have in the first table is the table that comes directly from the CFR, the medium electric motor regulation where, you know, they have one nominal efficiency value for each motor category, which is a combination of enclosure, pole, and horsepower.

Now, if you have a bare shaft fan and you need to calculate the wire to air, you know, what enclosure do you choose? That's the first question we had to find a solution to, and then what pole configuration do you choose and what horsepower do you choose?

And in the NODA, and again, like if you have feedback on that, we can address each of these sort of selection criteria for picking a default motor. In the NODA, we didn't know what the pole would be. We didn't have speed information. What we had was a lot of market data on the pole configurations that are sold on the market and some speed data from one manufacturer. So we ended up using sort of a market average across all pole configurations. The exact weights are in the LCC spreadsheet and I can pull that out afterwards.

Now, in selecting the horsepower for the default motor, what we used was simply sort of a sizing factor on the fan BHP which was of 1.2. And that's pretty much it.

And then on the enclosure, since we wanted to stay on the conservative side, we picked the minimum nominal efficiency between enclosed and open, whichever is the lowest.

Now let's say you're trying to evaluate a fan that's sold with a TEAO motor, so you have your electrical input power for that fan and you're going to compare this to the maximum allowable electric input power of a, you know, minimally compliant fan. So we have that efficiency equation. We can get the shaft input power. Now we need to get to the drive system. And in order to have a more comparable, a more fair comparison, instead of using the same default values, we developed default values specific to TEAO motors, which are currently not regulated. And if we look at the data we found on the market, for motors on the market, which are less efficient than other regulated three-phase induction motors.

So what we did is we looked at, you know, a list of catalog data from different manufacturers. We looked at where those values, those nominal efficiency values compared in comparison with the premium level or the level of the regulation, and so that's what you have on the left-hand side of that table. We use the term NEMA Band to try to see sort of how many NEMA Bands below NEMA premium are the TEAO motors, and that sort of varied by pole and horsepower. And based on that information we developed some TEAO default values, which are kind of, you know, they're expressed in terms of a number of NEMA Bands below the current regulation. And then for the selection of the pole or for the selection of the horsepower, then that would be the same process.

And so that's just a summary. So, you know, if you're trying to calculate the metric for just a fan that's sold without a motor, without controls, there's no motor, so you would use the default values corresponding to the regulation for medium electric motors. But that's only if it's a fan only.

Now, if it's a fan sold with a motor, or later we'll see fans sold with a motor and controls, if it's a regulated motor, you can just use the name plate nominal efficiency of that regulated motor, and for the calculation of the maximum allowable electrical input power you'd use the default values. So if your motor is better than, is performing above the current regulation, the metric would show that.

MR. SMILEY: I have a question. Bill Smiley, Trane, of course. So for a motor, you select the motor based on 1.2 times the fan brake horsepower to size or select what the appropriate motor horsepower rating would be. But the fan will operate on that motor at less than the motor full load. But the default efficiency value that you are using is based on the full load motor. So there would never be a reason to actually test the motor. You would always take the default.

MS. IYAMA: So there is actually another component to the -- that's sort of how we pick the default motor and its nominal efficiency and then in the next slide we'll see how we calculate the part load.

MR. SMILEY: Thank you.

MS. IYAMA: Now, if a fan is sold with a motor that's not regulated, you know, you can't use the name plate efficiency because it's not a regulated motor. So instead, it's a TEAO motor, you could use the TEAO default values that we just --

(Audio echoing.)

MS. IYAMA: Hello? Okay. So that would be, you know, when using the calculated based method to establish the electrical input power of your fan. If you're sold with a TEAO motor, you would use the TEAO default values.

And then when you're trying to get to the maximum allowable electrical input power, you know, you could use the same default values. There's different ways depending on what or how we want to do this. You could also use the same default values. But then, you know, you'd be sort of, you'd be negatively impacted if you're selling your fan with a TEAO motor because you'd be comparing your fan with a TEAO motor to a fan with a non-TEAO motor. So that's option one, option two.

And then for any other electric motor, you know, for now we would consider them similar to how bare shaft fans are rated, meaning there's no test procedure for that motor if it's not possible to get representative default values for these motors, rate them as a bare shaft fan. So that's just a summary of how we selected the horsepower --

MR. WHITWELL: So sorry, could you explain that again, what you do with the other electric motors?

MS. IYAMA: So we didn't do anything. It's just something that we need to think of. It's easy to establish default values for regulated motors. It's fairly easy to establish values for TEAO motors. But there are other motors like, I don't know, split phase or PSC motors, ECM motors that are out there that are driving fans. And so for those, what should we do?

MR. HARTLEIN: Sanaee, one of the things I don't see up there as well -- this is Dan Hartlein, TCF -- is the possibility, if that's an unregulated motor, or for any motor for that case, that a tested value would supersede the default value.

MS. IYAMA: Yes. Right.

MR. HARTLEIN: So does that go without saying I guess?

MS. IYAMA: Yeah. I think one thing to highlight is that in that table it says calculation-based method, so that's just for that scenario where we're --

MR. HARTLEIN: Ah, okay.

MS. ARMSTRONG: Hold on. What do you mean by tested value?

MR. HARTLEIN: Meaning that if I take a --

MS. ARMSTRONG: Tested value for the whole system or just the motor?

MR. HARTLEIN: If I take a motor driven fan and I measure the power in and the fan performance out --

MS. ARMSTRONG: I got it. That's fine.

MR. HARTLEIN: -- that should substitute.

MS. ARMSTRONG: Absolutely. So the question, though, is do you want that always to trump or do you want the manufacturers still to have the option? We can set the regs up either way.

MR. HARTLEIN: I'm not sure.

MS. ARMSTRONG: Well, think about that. That's something we'd like feedback on obviously. What's not here --

MR. HARTLEIN: I have a lot of votes for option, but I'm not sure. Let me think about it.

(Laughter.)

MS. ARMSTRONG: What's not here is testing a motor. You either test the system or you use the default values. So that's where we are. And like Sanaee said, we don't have default values for all types of motors, so if we end up finalizing as proposed and you have a different type of motor that's not in here, you would need to test the system, the full wire to air, yeah.

MR. HARTLEIN: And I'm assuming we could extend this to include controls like a VFD as well, in the same discussion basically.

MS. IYAMA: So we'll get to that in the next slides.

MR. HARTLEIN: Okay.

MR. SMITH: This is Wade. I'm not challenging what you said at all because I'm not sure what position we would want to take in any event, but is there a reason why you wouldn't allow a manufacturer to characterize a particular motor and then use it on several different fans with mathematics? Test a particular motor, characterize it, and then use the results of that test coupled with fan tests?

MS. ARMSTRONG: So I think from a high level point of view, in theory, I don't think or I guess in principle I don't think DOE has an issue with something like that. What we don't have is test procedures for all different types of motors to make sure they're tested in an equitable manner since all the defaults are derived in an equitable manner. So that's what's missing, and we wouldn't want to be a manufacturer-specific declaration of a method of test to get a motor efficiency to then use as default values. So, like I said, we're not necessarily opposed to the idea, but the hurdle is the absence of a test procedure that exists for a lot of other kinds of motors that are currently not subject to standards.

MR. FLY: This is Mark Fly with AAON. Ashley, and I'm not familiar at all with the motor test standards, but I'm sure you are, but are they looking at part load efficiencies in part of that standard, or is it a full load only test?

MS. ARMSTRONG: Right now it's full load.

MR. FLY: So your test method is only full load.

MS. ARMSTRONG: Right now.

MR. WHITWELL: Ashley, this is Bob from Carrier. So a follow-up question on this, and maybe I'm way ahead of where we need to be on this. So, if we're using regulated motors and we have multiple regulated motors that can go into a particular product, can we test the smallest or let's say our base regulated motor knowing that higher horsepower motors are going to be higher efficiency?

MS. ARMSTRONG: I think that's something for the group to discuss. You know, these fans that are coming up with the operating type metrics that operate in a certain range don't, for lack of a better term, cross-pollinate parts. They would be rating every point for that specific fan and system in the testable configuration.

So what you guys do for air conditioners and what DOE allows you to do is this concept of you can test a base model and then you can switch out otherwise larger types of motors and not have to test and rate all of them such that that motor's efficiency is roughly equivalent to or more efficient than the base motor is the concept in theory.

There's nothing like that in fans right now at least that we're considering. I guess if we had a reason to consider it or you had a suggestion or alternative that you wanted us to consider we could talk about it.

MR. WHITWELL: Yes. So I guess as we go forward we need to think about those kind of things, because I'm concerned about the test burden that we'll be under.

MS. ARMSTRONG: Why wouldn't you just use the defaults?

MR. WHITWELL: I don't know. I don't know yet.

MS. ARMSTRONG: I mean, that's what the defaults get you, right?

MR. WHITWELL: Maybe. Maybe we will want to use the default. I don't know.

MS. ARMSTRONG: To the extent you get a different default value because your motor has different properties, but that's what the defaults get you. They get you around that test burden in all those different combinations in theory. They give you default values so it's just a calculation.

MR. WHITWELL: So, okay, so we could -- yeah, all right, I see. We use the default value for all the different motor combinations.

MS. ARMSTRONG: You could. I mean, unless you wanted to run the full test, you just use the default and run calculations. It's kind of like, in essence, it's partially an AEDM that we're putting in regs, a standardized one.

MR. SMILEY: Bill Smiley, Trane. Along those same lines, Bob, I think you would have to somehow in your test measure directly the fan power in order to use the default, because you need the fan power in order to apply the default of the motor. So you'd have to do the test and actually measure the fan power.

MS. IYAMA: So I want to go back to this slide because I think it's relevant to what Bill's saying. So, in a calculation-based method, which is when we would use the default values, this is where you would measure. It's the shaft input power. And in the wire-to-air test you wouldn't be using -- it's that bottom row of the table. The test output would cover the whole thing, so you're not using default values.

MS. ARMSTRONG: Right. So, to answer your question directly, if you use option one, you would use these defaults for your different combinations, as long as you got to the same default you would get to the same default rate.

For the bottom one, though, the bottom ones would show up with different variations to the extent the motor transmission controls the result and variances that affect the FEP. But your default would be a way to streamline. So we've implemented here a different way to get to the same I think burden reducing type of scheme.

MS. IYAMA: Okay. So that was for the default values. Just a summary and we could also get feedback on those points that would be useful. So the sizing of the motor based on the 1.2, we could do it, you know, with a different multiplier. We could do it based on constant motor horsepower, especially when the fan is sold with a motor. For the motor enclosure we chose the enclosure leading to the lowest nominal full load efficiency. We could also do it as a sales weighted average like we're currently doing for poles. These are things that are up for discussion.

And then the next slide here is the equation that was used to get to part load efficiency. And, you know, we're also reviewing the draft 207 that AMCA put out. They also have another way of doing this. There's also, you know, in Europe other ways of doing this. This is how they did it in the pumps rulemaking. So the first equation here is just the losses of the motor at part load equal the full load losses times a factor, and that factor is a function of the load. And where did we get those coefficients? Well, we got them from analyzing data that was submitted by NEMA during the pump rulemaking process and ASRAC process.

MR. SMILEY: Question. Bill Smiley, Trane. So that polynomial curve fit was supplied by some data that you got from NEMA and is that -- that's assuming that every motor, every size has an off design efficiency reduction of the same amount?

MS. IYAMA: Yeah, and in a very conservative way. It's a pretty --

MR. SMILEY: Do you have the data that NEMA gave you? Is it a function of horsepower and poles or what?

MS. IYAMA: I think it's probably published as part of the pumps rulemaking. It's probably in the docket there. I don't have it with me.

MS. ARMSTRONG: How about we'll check and if it's in there we'll circulate it. We can also get someone from NEMA Motor Coalition to come in here at the next meeting and kind of present what they did, because they were the driving force behind this estimate in the pumps negotiation.

MR. SMILEY: I think this is excellent. My interest is --

MS. ARMSTRONG: Are they the same type of motors.

MS. IYAMA: I can tell you about the methodology.

MR. SMILEY: I would like to see what the data is because I could use that in some unit design work that I do.

(Laughter.)

MR. SMILEY: Okay? If it's available. Thank you.

MR. FLY: This is Mark Fly with AAON. As you went through this and you did the 1.2 times the fan, as I sell this in a piece of my equipment, if I'm not 1.2 times the fan horsepower above, do I rate it at 1.2 or do I rate it at the actual applied? Because maybe I'm 1.0 because that's what the customer -- I mean, basically we let the customer select the motor and the fan, and what I'm going to have to do with all of this as I'm thinking ahead is I have to be the application police to make sure that they select something within that's legal.

MS. IYAMA: There's the case when you're not selling a motor with your fan, and then you need to know what's your multiplier to select the default motor and you want everybody else to do the same, so that would be 1.2. And then the case when you're selling a motor with your fan. And then, you know, do you use the actual horsepower of the motor provided with your fan? Keep in mind that you would be comparing that electrical input power to the theoretical one, the maximum allowable one, and for that one the motor would probably be sized, you know, with the 1.2 factor or whatever factor you agree on.

MR. SMILEY: Well, I think what you're saying -- Bill Smiley, Trane -- is that if you test with a motor, you don't need to worry about the 1.2 because you're testing with the motor and the motor sized at .9 or 1.4 or whatever.

MS. IYAMA: Right.

MR. SMILEY: Because a lot of times it depends on the load compared to the motor full load, where 1.2 may not be --

MS. IYAMA: Right.

MR. SMILEY: But if you don't know any of that, you use the 1.2 in order to develop into the default values, right?

MS. IYAMA: That's right. Correct.

MR. SMILEY: Correct. Thank you.

MR. FLY: This is Mark Fly with AAON. What I want to do is click the box that says this is a good fan in this unit, right? So do I need to analyze it with the motor I supply? If I'm supplying a motor, is that always the case, or has that not yet been decided?

MS. ARMSTRONG: So what I heard I think at the beginning of it is you guys want the option to elect to do -- potentially. We're still deciding, but, you know, that you guys want the option to do one way or the other at your discretion. And so we either standardize it with the 1.2 nominal or you do the full test. In other words --

MR. FLY: Because one way is saying at this application point this fan alone is valid.

MS. ARMSTRONG: Yep.

MR. FLY: You know, with all the assumptions attached. And the other way is saying that at this particular operation point this assembly with the controls and everything through a calculation default method is valid. So I think it could give you two different answers.

MR. DIKEMAN: Ashley, let's go this other way. Above and below the line.

MS. ARMSTRONG: Yeah, I hear what we're doing. I think we were --

MR. DIKEMAN: No, no, no, please. Here's the motor losses. If they're the same above and below the line, the default VFD losses are the same above and below the line, it all comes back to impeller BHP. That's the difference between the required performance and what you're actually doing. Default is the same above and below the line. It washes out. It comes back to impeller BHP.

Now, in Dan's case, he brings in a different case. He tests this motor drive bumper to bumper. Now he can bring a new performance into the conversation. But defaults are above and below the line, they wash. You don't have to be motor -- you used a six pole motor, but the rulemaking is done on an average motor. You're not getting penalized for that either unless you test the six pole motor. Now you're dragging along some additional inefficiency.

MR. HARTLEIN: This is Dan from TCF. I would also add to that that there are certain areas, for example, high-performance axial fans where we probably know more about that air over motors performance with that flow than NEMA does and we're better at it than they are, so we can do things with that fan and design that the standards that NEMA would provide or the motor manufacturer wouldn't have because we've actually tested that fan in that configuration, and so therefore we know actually what that motor is consuming because of its air over and the capacity for us to get additional cooling to that motor and keep them at optimum temperature. So we, in some areas we've actually gone beyond where the motor guys are in applying their product and ours.

MS. IYAMA: Dan, just on that, this equation was developed based on data provided by NEMA, but the default TEAO values that I showed, that was not. That was just us looking at catalog data, TEAO ratings that are available.

MR. HARTLEIN: Yeah. Thank you, and I would just like to add that I didn't state that we knew more than the DOE.

(Laughter.)

MS. IYAMA: All right. So next slide is --

MR. SMILEY: Excuse me, Bill Smiley, Trane. This equation does not apply to TEAO or it applies to any motor?

MS. IYAMA: It would apply to, yeah, all types. Yeah.

MR. SMILEY: Okay.

MS. IYAMA: So here I was going to put the equation we use for the transmission efficiency, but those slides were actually not really finalized, but they're in the spreadsheet, so we can go over that a little later. But the main thing is it's the same form then, what AMCA uses in its AMCA 203 standard, and I don't know how familiar you are with that document, but in that document they have three equations to represent belt efficiency, one with higher losses, one with medium losses, and one with low losses, and we use the high losses because we want to be conservative.

Now for fans with motors and controls --

MR. WOLF: Sanaee, Mike Wolf here, at the expense of slowing you down here a little bit. Mike Wolf with Greenheck. So, with the transmission losses, you used a worst case even though there's three different scenarios in AMCA 203, right, I think? And you said you did it because you wanted to make a worst-case conservative rating I guess, if you will.

Why would we not have used that same methodology or assumption with all the motor data that we ran? And the reason I ask that is I'm starting to think ahead a little bit to what we're going to publish to the field and how this whole thing is going to work down the road, you know, kind of relative to the catalog page Tim showed here earlier where you've got the products that are in or the selection range in compliance and then those that are out. And I'm just starting to get concerned that okay, so we're going to have different motors that might be in compliance or out of compliance depending on what motor default coefficient we use for our rating.

Steve, you're looking puzzled. I'm not sure I'm being clear. So I guess to simplify the question, why don't we just the worst case for the motors too and keep it simpler?

MS. ARMSTRONG: I agree.

MS. IYAMA: So here, when we say that we're using the nominal efficiency values as established by the regulation, that's pretty conservative.

MR. WOLF: Right, but go to your slide where you have the green. Yeah, okay. So there.

MS. IYAMA: So these are going to be the minimal nominal efficiency values that you're going to be finding on the market once the new medium electric motor regulation comes into force.

MR. WOLF: Okay. So it's a minimum based on the horsepower. But then you had another one for the TEAO I thought that you came up with.

MS. IYAMA: TEAOs are even lower because these are nonregulated motors, and we felt like since they're so -- they represent a pretty significant share of the motors that are sold with fans, we should try to develop default values for those, especially because they're even lower than the ones on the market.

MR. WOLF: Just to make sure I'm understanding this right. So going forward if we're going to look at say a given fan, let's say running at one, roughly one horsepower, it might have two different ratings, two different, and I think I'm saying this right, two different FER calculations depending on whether I'm calculating the FER with a totally enclosed air over or a standard motor or if I --

MR. DIKEMAN: Or a belt drive.

MR. WOLF: Say that again, Steve.

MR. DIKEMAN: Steve Dikeman. Or a belt drive.

MR. WOLF: Well, but I'm assuming they both have belts.

MR. DIKEMAN: Okay.

MR. WOLF: Okay. But that would be a fourth one. You've got a direct drive without belts, and then you could have another one where you've got your own motor that you've done wire to air, so I'm just trying to think through how many permutations of ratings are going to be out there.

MS. ARMSTRONG: So, as you presented the question that way, I think you raise a completely valid issue and that is if a given fan is offered with a number of different motors, which default value do you choose? And do we really need -- does the committee think we really need a variety of defaults, or can we just say this is the default motor? It's not by type. Do we need to actually characterize it by type, by motor type? Or can we just say this is the least efficient motor and if you use default values, that's what you get?

MR. WOLF: So Mike Wolf here again. So I'm thinking about, okay, we're going to establish some base level here, and ultimately what we're trying to do is drive the manufacturers and the market to more efficient, better selections. So, as I go through the thought process here with looking at how I calculate an FER, well, one way to get a better FER is to eliminate belts, right? Because I have a worst-case scenario, so I think that's obvious. I'm just wondering if we've got multiple motors, you know, we're going to drive people to a certain motor, which that's probably the desired outcome here. I just want to make sure that what we're doing is driving the right behavior after this is in place. And having multiple metrics I don't think is the important thing. The important thing is having the right things accounted for so that we can again --

MS. ARMSTRONG: So I think a question, though, is do you guys want the ability to rate different kinds of motors, perhaps differentiate between more efficient kinds of motors in a different way other than tests? Because if we don't provide default values for different kinds of motors you preclude yourself from ever differentiating by motor efficiency if you don't test full wire to air. So that's really a question for you guys.

MS. IYAMA: I can give another example just to illustrate the sort of issues that you would think through. Just here, for example, so when you're using a calculation-based method and you're trying to establish the electrical input power of your fan, but you only did a bare shaft test. So, if you were to use the TEAO default values to represent the motor that you're selling with your fan or if you were to do a testing-based method where you would, you know, establish electrical input power of your fan based on the TEAO performance, you would be comparing that to the column that's right on the left here where the electrical input power of your minimally compliant fan is calculated with the default values. If that default value is equal to the regulation, you may be, you know, in a different position than if that default value is equal to those TEAO values that we just showed that are lower.

MR. MATHSON: A comment. Tim Mathson from Greenheck. A couple of comments. One is I think what we're weighing here is simplicity with accuracy probably. That's kind of what it sounds like. If we go with single numbers for defaults, that makes it more simple but maybe not quite as accurate. So that may be something that we're weighing.

Another comment that I would say is the AMCA 203 belt losses or drive efficiencies that you get from AMCA 203, in AMCA 207, which is still under development, we're using the middle curve, that average one. And, you know, nobody has good information on belt drive performance. I only have the information, I've tested maybe a dozen combinations and never gotten as bad as that most conservative line. So I personally think it's a conservative standard, but again, that's only on a dozen drive combinations.

And the third thing to keep in mind is that as we compare belt drive with direct drive, we want to incentivize the use of direct drives, but we want to be somewhat realistic because a belt-driven fan running at 800 RPM still uses a four pole motor, which is much more efficient than an eight pole motor. So it may be weighted a little bit too much that way if we use a single number for all the poles. Does that make sense?

MR. PERSFUL: This is Trinity with Clarage. To address Ashley's question about should you use one default value regardless of type of motors or multiple, I would say it depends on what type of behavior we want to drive. If you use just one, I think in my mind I call that the least common denominator, and it's going to drive -- and if it happens to be the cheaper motor, it's going to drive people to use the cheap, less efficient option. If you have multiple ones, it's now going to reward people for using a more efficient motor. So I would suggest that you look at it.

MR. WOLF: I think we need to think about this and get back to it.

MS. ARMSTRONG: Well, so if we pick a default motor and it's just one nominal value and that one nominal value is the same value used across the board no matter what, you would never be able to claim the savings you might get from using a more efficient, different type of motor, thus incentivizing -- you would lose that differentiation, period, unless you test.

So I think to Mike's point, if you want to incentivize the differentiation and you're going for labeling differentiation, utility program differentiation, et cetera, et cetera, what you really want is default values, conservative default values, but default values for all the different types of motors, that we can come up with reasonable default values that they're tested the same. At least then you wouldn't necessarily see the difference in efficiency within a motor category, but you would be able to see that certain types of motors, perhaps those that are subject to standards, are more efficient just generally than other types of motors that are currently unregulated, like TEAO motors, and you may be able to make better choices.

MR. DIKEMAN: So, Ashley, may I take that one step further? If the default motor efficiency is reflective of four pole, just for purposes of conversation, and you happen to live in a 1200 six pole motor world, and you went and tested your six pole motor, you're going to struggle to get back to the bench line. So, if 1200 can stand by itself and 1800 can stand by itself, I think you'll get more of what you want.

MR. HARTLEIN: So I would argue a little bit to the contrary. Dan from TCF. And I think you have to look at the behavior of fan manufacturers to totally understand this, and if there's an advantage to be gained through a testing program, it's going to be done. So, if I can save a motor class, if I can save a motor frame, drop to a lower frame size because I went through the testing, attached a VFD, did all that work, I'm going to do it because it gives me an advantage in the marketplace. I'm going to rate my product according to that.

If I don't need those default values to incentivize the operation to do that, because we're going to do it because we're going to take that advantage. Because if I can stay down a frame size in motor and my competition can't, I'm going to get the order and they're not. So I would think it's going to happen anyway. That's basically the way we're going to behave.

MS. ARMSTRONG: Okay. So you guys might want to think about this a little bit. I think we can do it either way. Obviously DOE, as a policy position, we want to incentivize more efficient systems, so we want to give you the tools, whatever that is necessary.

One thing to think about when you're talking about your method, Dan, is that, I mean, you're talking about testing every variation out there. If you have a fan that an accessible configuration is offered with different motors, is offered with -- you would then be testing --

MR. HARTLEIN: Can I ask a question? This is Dan, to that.

MS. ARMSTRONG: Yes.

MR. HARTLEIN: Not having been through the gristmill of DOE regulation before, so if I as a manufacturer take the information and knowledge that I have on how my products perform across the range with particular motors and things and I choose to make the decision to rate that at a certain point, so I apply those standards to rate that product and to represent it as being something that I'm sure it is, then I'm falling well within the reg. I don't have to test, right? The only thing is you may test and I better be right. Is that correct?

MS. ARMSTRONG: No.

MR. HARTLEIN: No, it's not?

MS. ARMSTRONG: No.

MR. HARTLEIN: Okay. So help me understand.

MS. ARMSTRONG: So the way this works is

your ratings must be based upon the DOE test procedure, must, and applicable sampling provisions. So, if we don't provide you with a method in the test procedure to either extrapolate to other ratings, nontested ratings, so calculation-based ratings, you must test every single model that you're going to rate. And when you would submit that information to DOE, you would sign a legal binding statement that says I have developed these ratings in accordance with the DOE test procedure and sampling provisions. They're tried, true, accurate, et cetera, et cetera. So no, you can't just rate without testing.

MR. HARTLEIN: So therefore -- this is Dan again -- a custom fan has to be tested.

MS. ARMSTRONG: So not necessarily.

MR. HARTLEIN: Okay. So if the rule allows.

MS. ARMSTRONG: We have provisions for dealing with that stuff, but they need to be provisions in this rule. So the moral of the story is that if you want to have what you call untested ratings, whether that be calculation-based ratings, whatever, we need to make sure that the regulations allow for that.

MR. HARTLEIN: Okay. Gotcha.

MR. FLY: This is Mark Fly. Dan, I need to talk to you about your motor supplier because if you've got a motor supplier that's never going to do a design change and that you can buy from the same guy every day, I need to know who that is, because otherwise you're going to have to retest when that motor supplier changes their efficiency or you have to -- I can't get this one this week. I have to go buy somebody else's. Or you have to test all of them and rate on the minimum one.

MR. HAUER: Ashley, it's Armin Hauer speaking. I have to jump ahead and ask about labeling and certification. Is it sufficient that I put on a label compliant, yes/no? Or do I have to put on percentage 92.8 percent? That's really a difference because it's very easy for if you have your process under control as a motor manufacturer to basically just stick your head out the window and say yes, my fan is going to be compliant, I don't have to test because I have the experience.

MS. ARMSTRONG: Okay. So I think the answer is I'm going to split the parts.

Certification is different than labeling for DOE. We can definitely talk about what you guys want your labels to look like, whether it's a yes/no type of scheme or it's an actual number type scheme. What that number is, what the metric is, we can talk about those types of things. Certification, you must submit paperwork to DOE that shows your products are in compliance or self-certifies that your products are in compliance before distribution and commerce in the U.S. That includes importation.

So that being said, our certification scheme for all the places where we have efficiency or consumption metrics right now, you tell us the number for every single product that you have and that number must be based on the DOE test procedure and sampling plan. Now many of our commercial equipment allows for estimations based on modeling or calculation-based methods as a burden reducing measure because we understand there are custom products. Not everyone has the ability to test everything, et cetera, et cetera. So that's all open, but it all has to be provided by in regulation. So I would assume that at the end of the day you will have to certify the actual efficiency values and then the content of the label is up to you.

MR. FLY: And this is Mark Fly with AAON. And so as part of this we're going to have to define models, which is one of my favorite subjects, and so you're going to list a model with the DOE --

MS. ARMSTRONG: So I think it's a little easier for this one because we're doing this range concept. But you're right. We do need to talk about if you have a given fan, and this is what I don't have a true appreciation of in your industry, but if you have a given fan, what are all the variations thereof that get added to that fan, that same I guess -- I don't know the best way to say this. I mean, some may be non-efficiency, some may be efficiency related. That's kind of a conversation we need to have at some point because we need to translate that into how many different ratings you will end up having to tell the department. That's kind of how the regs work.

But I think that's one of the reasons you see this scheme from the department. We were trying to give you options for not having to test everything. This is a calculation-based method, which is different than a full-blown AEDM. I still call this based on testing because you're still testing the fan component, but it allows you to calculate the downstreams. So you guys think about it. That's kind of how in high level terms our regs work. Yeah, go ahead.

MR. SMILEY: Bill Smiley, Trane. If you go back to your slide where you had the motor poles and efficiency for the DOE regulated ones, yeah, that chart, now you look at the TEAO, which is the next chart, and you have efficiency values as a function of motor speed or number of poles. But if you back up a slide, you say oh, okay, for all these motors we're just going to have one number that represents everything all the way across there. Is there a reason for that? I mean, we could actually do the same thing to this that we did to TEAO.

MS. IYAMA: They're used for two purposes, and I think that's where the difference is. If you're selling or if you have just a fan without a motor, you don't know what the pole is. You can't, if I give you this table, you don't know what value to pick, the two pole, the four pole, six pole, eight poles,

MR. SMILEY: But isn't it the same with TEAO?

MS. IYAMA: If a fan's sold with a TEAO motor, if now you're trying to establish the electrical input power of a fan sold with a TEAO motor, you know what the pole of that motor is.

MR. SMILEY: Not necessarily. It could be belt drive.

MR. WHITWELL: Or it could be the fan. Bob Whitwell.

MS. IYAMA: But if the motor is provided with the fan.

MR. WHITWELL: Okay. But there are other

cases where we buy fans and we might apply them with a TEAO motor in some case or we apply them with a regulated motor in other cases.

MS. ARMSTRONG: Right. So what Sanaee has set up here originally, it's for discussion purposes. If you just have a fan, you're actually getting a better number than you would as if you had a fan and you know you're ultimately going to end up in a TEAO setting, but you don't know the specifics of that motor. Because if you look at the two numbers -- I mean, you're getting some benefit there that maybe you're arguing you shouldn't be getting.

MR. WHITWELL: Well, no, no. My argument -- I'm with --

MS. ARMSTRONG: We can go back.

MR. WHITWELL: I think I'm with Bill that on the -- if we go back to the regulated motors --

MS. ARMSTRONG: Yeah, except for what she's saying is if you have a fan, irrespective of motor, that even if you know the motor it's going into, but you don't know all the motor's characteristics, you go to that first table. So you know it's air over, but that's irrelevant to the way we set this up. So you're actually arguing for us to set up default values for I'm a manufacturer --

MR. WHITWELL: Sorry. Forget the air over part of it because that's a small piece. I'm more on the --

MS. ARMSTRONG: So just go to one.

MS. IYAMA: Okay. So okay. So I guess here, let's go to this.

MS. ARMSTRONG: I have a fan, right?

MS. IYAMA: The first row. I have a fan only, no motor, and I don't know anything about that motor that's going to be --

MS. ARMSTRONG: You don't know any characteristics of that motor. You may know the specific category, but that's it.

MR. WHITWELL: Right. So then I go to the -- so, okay, so what's the basic default then? I guess I don't understand then. Is it the regulated motor default or is it TEAO default? Where do I go?

MS. IYAMA: So I'm going to try to explain how to read that table and then maybe it's going to clarify.

MR. WHITWELL: Thank you. Sorry, I'm slow about this.

MS. ARMSTRONG: It's okay.

MS. IYAMA: If it's a fan being sold without a motor, without transmissions, without anything. It's just the non-driven fan, bare shaft fan. When you're calculating the electrical input power based on the calculation-based method, you're going to use default values for the motor which are the default ones. The default ones are equal to the minimum efficiency standard that is in place for medium electric motors.

If your fan sold with a motor and that motor is a regulated motor, you can use the name plate efficiency of that motor --

MR. WHITWELL: Without testing.

MS. IYAMA: -- as your default value in the calculation-based method when calculating --

MS. ARMSTRONG: So right now this is all up for discussion, right? This was our going-in kind of how this might all work. But obviously let it sink in. We'll red line this to reflect some of our discussions maybe not to send out tonight, but give us a day or so.

MR. SMILEY: Well, my question originally was really, didn't have much to do with any of that. It was why do we have efficiencies as a function of poles on one type of motor and not as a function of poles on the other type of motor --

MS. IYAMA: I can answer that.

MR. SMILEY: -- because if we have to develop a process to take a default value, it's a table look-up.

MS. IYAMA: I'll try to answer that.

MR. SMILEY: But you're actually right, though, if we don't know what the motor poles are, then we have to have a value to use, and that could also be the situation for TEAO.

MS. ARMSTRONG: Right.

MR. SMILEY: So which one of those -- we can use whichever one we want or --

MS. ARMSTRONG: So we're going to clarify this table first of all because I think that some clarification of this table would go a long way.

MR. SMILEY: That was really -- it's kind of -- I agree with everything you're doing.

MS. IYAMA: I should have introduced it in a better way, and I'll try to clarify, but it's really two tables in one where you have a situation for when you're just a fan without a motor and you don't know anything about the fan, and in that case, how do you calculate your wire to air while you use those default values. And you don't need to worry about which pole to pick. It's just one value by horsepower.

MR. SMILEY: Or what type of motor.

MS. IYAMA: Or what type of motor. Exactly.

And then there's a different situation,

different situation for a fan sold with a motor where you know what the main characteristics of your motor are, so you can identify if you're in a case where you're a regulated motor, a TEAO motor or another kind of motor. And based on which case you're in, you're going to either use the name plate efficiency of your motor, the TEAO efficiency of the pole and horsepower that corresponds to the motor supplied with your fan, and for other motor we don't know yet what we want to do.

MR. SMILEY: So basically you're saying on a TEAO motor there's no name plate efficiency, so you have to define what that is.

MS. ARMSTRONG: Yes.

MR. SMILEY: Is that what you're saying?

MS. IYAMA: Yes.

MS. ARMSTRONG: They're not regulated.

MR. SMILEY: Okay, thank you. That would have been the answer to my question.

MR. WHITWELL: Thank you.

MS. IYAMA: Sorry.

MR. AUTH: Chris Auth, Baltimore Aircoil. The TEAO motors we use are name plated by NEMA. I don't know if they're regulated or not, but there is a nominal efficiency on the name plate.

MS. ARMSTRONG: It's not required, so some do it and some aren't. So we can't depend on it being there. It's not --

MALE VOICE: It's not a regulated value.

MR. AUTH: But would that name plate value work in this analysis?

MS. ARMSTRONG: No. I mean, you can argue that it should, but not everyone's doing it the same way, as we have learned through experience.

MR. SMILEY: If that's not regulated, there's nobody saying that that's the true number.

MR. WHITWELL: My understanding for most of the motors that we purchase, they're basically, they're actually TEFCs with the fan removed, but these are larger motors. It's not always the case, but I'm just -- I believe the motor is tested.

MS. ARMSTRONG: So TEFC, whatever, those are regulated, so that's why. Those are in a different --

MALE VOICE: (Away from microphone.)

MS. ARMSTRONG: Right, but that's why you're seeing name plates. They're required.

MR. WHITWELL: So that rating's not right because the cooling fan internally --

MS. ARMSTRONG: So you want me to call NEMA tomorrow?

MR. SMILEY: No. I think what you're doing is --

MS. ARMSTRONG: Okay, sufficient.

So a couple things. I do want to wrap up this discussion in about 10 minutes or so. We're about 30 minutes out from our end and I do want to do some recaps of where we are, where we're going, kind of homework items, what we've promised around the table before do actually wrap up.

MR. BUBLITZ: Mark Bublitz, New York Blower. Sanaee, I want to circle back to nominal efficiency values for motors. If all my components are right at the margin and I acquire a regulated motor and that motor performs under the nominal value, but it's still regulated, I would fail the test because that minimum nominal is not a minimum value. So I just want to throw that out there as what's the true floor of that test.

MS. ARMSTRONG: So this came up and I think I'm going to say your question a different way. But I see that as, DOE, how would you enforce. So, in other words, DOE, if you're going to enforce my rating and I had developed it through the application of the nominal values, recognizing that those nominal values are really closer to average values, not the least efficient of the population and I happen to get the least, DOE, if you tested that and it came out below, if you did the full wire-to-air test and it came out below, what would you do? I mean, that's how I translate what you're asking me.

MR. BUBLITZ: That's fine. I'm going to say it's accurate.

MS. ARMSTRONG: I think that's up for discussion. One of the things that we have discussed is DOE enforcing the same way you generate your rating. So, if you do it with nominal values, we would do it too. We would test your fan and we may get different fan numbers, but if you applied nominal values, we would too.

Alternatively, we could all do testing values representing, with the realization that those nominal values should be conservative and testing should always result in better or greater. Really, it's up for discussion.

So do you guys want to keep going? How many more slides do you have?

MS. IYAMA: I have two on the controls and then three on the test procedure.

MS. ARMSTRONG: So do you want to talk about controls at this point or do we want to start wrapping up?

MR. DIKEMAN: You're mailing this out, right?

MS. ARMSTRONG: We are going to mail it out.

MR. DIKEMAN: We can read it.

MS. ARMSTRONG: That's correct. The only benefit is, do you want Sanaee to at least start presenting and get a little bit of feedback for the next 10 minutes or 15 minutes or so. I don't think it's going to take 30 minutes to wrap up.

MR. DIKEMAN: Sure.

MS. IYAMA: I'll try to do this in like five minutes.

So we also looked at, and that's not in the NODA because it wasn't used in there, developing default values to model motor and controls, so the whole motor control, motor and VFD part. And it looks like this, and it's similar to what was done and used in the pumps rulemaking. So, if you want more details, you can go into that docket, but it's the same concept where the losses of the motor plus VFD, which is the LD here, equals the full load losses of the motor only times a factor. That factor is a polynomial equation with different coefficients depending on the size of the motor. So it's a pretty simplified model.

Again, I think in the draft 207 there's another way of doing this. I don't think --

MR. DIKEMAN: Steve Dikeman. We've combined motor and VFD into a single aggregate loss in the most recent writeup.

MS. IYAMA: Yeah, so it's similar. I think the form of the equation and the way it's calculated, it's a bit different.

MR. SMILEY: Question. This is Bill, Trane. This only applies to full load.

MALE VOICE: No.

MR. SMILEY: It applies to part load too? Where's the part load?

MS. IYAMA: So the little i that's like in subscript means the load. So the first thing -- so here, this component here, and I'm going to increase the --

MR. SMILEY: So it's the motor full load times --

MS. IYAMA: It's the motor VFD --

MR. SMILEY: -- a de-rate factor as a function of what?

MS. IYAMA: So that's the load of the motor, of the VFD, sorry. Of the motor, sorry.

MR. SMILEY: Okay.

MS. IYAMA: So, in other words, the part load losses of your motor plus VFD equal a certain factor times the full load losses of the motor.

MR. SMILEY: So you're saying that all the data that this is based on is available somewhere as well?

MS. IYAMA: Maybe not the disaggregated data, but there's more details in that docket that's referenced on that slide.

MR. SMILEY: Okay, thanks.

MR. WHITWELL: So, if you can send that to us and we don't have to go looking for it, that would be nice.

MS. IYAMA: Sure. Yeah. I'll dig up the -- and then -- so I think that's all. These are just sort of summary tables of all the things we've discussed.

And then on the test procedure --

MR. SMITH: Sanaee, this is Wade Smith. I apologize. Could you just describe once again the source of the default values for --

MS. IYAMA: Motor and drive?

MR. SMITH: Yeah, motor and drive, the combination.

MS. IYAMA: That was based on a combination of data, some from motors and VFDs that DOE tested at different loads, some that one manufacturer provided.

MR. SMITH: And it was commented earlier that the efficiency performance of the motor and drive in combination, it depends upon the settings, the setup and the settings, and that they're easy to change. So is there some caveat about these default values in terms of how the drive is set up?

MS. IYAMA: Currently, no.

MR. SMILEY: Well, that would -- Bill with Trane. That would go along with that, would be the type of inverter and the type of motor would play into that as well, I mean, you know, if you really needed to dig into the minute details. You're coming up with a default relationship.

MR. SMITH: And the default, you referred to a docket. Is there a docket where this question is being dealt with? No?

MS. ARMSTRONG: So I think the answer is kind of. We can refer you to it.

MS. IYAMA: I put the docket number.

MR. SMITH: It's in the pump rule?

MS. ARMSTRONG: Kind of. So I think that, and I wish some motor guys were here today. So the motor guys are in the process kind of of coming up with this motor drive controls type methodology. It was based somewhat on that. It's generally similar to that whole exercise they are going through.

Why don't we do this. We will commit to circulating the explanation of that so you guys can look at it, and obviously we welcome your feedback on it here. It's open. So let's do that. We'll just pull it off the docket. It's easier that way.

MS. IYAMA: Yeah. There's the AMCA 207 way, there's this way, there's the NEMA way, so we can just compare them all.

MS. ARMSTRONG: The NEMA way is really close to what we did in pumps. It wasn't done when we had to go out with pumps, but we had the draft.

MR. WAGNER: Are we able to get the AMCA 207 draft then?

MS. ARMSTRONG: I'm circulating that.

MR. HAUER: I think AMCA 207 was part of the NODA response, was it not?

MS. ARMSTRONG: Yeah. So the answer is it's in the docket.

MS. IYAMA: Okay. So quickly, test procedure, I have three slides really. So we need -- why do we need -- we need a test method to either get to the shaft input power if we're using a calculation-based method or we need to be able to measure the electrical input power at the arrow number two here on the slide.

One approach that we've been considering is to use AMCA 210 as the basis for the DOE test procedure. Question, is there any modifications necessary to ensure that every time someone does the test we get the same answer? These are lists, and we don't need to go through all of them, but these are the sort of --

MS. ARMSTRONG: Yeah. So we are going to leave you with this as homework for next week because what we have done is taken a deep dive into AMCA 210 and we had some questions.

MS. IYAMA: And some of those are not very detailed. It's just to get the conversation started and sort of give you the sort of topics that we're interested in and get your feedback, and we can get in more details at the next meeting.

MR. SMILEY: This is Bill with Trane. Are you asking for additional test methodologies that may already be out there that people use for lots of different types of products to be brought forward as well? We haven't settled on AMCA 210.

MS. ARMSTRONG: Sure. I mean, I think at this point you're right, DOE hasn't put a proposal out, so at this point it's open-ended. If there are certain categories of fans or equipment classes of fans that you believe should be tested with a different methodology, we're open to having that discussion. One thing that will be important is that at the end of the day ratings are generated in an equitable manner. So we'll need to understand -- and if they're not, why they're not generated in an equitable manner, so if certain equipment classes need to be tested in a different manner.

MR. SMILEY: Well, the reason I bring it up is there are existing tests that are already being performed on a lot of the equipment that will probably be covered by this, and nobody wants to do additional testing just for the heck of it. That's why I bring that up.

MS. ARMSTRONG: No, but I would say one of the purposes of this regulation obviously isn't to make everyone retest the testing they had already done but make sure testing is done in the same manner. So if there are some differences or nuances it would be great to have a discussion around what those are. Okay?

So, with that, I think Sanaee is done. So I do want to go back and do some kind of close-out items. I'm happy to open the floor to others for closure, but

I also have tried to come up with a list over the past couple of hours of things that at least were in my mind. You guys can remind me if I missed anything. And I think it would be a good idea to put some dates around these. I will say over half of them are for DOE, so obviously we're going to have our work cut out for us over the next couple of days.

But one thing. First off, AMCA was going to provide feedback on the compressor cutoff in the definition. When can you do that?

MR. SMITH: Before the next meeting or at the next meeting.

MS. ARMSTRONG: Great. Thank you.

MR. SMITH: Meaning that we agree with it or don't agree with it?

MS. ARMSTRONG: So either you agree with it or if you don't agree with it an alternative solution.

MR. SMITH: Okay.

MS. ARMSTRONG: Great. Thank you.

So next was AHRI's data request. There's two parts to the data request, so, Karim, I'm looking to you. When do you at least think you'll be able to respond to part one, which is just simply a list of different categories of fans, what type of equipment they may or may not go into, in this case will go into, and are those fans regulated? So is the energy consumption of those fans that are in embedded equipment regulated in another manner, system metric or otherwise?

MR. AMRANE: At the next meeting?

MS. ARMSTRONG: Great. Thank you.

And so the next one is DOE's going to send out red lines of all these. We may do this in phases. So we may do tomorrow's first and then this one will follow in a day or two. One of the things we've already done is include the EU comparison of definitions that was asked for, so you're going to see that in the red lines that we sent out for you guys to all mull over, so be on the lookout for that. We'll commit to sending one out today and one out tomorrow. It's going to be a fun night.

Okay. So one of the things I think for all of us is to review the definitions for the equipment classes and the testable configurations. So, when we send out those red lines, you're going to see the reflection of what is this testable configuration for a variety of different things. We'll also include the examples, so we'll want to get back with feedback on that if anybody has any or obviously agreement on that at the next meeting.

So one of the things that I think the embedded product manufacturers, including AHRI, were going to bring to the table, and I'm just asking for a time frame, was some type of counterproposal or pathway forward for some of the embedded products in terms of how they would like the working group to consider them and consider treatment of them. So my ask of you guys is, what is your timing on that one?

MS. SHEPHERD: Well, I think we were planning for the next meeting, so I would say within the next two meetings you're going to have or the next week of meetings.

MS. ARMSTRONG: Okay. So I think the first part of June is our next meeting?

MS. SHEPHERD: Right.

MS. ARMSTRONG: Thank you. If you want to add, go ahead.

MR. JASINSKI: Yeah. It's not an additional to do, but it's related to both of those. In addition to revised definitions for testable configuration as part of that exercise or as part of any proposal from AHRI, I think it would also be useful to bring up your own examples of fans that can be used or come up with your example fans that test the definitions in the way that you want to test them and as part of justification for tweaks or as additional examples to be discussed at the working group. I know some people mentioned that they had fans in mind while we were talking about that separately. So, if you have fans that you're particularly interested in knowing how they would be impacted by the definitions that are being proposed, those examples would be really helpful.

MS. ARMSTRONG: Okay. So the next one I have for us is to circulate the pump motor variable speed info in terms of how we got to that. There is a memo in the pump docket, so we'll just pull it out and circulate it so you have that as background.

The next thing we'll do is send out a link to the draft AMCA 207 that's also already in this docket, but just so ease of use.

The last one -- we can do all these things tonight, but the last one is the feedback on what we just presented in terms of we went through some sticky issues today in terms of an approach for a test procedure. We listed a whole page of questions we have relating to AMCA 210. We have questions relating to nominal values versus tested values, nominal values for specific categories of motors, nominal values versus in control and drive systems. So we'd really like your feedback on certain of those, so you'll see some red lines coming out probably tomorrow, so we'd like some feedback on that. So does everyone around the table think they can be prepared to discuss that at the next meeting? Okay, I see nods.

And last but not least, we are going to be prepared at the next meeting to present the NODA analysis, so we're going to walk through the spreadsheets. If anyone has an issue with downloading the spreadsheets, using the spreadsheets, come talk to us or send us an email. They've been up there. They should be able to be used, but like I said, if there's an issue, let us know. We'll walk through them at the next meeting so we can talk about analysis.

If we make some decisions on this stuff that impacts the analysis, we can then revise after the next meeting, but we want to be in a position to move forward with some of the analysis discussions so everyone will have a good basis for that understanding. okay?

MR. WAGNER: Ashley, I noticed some of the pull-down boxes and stuff like that weren't functional. Is that because of the way I downloaded it or --

MS. ARMSTRONG: I don't know. It could be your security settings that are off, like not --

MR. BUBLITZ: I have a screen snapshot.

MS. ARMSTRONG: You'll show me. Okay, no worries. We'll get it fixed if there's an issue.

MR. WAGNER: Okay. Like the direct drive, belt drive, and some of the others, it wouldn't pull down.

MS. ARMSTRONG: We'll look at it. No problem. If we need to recirculate a new version, we can. No problem.

MR. SMITH: I had the same issue.

MS. ARMSTRONG: Okay. Maybe you just have to be on a DOE computer, so you all can come visit to work on these spreadsheets.

So that's all I had. Does anybody have anything else?

MR. SMILEY: Yes. Bill, Trane. You said you were going to give us the information you have on the drive motor interaction, which was the last thing you showed on the efficiency de-rate for a variable speed.

Also, previous to that I think I'd asked for if you had any data on just the motor and the load point on the motor efficiency reduction, because what you showed was a nominal curve to apply to everything, but what I was interested in is if you had the backup data that might show the function of other variations.

MS. IYAMA: So I would need to check if we're allowed to share the data. I mean, we have the data, but I know for sure that the one for the drive in VFD was confidentially --

MR. SMILEY: Yeah, I figured that probably was.

MS. IYAMA: So --

MR. SMILEY: I just wanted to compare it to stuff I have and I use.

MS. ARMSTRONG: So anybody want to say anything else?

MR. AUTH: Just one more comment about the NODA spreadsheet. Chris Auth, Baltimore Aircoil. Right now it's set up for total efficiency and we did discussions today with static efficiency. Is there going to be a revision to that before next meeting or just use it the way it is?

MS. ARMSTRONG: So we have the results for the next meeting for sure. We can have clean spreadsheets by the next meeting and we'll see how early we can have the clean spreadsheets to you guys before the next meeting. But yeah, we have the results at least to show you for the next meeting or to circulate before the next meeting so you can see them. No problem.

Anything else?

MS. WALTNER: Yeah. This is Meg, just really quickly. Earlier some of us were asking about the times of the meetings. I think we confirmed them last time, but I think it would be helpful to just go over again the start and end times we agreed to for the meetings. I don't know if we have that.

MS. ARMSTRONG: Yeah. I'll send out the schedule as part of the email for the next one.

You can go off the record now.

(Whereupon, at 2:48 p.m., the meeting in the above-entitled matter was concluded.)

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REPORTER'S CERTIFICATE

DOCKET NO.: N/A

CASE TITLE: ASRAC Fans and Blowers Working Group Meeting

HEARING DATE: May 19, 2015

LOCATION: Washington, D.C.

I hereby certify that the proceedings and evidence are contained fully and accurately on the tapes and notes reported by me at the hearing in the above case before the U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy.

Date: May 19, 2015

David W. Jones
Official Reporter
Heritage Reporting Corporation
Suite 206
1220 L Street, N.W.
Washington, D.C. 20005-4018