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Variable Refrigerant Flow ASRAC Working Group Evaluation

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1 EXECUTIVE SUMMARY

NEEA, together with other energy efficiency organizations, participated in the Appliance Standards and Rulemaking Advisory Committee (ASRAC) Working Group on Variable Refrigerant Flow (VRF) system standards and test procedures[1]. The Working Group was established by Department of Energy (DOE) to provide a forum to raise issues and resolve differences among stakeholders regarding creation of a standard for VRF systems.

The Working Group met between September 2018 and November 2019. NEEA contracted TRC to conduct an independent evaluation of the Working Group's efforts, and specifically the influence of efficiency organizations, including NEEA, on the final terms agreed to by the Working Group.

The Working Group was comprised of manufacturers, energy efficiency organizations, industry organizations, government organizations, DOE, and DOE's consultants, with a total of 21 members. The Working Group produced two term sheets[2]:

1. A standards term sheet with two recommendations: specific efficiency levels for various equipment classes and a recommended compliance date for all efficiency levels
2. A test procedure term sheet with eight recommendations around the test method, the compliance date, and the efficiency metric.

Following the conclusion of the Working Group, DOE will still have to publish a notice of proposed rulemaking and final rule for both the standard and the test procedure before this rulemaking cycle is complete. As part of its codes and standards program, NEEA is supporting the development and adoption of the VRF systems standard by participating in the Working Group through submitting comments at various stages of the standard and test procedure development and by participating in public meetings.

Though NEEA typically requests evaluations after a rulemaking is complete, in this case, NEEA requested an evaluation at the conclusion of the Working Group. The primary reason was because an appliance standards evaluation typically includes interviews with stakeholders, and stakeholders have a more accurate memory of activities closer in time to Working Group activities Therefore, TRC conducted this evaluation of efficiency organizations' role in the Working Group. If at the conclusion of the DOE rulemaking NEEA requests another evaluation,

[1] VRF is defined as variable refrigerant flow multi-split air conditioners and heat pumps. Applicable specifications are found at Code of Federal Regulations at 10 CFR 431.97. The current DOE test procedure references ANSI/AHRI Standard 1230-2010, "2010 Standard for Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment," approved August 2, 2010 and updated by addendum 1 in March 2011 (AHRI 1230-2010) with several omissions and additions

[2] A term sheet is the document which represents the outcome of the ASRAC meetings, with terms agreed upon by the ASRAC working group members through negotiation. The terms can recommend efficiency levels, engineering analysis issues, and test procedures. The ASRAC working group provides the term sheet to the DOE, which usually adopts some or all of these terms in its rulemaking.

that evaluator may find it useful to incorporate appropriate findings presented here into that evaluation.

To conduct this evaluation, TRC reviewed the DOE docket for the Working Group. TRC also interviewed six stakeholders active in the Working Group: one NEEA staff member, three staff members from other efficiency organizations, and two manufacturers.

In our qualitative assessment, TRC found that in support of this Working Group, NEEA engaged in most of the activities identified in NEEA's codes and standards logic model, particularly through comments submitted in the public review process, including submitting written comments and participation in public meetings.

For the quantitative assessment of the standard, TRC found that the efficiency organizations' activities contributed to 50 percent of the outputs of the ASRAC Working Group. More than half of this influence, 31 percent, came from efficiency organizations presenting test data and convincing DOE and the Working Group to pursue significant revisions to the test procedure.

Once a Final Rule is developed for VRF, the evaluator should combine the results presented here with the evaluator's estimate of the influence of the Working Group's terms on the Final Standard.

2 INTRODUCTION

The United States Department of Energy (DOE) specifies the current energy conservation standards for variable refrigerant flow multi-split air conditioners and heat pumps (VRF systems) in the Code of Federal Regulations at 10 CFR 431.97. The current DOE test procedure references ANSI/AHRI Standard 1230-2010, "2010 Standard for Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment," approved August 2, 2010 and updated by addendum 1 in March 2011 (AHRI 1230-2010). In DOE's adoption of AHRI 1230-2010, DOE omits the adoption of section 5.1.2 and 6.6 of AHRI 1230-2010 and has additional provisions for optional break-in period, refrigerant line length corrections, equipment set-up, and manufacturer involvement This evaluation abbreviates the name of this test procedure as "AHRI 1230".

DOE initiated a new rulemaking for VRF systems in July 2017, starting with a request for information for the VRF systems test procedure. In July 2018 DOE published a notice announcing the formation of an Appliance Standards Rulemaking Federal Advisory Committee (ASRAC) Working Group[3] for VRF systems standards and test procedure. The Working Group met regularly from September 2018 through November 2019. The Working Group was comprised of manufacturers, energy efficiency organizations, industry organizations, government organizations, DOE, and DOE's consultants, with a total of 21 members.

The Working Group concluded its work with two term sheets[4]:

1. A standards term sheet with two recommendations: specific efficiency levels for various equipment classes and a recommended compliance date for all efficiency levels; and
2. A test procedure term sheet with eight recommendations around the test method, the compliance date, and the efficiency metric.

Following the conclusion of the Working Group, DOE will have to publish a notice of proposed rulemaking (NOPR) and final rule for both the standard and the test procedure before this rulemaking cycle is complete. NEEA is supporting the development and adoption of the VRF systems standard by participating in the Working Group, submitting comments at various stages of the standard and test procedure development and by participating in public meetings.

Though NEEA typically requests evaluations after a rulemaking is complete, in this case, NEEA requested an evaluation at the conclusion of the Working Group. The primary reason was

[3] DOE's Appliance and Equipment Standards Program created the Appliance Standards and Rulemaking Federal Advisory Committee (ASRAC) to aid in DOE's process of establishing energy efficiency standards for certain appliances and commercial equipment. For more information see: https://www.energy.gov/eere/buildings/appliance-standards-and-rulemaking-federal-advisory-committee

[4] A term sheet is the document which represents the outcome of the ASRAC meetings, with terms agreed upon by the ASRAC working group members through negotiation. The terms can recommend efficiency levels, engineering analysis issues, and the test procedure. The ASRAC working group provides the term sheet to the DOE, which usually adopts some or all of these terms in its rulemaking.

because an appliance standards evaluation typically includes interviews with stakeholders, and stakeholders have a more accurate memory of activities closer in time to Working Group activities. If at the conclusion of the rulemaking NEEA requests another evaluation, the evaluator can use the analysis results presented in the evaluation of the Working Group.

2.1 Study Purpose

The scope of TRC's evaluation was to investigate the impact of energy efficiency organizations within the VRF Working Group, and particularly their impact on the final terms from the Working Group[5]. To assess this, TRC investigated issues that the Working Group discussed as potential terms, barriers to adoption of Working Group terms, the activities that NEEA and other efficiency organizations conducted to overcome these barriers, the activities that other stakeholders conducted, and the effectiveness of these activities. Based on the results, TRC provided two assessments:

1. A qualitative assessment of NEEA's influence in the establishment of the VRF Working Group terms; and

2. A quantitative assessment of the influence from all energy efficiency organizations, including NEEA, on the Working Group's final terms

2.2 Proposed Use of this Evaluation's Result in Determining Energy Savings Once The Final Standard Is Adopted

As part of the VRF Final Rule at the completion of the rulemaking, the DOE will estimate energy savings from the standard (compared to the previous baseline conditions). At that point, the evaluator will then estimate savings due to efficiency organizations' activities (including NEEA's). As a key factor in this determination of impact, the evaluator could include the results of this VRF ASRAC Working Group evaluation as input for their influence on Working Group terms.

2.3 AHRI 1230 Test Procedure Development

In parallel with the DOE rulemaking, an AHRI committee, including some efficiency organizations, has been working to revise the AHRI 1230 test procedure. While there is significant overlap between participants and work in the AHRI committee and the ASRAC Working Group, TRC limits this evaluation to the DOE rulemaking. However, it is noted in this report that efficiency organizations had additional influence in the AHRI committee.

[5] Because the VRF systems rulemaking is still in progress, NEEA limited the scope of the evaluation to the activities of the Working Group.

2.4 Description of ASRAC Working Group Role in DOE Adoption Process

As background, TRC provides the following description of the DOE federal standard adoption process. The DOE is the government agency responsible for developing and adopting national appliance energy standards. During the standard development process, the DOE seeks input from stakeholders. During the process, the DOE may determine that an ASRAC Working Group is needed to support the standard development. As described by the DOE[6]:

> *The Appliance and Equipment Standards Program established the Appliance Standards and Rulemaking Federal Advisory Committee (ASRAC) in an effort to further improve the Department of Energy's (DOE) process of establishing energy efficiency standards for certain appliances and commercial equipment. ASRAC will allow DOE to use negotiated rulemaking as a means to engage all interested parties, gather data, and attempt to reach consensus on establishing energy efficiency standards.*

The DOE may form an ASRAC Working Group for several reasons, including the development of minimum efficiency standards for appliances and equipment, or development of product test procedures, both of which applied for the VRF. DOE may also form an ASRAC Working Group for rulemakings where reaching consensus on energy efficiency standards may otherwise be challenging. Various stakeholders may participate in the ASRAC Working Group, including manufacturers, energy efficiency organizations, and utilities.

[6] From the U.S. DOE: https://www.energy.gov/eere/buildings/appliance-standards-and-rulemaking-federal-advisory-committee

3 METHODOLOGY

This section provides an overview of the data collection activities and analysis methodology for this evaluation.

3.1 Data Collection Approach

To collect data for this evaluation, TRC:

1. Reviewed literature primarily from the DOE docket for this standard and ASRAC Working Group, and
2. Gathered feedback from stakeholders involved in the rulemaking process, primarily through phone interviews.

TRC's literature review included:

- Docketed comments from stakeholders, including manufacturers, energy efficiency organizations, and other interested parties.
- Docketed meeting presentation documents and transcripts from the ASRAC Working Group meetings.
- The Energy Conservation Standards term sheet recommended by the ASRAC Working Group.
- The Test Procedure term sheet recommended by the ASRAC Working Group.

TRC conducted phone interviews with staff at various organizations that were active in the adoption of this standard. This included:

- One NEEA staff member.
- Staff members from energy efficiency organizations that played a prominent role in developing the Working Group's recommended terms. TRC interviewed staff from three of the efficiency organizations, two of which are representatives from a utility that TRC categorizes as an efficiency organization, because they consistently provided comments in support of high efficiency levels.
- Two manufacturers that played a prominent role in supporting the ASRAC Working Group's terms.

In acknowledgment of their time, TRC offered a gift card to interviewees (except NEEA staff).

Figure 1 summarizes the interview dispositions. As shown in this figure, TRC met the total number of target interviews.

Figure 1. Number of Targeted and Completed Interviews by Stakeholder Category

Stakeholder Category	Target Interviews	Candidates Contacted	Completed Interviews
NEEA C&S Staff	1	1	1
Energy Efficiency Organizations and Utility Representative	2 – 3	3	3
Manufacturers and Trade Organizations	3 – 4	9	2
Total	**6 – 8**	**13**	**6**

3.2 Limitations of Data Collection Efforts and Analysis

One limitation with data collection efforts specific to the VRF systems rulemaking is availability of data. Some members of the Working Group formed a Test Subcommittee with the purpose of testing equipment, conducting analysis, and reporting back to the Working Group. While all Working Group meetings are public, with transcripts and meeting materials available in the public docket, the Test Subcommittee meetings were not public. Members of the Test Subcommittee signed nondisclosure agreements, as manufacturers shared proprietary information during the meetings. Therefore, the details of those meetings were not available for review. To evaluate efficiency organizations' impact in the Test Subcommittee, TRC relied heavily on interviews and what the Test Subcommittee reported back to the main Working Group. TRC found that the interview responses were all consistent with each other.

Based on TRC's review of the dockets and from information collected through interviews with participants in the process, we believe that our quantitative and qualitative assessments accurately portray the proceedings and that the conclusions regarding efficiency organizations' influence are reasonable.

3.3 Methodology to Assess NEEA's Influence

To assess NEEA's influence on the development and adoption of the Working Group terms, TRC compared the proposed activities from NEEA Logic Model for Standards Rulemaking Process with activities that NEEA conducted, based on interviews and the literature review. TRC identified barriers to the adoption of Working Group terms, and then we identified influential activities that addressed the barrier in which NEEA participated. Finally, TRC identified NEEA's role and contribution for each activity and output.

3.4 Methodology to Estimate Influence from Efficiency Stakeholders in Working Group Terms

To estimate influence from energy efficiency organizations' efforts on Working Group terms to support the upcoming standard adoption process, TRC first developed a qualitative assessment of the impact of energy efficiency organizations' efforts. Specifically, TRC:

1. Used the docketed literature to identify barriers to the future adoption of the standard.

2. Used the docketed literature to identify the outcome of each issue where the efficiency organizations provided comments and identified those for which DOE made a change based on the comment—such as presentations, comments, and data presented during ASRAC Working Group meetings.
3. Used the docketed literature and interviews with stakeholders to understand:
    a. The relative significance of the issues where efficiency organizations provided influence.
    b. For each issue affected by the efficiency organizations, the relative impact of the efficiency organizations' activities on the final outcome.

TRC then translated this qualitative assessment into a quantitative framework to approximate the influence of energy efficiency organizations on the Working Group's recommended terms. Section 5.1 provides detail on TRC's methodology for the quantitative analysis. Section 2.2 describes how the results of this evaluation could be incorporated into a future evaluation of the energy savings, once a standard is finally adopted.

4 NEEA EFFECTIVENESS ASSESSMENT RESULTS

Figure 2 summarizes the results of TRC's assessment of NEEA's efforts associated with the ASRAC Working Group. TRC developed this figure using the NEEA logic model as an assessment framework. NEEA adapts its activities to suit the specific needs for each particular standard or standard-supporting effort; therefore, not all barriers or activities are relevant for every effort. In addition, this is the first time that an evaluation has used the logic model to assess NEEA's role in the Working Group. The figure presents NEEA's activities (relative to possible codes and standards activities) and what results would be expected from each activity. In addition, the figure provides a rationale for TRC's findings.

NEEA's primary influence at this stage in the VRF systems rulemaking came from participating in the Working Group, including participation in the Test Subcommittee, and working with utilities to provide test data.

Overall, NEEA engaged in several activities. There were two activities identified in the logic model that NEEA did not undertake for the ASRAC Working Group: conducting primary research and providing savings and economic analysis based on Northwest data. In general, TRC found that at this stage in rulemaking process for this standard, the need for primary research was limited. Regarding savings analysis, both the manufacturers and some of the efficiency organizations provided this, so there was no need for NEEA to replicate this work.

Note: In the following table, the white cells show the logic model inputs. The blue cells show TRC's assessment of NEEA's activities for this standard.

Figure 2. Assessment of NEEA's Activities on the VRF Systems Working Group

Barrier (NEEA logic model)	Manufacturer opposition			Lack of data with which to conduct the necessary analyses in a rulemaking		Lack of common interest among certain stakeholders	Insufficient funding/staff for US DOE to run standards processes
Proposed Activity (NEEA logic model)	Negotiation with manufacturers.	Attend public meetings held by DOE.	Analyze and critique organizations, manufacturers and rulemaking documents.	Conduct primary research to create data for standards and test procedures.	Provide savings and economic analyses based on Northwest data.	Collaboration with other efficiency organizations.	Encourage utilities to provide data and political support for standards.
Undertaken by NEEA? (TRC)	Y	Y	Y	N	N	Y	Y
Rationale/ explanation (TRC)	NEEA directly negotiated with manufacturers during Working Group meetings on issues related to the test procedure.	NEEA attended public meetings, including Working Group meetings at all stages of rulemakings so far.	NEEA submitted joint comments on standard development. NEEA attended and actively participated in all public DOE hearings.	NEEA did not collect or provide primary data.	NEEA did not provide savings data for the Northwest.	NEEA submitted joint comments and collaborated with ACEEE, NRDC, CA IOUs[7], and other organizations through the Working Group.	NEEA worked jointly with CA IOUs, who provided data in the support of the standard.
Outputs (NEEA logic model)	Consensus-based proposals to submit to DOE or better general understanding of manufacturer positions and concerns	NEEA adds valuable information at each stage of the rulemaking process.		NEEA adds valuable information at each stage of the rulemaking process.	NEEA information/ analysis referenced in rulemaking proceedings/ documentation	NEEA adds valuable information at each stage of the rulemaking process. NEEA information/ analysis referenced in rulemaking proceedings/ documentation	Utilities are present at hearings/ publicly support new standards.
Accomplished by NEEA? (TRC)	Y	Y		N/A	N/A	Y	Y
Rationale/ explanation (TRC)	The Working Group meetings had significant collaboration between manufacturers and NEEA.	NEEA provided comments in support of DOE and other efficiency organizations that influenced the test procedure and efficiency level recommendations from the Working Group.		N/A, because NEEA did not complete any primary research for this standard.	N/A, because NEEA did not provide any research for the docket.	DOE rulemaking documentation references NEEA joint comments. NEEA was active during public stakeholder hearings.	NEEA collaborated with CA IOUs, which submitted comments that generally aligned with NEEA's.

[7] ACEEE = American Council for an Energy Efficient Economy, NRDC = Natural Resources Defense Council, CA IOUs = California Investor Owned Utilities, which are utilities but also acted as efficiency organizations in this standard development based on the nature of their comments.

5 INFLUENCE OF EFFICIENCY ORGANIZATIONS

DOE developed an ASRAC Working Group and tasked them with negotiating to reach consensus on proposed federal test procedures and standards for VRF systems.

Figure 3 shows the ASRAC Working Group members, from the docket.

Figure 3. ASRAC Working Group Members

Stakeholder Category	Organization	Member
DOE	U.S. Department of Energy	John Cymbalsky
Energy Efficiency Organization	NEEA	Louis Starr
	California Energy Commission*	Ronald Balneg
	Alliance to Save Energy	Mikelann Scerbo
	NW Power and Conservation Council	Tom Eckman
	Consultant*	Marshall Hunt
	Appliance Standards Awareness Project	Joanna Mauer
	American Council for an Energy-Efficient Economy	Christopher Perry
	Natural Resources Defense Council	Joe Vukovich
Manufacturers and trade organizations	United Technologies Corporation	Robert Whitwell
	Trane Commercial HVAC/Unitary	Jill Hootman
	Rheem Manufacturing Co.	Diane Jakobs
	Midea America Research Center	Marc Neufcourt
	Air-Conditioning, Heating, and Refrigeration Institute	Laura Petrillo-Groh
	Goodman Manufacturing Company	Rusty Tharp
	Fujitsu General American, Inc.	Arturo Thur de Koos
	Mitsubishi	Douglas Tucker
	Johnson Controls, Inc.	Wei Wang
	Lennox International	David Winningham
Other Stakeholders	GLUMAC, Tetra Tech	Michael Adams
	George Mason University	James Broughel

*Marshall Hunt was a consultant for the California Investor Owned Utilities (CA IOUs). TRC classified the California IOU and California Energy Commission contributors as efficiency organizations, because they worked with and generally supported proposals put for by the efficiency organizations.

The Working Group included ten manufacturers, eight efficiency organizations, two other stakeholders, and one DOE staff member.

5.1 Description of Calculation of Influence

TRC estimated the energy efficiency organizations' influence using an analysis framework described below. Sections 5.3 and 5.4 provide descriptions of TRC's rationale for our rankings and estimates of percentages. This section (5.1) includes an example calculation to demonstrate how we arrived at our estimates in the following Sections 5.3 and 5.4. In this example, we

estimate the impact of addressing a barrier to future standard adoption. For example, one barrier that existed was the lack of an accurate test procedure. We estimated influence by first estimating the significance of this barrier compared to other issues at this stage of the standard development process. We then estimate the importance and effectiveness the work of the energy efficiency organizations had in removing the barrier. Below we lay out the steps more explicitly, including the estimated input we used (shown in *italics*).

a. **Identified and estimated the relative significance of the barriers** to future adoption of the standard. TRC identified two over-arching barriers: "lack of accurate test procedure to support the upcoming standard," and "lack of data with which to conduct the necessary analyses in a rulemaking." Within each, TRC identified three sub-barriers that were significant for future standard development. Based on the importance of each sub-barrier, TRC assigned a weighting factor to each so that their sum would total 100 percent:
    i. DOE and industry were prepared to adopt the draft version of test procedure AHRI 1230, which only had minor revisions compared to the previously adopted version of the test procedure. *Very high: 42 percent*
    ii. The current test procedure is a steady state test procedure, which does not adequately account for the dynamic nature of VRF systems in field operation. High: 21 percent
    iii. The maximum sensible heat ratio (SHR) in the test procedure is not representative of field operation. Medium: 11 percent
    iv. The airflow and number of indoor units operating at the low-load test point was not representative of field operation. Medium: 11 percent
    v. There was no standardization of what instructions to use to setup a unit for test: supplemental test instructions, manufacturer installation instructions, then "as-shipped". Very low: 2.5 percent
    vi. There were not sufficient instructions on how to set airflow during the test, including how to set it and what changes would be allowed during the test. Very low: 2.5 percent
    vii. All other barriers over which efficiency organizations did not have influence: 10 percent.

b. **Identified and estimated the significance of each efficiency organization activity to overcome each barrier.** As one example activity, the energy efficiency organizations presented test results showing the need to have a procedure that represented the dynamic nature of VRF systems in field operation. They also worked with industry and DOE to further test systems and to define what that procedure would be. TRC found that this activity had a very high significance in reducing the barrier, "lack of accurate test procedure to support the upcoming standard". TRC estimated the significance as 100 percent for addressing this barrier, based on the following scale:

    Low = 13%, Medium = 25%, High = 50%, and *Very High = 100%*

c. **Estimated the effectiveness of each efficiency organization activity relative to all efficiency organization activities to overcome all barriers**. Following our example activity, TRC rated the sub-barrier, "The current test procedure is a steady state test procedure, which does not adequately account for the dynamic nature of VRF systems in

field operation" as 21 percent of significance across all sub-barriers. Consequently, TRC estimated that the significance of this energy efficiency organizations activity relative to all activities was 21% x 100% = 21%.

d. **Estimated the role of efficiency organizations in each activity relative to all participants to support DOE (i.e. all, primary, major contributor, minor).** TRC estimated efficiency organizations' role to support DOE and address each barrier and applied a weighting to the significance of their activities. Note that in other evaluations that TRC has conducted for NEEA, DOE does the majority of the work to develop the draft test procedure, NOPR, draft engineering analysis, and final rule, so TRC assumes that the maximum role played by the energy efficiency organizations for comments affecting these documents and analysis is 50 percent. In the case of the VRF systems Working Group, TRC found that the efficiency organizations had a larger role than typical, and as a primary support, could be responsible for up to 75 percent of the work.

   Primary Support (75 percent): Led efforts to provide comments to DOE.

   Major Support (30 percent): Did not lead efforts but contributed significantly.

   Minor Support (10 percent): Did not contribute significantly.

   Using the example activity of leading the development of the Controls Verification Procedure (CVP), efficiency organizations provided the Primary Support to the DOE. For this example activity, the final estimated significance for this energy efficiency activity is 21% (calculated in step c) x 75% = 16%.

e. **Estimated the total impact of efficiency organizations' activities.** For each activity, TRC estimated the significance of each activity to overcome all barriers (step c) and multiplied this by the relative role of the organizations (step d). TRC then summed the significance of all activities.

5.2 Efficiency Organizations' Contribution to ASRAC Working Group Terms

TRC estimates the efficiency organizations' influence for the Working Group process is about 50 percent. Figure 4 presents the detailed results. TRC provides a supporting rationale for each input in the sections below the figure. Note that this figure only lists barriers for which TRC found that the efficiency organizations impacted the final standard.

To summarize the results of Figure 4, the energy efficiency organizations' biggest accomplishment was to convince the Working Group to agree that the test procedure needed to be changed, which is a critical accomplishment in the pursuit of a new, more effective standard. The design of the new test procedure (dynamic v. static) was important because it captures operational reality – but the specific design was less important than the decision to move away from the established test procedure. In addition, revising the estimates of SHR in the new procedure (to more appropriately reflect operational reality) aligned it with the move to a dynamic design, but is less fundamental to the impact on the standard than the test procedure dynamic design. Figure 7 and Figure 8 in the Appendix present the detailed impact analysis.

Figure 4. Summary Impact Analysis of Efficiency Organizations' Contributions

Barrier, based on NEEA logic model	**Lack of accurate test procedure to support the upcoming standard**			**Lack of data with which to conduct the necessary analyses in a rulemaking**			**Total**
Sub-barrier specific to standard	No plan for significant revisions as part of this rulemaking	Not adequately account for the dynamic nature	Maximum SHR not representative of field operation	The airflow and units operating not representative	No standardization on instructions to setup a unit	No sufficient instructions on how to set airflow	
Significance for energy savings	**Very High**	**High**	**Medium**	**Medium**	**Very Low**	**Very Low**	
a. Significance of barrier (%)	**42%**	**21%**	**11%**	**11%**	**2.5%**	**2.5%**	**90%**
Effectiveness of activity for addressing barrier	**Very High**	**Very High**	**High**	**High**	**High**	**High**	
b. Significance for each barrier (%)	**100%**	**100%**	**50%**	**50%**	**50%**	**50%**	
c. Significance across <u>all</u> barriers: *a * b* (%)	**42%**	**21%**	**6%**	**6%**	**1%**	**1%**	
EE orgs' role	**Primary**	**Primary**	**Major**	**Major**	**Minor**	**Minor**	
d. EEs' Relative Role in activity (%)	**75%**	**75%**	**30%**	**30%**	**15%**	**15%**	
e. Significance of EE activity relative to total savings, cxd (%)	**32%**	**16%**	**2%**	**2%**	**0%**	**0%**	**50.6%**

5.3 Rationale for Weighting Significance of Barriers

To identify barriers, TRC considered what challenges needed to be resolved for DOE to move forward with the standards rulemaking for VRF. TRC identified two overarching barriers: "lack of accurate test procedure to support the upcoming standard," and "lack of data with which to conduct the necessary analyses in a rulemaking," with six total sub-barriers.

Note the sum of the significance of the barriers is 89 percent. The remaining 11 percent is for issues that arose in the Working Group that the efficiency organization did not influence, and that other stakeholders influenced.

5.3.1 Sub-barrier: DOE and industry prepared to adopt the pre-existing test procedure with only minor revisions

Significance: Very High

Rationale and Findings: DOE and industry were prepared to adopt the draft version of AHRI 1230 dated August 30, 2016, which only had minor revisions that impact savings compared to the previously adopted version (2010). DOE and industry had not anticipated making significant revisions to the test procedure as part of this rulemaking.

A key indicator is the amount of time that DOE had allotted for the Working Group meetings. In the initial call for Working Group members, DOE noted it expected to have ten one-to-two-day meetings, with the potential for two additional one-to-two-day meetings (EERE-2018-BT-STD-0003-0001). DOE noted the expectation that the Working Group conclude with first a term sheet on test procedures then a term sheet on energy conservation standards within six months of its first meeting.

Following the initial call on July 2, 2018 DOE announced one two-day meeting (EERE-2018-BT-STD-0003-0002). After that meeting on September 5, 2018 DOE held another five meetings conducted over ten days (EERE-2018-BT-STD-0003-0007) in the fall of 2018. Then, DOE announced another meeting for April 17-18, 2019 (EERE-2018-BT-STD-0003-0031), after which DOE announced another five meetings conducted over ten days (EERE-2018-BT-STD-0003-0038) in the fall of 2019. Finally, on October 24, 2019, DOE announced an additional two-day meeting, concluding on December 19, 2019 (EERE-2018-BT-STD-0003-0049).

In the end, DOE held 13 two-day meetings over a span of 17 months. This does not include separate meetings conducted by the test subcommittee, which met multiple times from February to October 2019. During these meetings, DOE, industry, and efficiency organizations tested equipment, analyzed test data, and determined test procedure revisions, which ultimately have a very large impact on measured efficiency during a test procedure.

Interviewees similarly reported the significance of this barrier, with one efficiency organization highlighting the initial meeting plan for Working Group meetings compared to the ultimate number of meetings and a manufacturer noting that they had expected that DOE would have adopted the 2016 draft of AHRI 1230.

TRC ranked the significance for influence due to this barrier as ***very high*** because if this barrier had not been addressed, DOE would not have made any significant changes to the test procedure, and the Working Group would have adopted a test procedure that was essentially the same as the currently adopted test procedure.

5.3.2 Sub-barrier: Lack of a test procedure which represented the dynamic nature of VRF systems in field operation

Significance: High

Rationale and Findings: The current test procedure is a steady state test procedure, which does not adequately account for the dynamic nature of VRF systems in field operation. A major issue at the start of the negotiations was whether the test procedure should continue to consist entirely of tests done at steady state conditions or whether it should be a dynamic test. The current test procedure includes a full-load steady state test as well as three part-load steady state tests (each done at different part load conditions). VRF systems equipment has complex controls to continually adjust the equipment in response to space conditions. In the traditional steady state test, manufacturers (or whoever was testing the equipment) would have to override the programming of these modulating components in order to test the equipment.

Efficiency organizations were in favor of having a dynamic test, as they thought that the current lab test was not representative of actual operational condition found in the field. Manufacturers were largely in favor of continuing to have only the steady-state tests and were concerned with burden and reproducibility of dynamic tests. Current DOE test procedures of other heating, ventilation, and air conditioning (HVAC) equipment require manufacturers to test equipment at steady state, so a dynamic test would have been a departure from the norm and would have made it even more difficult to adopt. Additionally, though the AHRI 1230 committee had been working to revise the test procedure, they had not implemented a dynamic test.

Ultimately DOE, industry, and the efficiency organizations came to consensus on a middle ground, which was a steady state test with the inclusion of a Controls Verification Procedure (CPV). In the CVP, the unit operates with its native controls without overrides, and the manufacturer monitors critical parameters throughout. The manufacturer then feeds the values of those critical parameters into the steady state test.

In the October 9, 2019 Working Group meeting, DOE noted that the test procedure term sheet recommendations that have the highest potential to impact measured efficiency are: De-humidification requirements, and limits on critical parameter settings in accordance with the controls verification procedure (CVP).

Multiple stakeholders echoed in interviews that this parameter is important, noting that the CVP significantly impacts the test procedure results. One manufacturer did note that the CVP changes the outcome of the test procedure measurably for some products, minimally for others (depends on manufacturer), but that the CVP helps make the outcome of the test procedure more applicable to the majority of applications by providing a more level comparison between products.

TRC ranked the significance for influence due to this barrier as ***high*** because interviewees and the docket review both indicated that the addition of the CVP had a significant impact on the measured efficiency.

5.3.3 Sub-barrier: Max SHR in the test procedure not representative.

Significance: Medium

Rationale and Findings: The maximum SHR in the test procedure was not representative.

The current test procedure provided no guarantee that VRF systems would provide dehumidification. This made VRF systems difficult to compare to other HVAC systems, whose efficiency ratings did factor in dehumidification. There was a need to limit the sensible heat ratio, particularly at the 75 percent and 100 percent load points, to ensure that the test procedure would account for dehumidification.

During stakeholder interviews, manufacturers and efficiency organizations commented that this issue has a big impact on the test procedure, with this recommendation being a significant improvement in terms of making the test procedure more representative.

Interviewees also noted that there was initially a fairly large barrier to addressing this issue. Some manufacturers were resistant to adding such a requirement. One manufacturer noted that once the Working Group started down the road of the evaluation and internal reviews, they highlighted inequities among manufacturers. Though this was a significant barrier in the beginning, once they got past the initial resistance, there was more collaboration between the efficiency organizations and manufacturers.

Note that this issue was not in the term sheet but was directly implemented in AHRI 1230. The updated AHRI 1230 draft required limiting the SHR for the 100 percent and 75 percent load points.

TRC ranked the significance for influence due to this barrier as ***medium*** because interviewees indicated that it had a significant impact on the test procedure, but less impact than the CVP.

5.3.4 Sub-barrier: Conditions for low-load test point in the test procedure not representative

Significance: Medium

Rationale and Findings: The airflow and number of indoor units operating at the low-load test point was not representative of field operation.

In stakeholder interviews, efficiency organizations and manufacturers noted that this provision has a big impact on the test procedure in making it more representative of field operation. One manufacturer noted that the manufacturers were comfortable with keeping all of the units in operation during the part load test, and in some applications, that would be representative of field operation. The manufacturer noted that the change to the test procedure was primarily due to participation by efficiency organizations.

Note that this issue was not in the Working Group term sheet but was directly implemented in AHRI 1230.

TRC ranked the significance for influence due to this barrier as ***medium*** because interviewees indicated that it had a significant impact on the test procedure, but less impact than the CVP.

5.3.5 Sub-barrier: No standardization of what instructions to use to setup a unit for test

Significance: Very Low

Efficiency organizations wanted the test procedure to reflect as-shipped and installed controls and to limit the amount of proprietary information required to run a test.

Rationale and Findings: There was no standardization of what instructions to use to setup a unit for test: supplemental test instructions, manufacturer installation instructions, or "as-shipped".

In stakeholder interviews, two efficiency organizations and one manufacturer commented that this issue was a smaller issue relative to the other issues raised during the test procedure revisions, but that it does help provide consistency and some equitability of how products are tested, and adds to the representativeness of the test procedure. Another efficiency organization commented that this term has a huge impact on the test procedure.

TRC ranked the significance for influence due to this barrier as ***very low*** based on the majority of interview results.

5.3.6 Sub-barrier: No standardization of how to set airflow during the test

Significance: Very Low

Rationale and Findings: The existing test procedure does not have sufficient instructions on how to set indoor unit airflow during the test, including how to set it and what changes the manufacturer could make during the test.

During interviews, stakeholders commented that there was considerable discussion on this issue and that this airflow issue connects to the SHR issue. Similar to the SHR issue, adding these instructions for setting airflow during the test helps make the test procedure more representative of field operation. However, multiple stakeholders did not include this barrier when considering the barriers with the greatest impact on the test procedure.

TRC ranked the significance for influence due to this barrier as ***very low*** based on interviews.

5.4 Rationale for Weighting Significance of Activities

This section describes TRC's rationale for weighting the significance of each activity that the efficiency organizations conducted.

5.4.1 Sub-barrier: DOE and industry prepared to adopt test procedure with only minor revisions

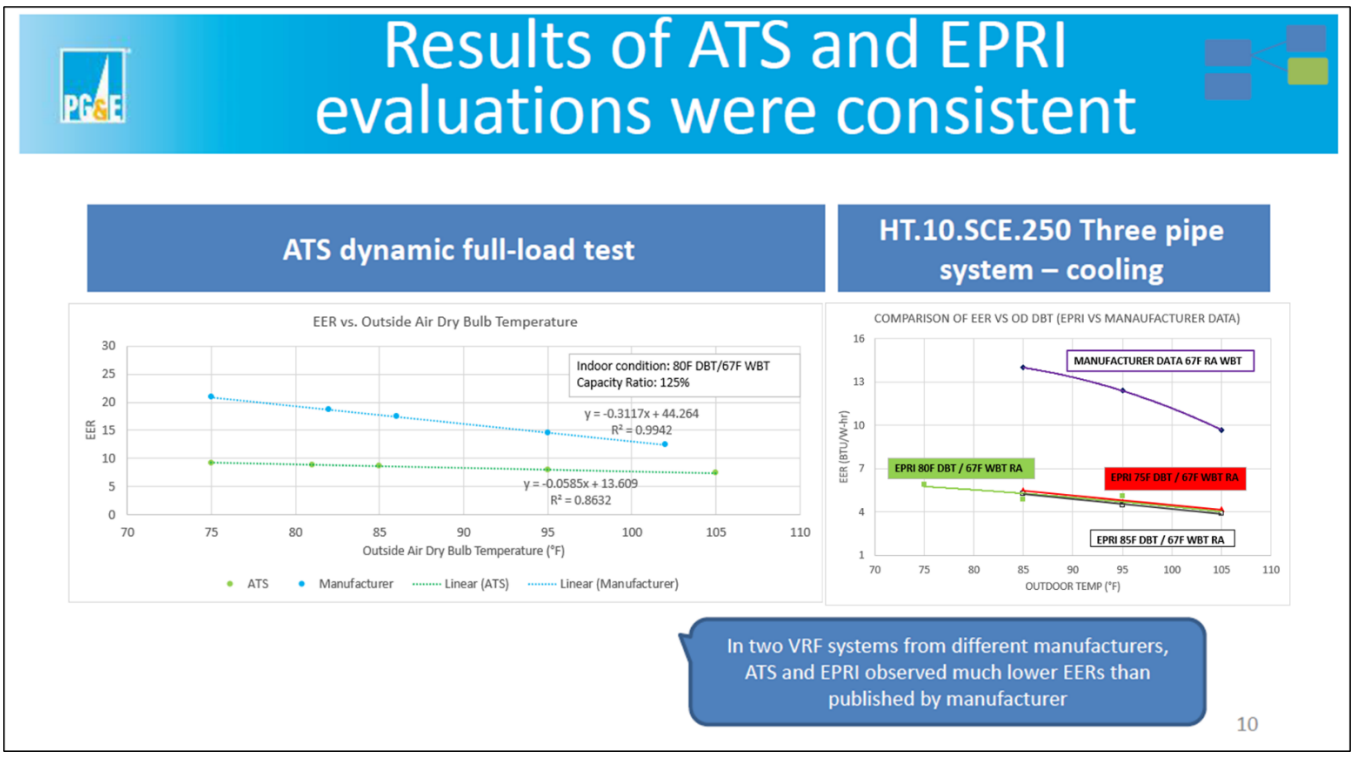
Activity and Significance: Efficiency organizations presented test data and convinced DOE and the Working Group to pursue revisions to the test procedure.

In the initial Working Group meetings, efficiency organizations presented test data showing results from conducting the test per the current DOE test procedure, which adopted AHRI 1230-2010. The test data showed that variability within the test procedure allowed the same VRF system to achieve different efficiency ratings by varying parameters allowed by the DOE test procedure. The efficiency organizations concluded that they needed more test data in order to conclude this more robustly and that DOE should revise their test procedure to be more representative and reproducible.

In a presentation at the October 15, 2018 meeting, efficiency organizations presented the slide below, indicating that test data showed much lower efficiencies than efficiency data published by manufacturers, and that this was due to a lack of stringency in the test procedure. The slide presents results from tests conducted by Applied Technical Services (ATS) lab and the Electric Power Research Institute (EPRI) alongside manufacturer's published data. The figure shows energy efficiency ratio (EER) at different outdoor air temperatures, with the manufacturer's published data shown by blue lines and ATS lab and EPRI test data shown by red and green lines. The figures show that the manufacturer's published data (blue lines) have much higher energy performance than what ATS and EPRI measured at the lab (red and green lines).

Figure 5. Slide from presentation to Working Group by Pacific Gas and Electric Company (PG&E) on October 15, 2018[8]

[8] TRC re-created the figure with increased font sizes.



Further testing and analysis by the efficiency organizations presented at subsequent meetings confirmed these early results and identified specific areas of the test procedure that could lead to misrepresentative testing conditions and therefore misrepresentative efficiencies.

This presentation of results by the efficiency organizations caused DOE to extend the time and scope of the Working Group. This also led to the creation of a Test Subcommittee which, in addition to the formal Working Group meetings, met at test facilities and conducted additional testing and discussions, the results of which they presented to the main Working Group.

The outcome of the Working Group primarily impacts the test procedure. Testing conducted was not thorough enough to do a sensitivity analysis to attribute savings to individual revisions in the test procedure. DOE did analyze the cumulative impact of all these changes, as presented to the Working Group in the slide in ***Figure 6***. DOE requested VRF manufacturers to provide efficiency results from testing their systems under the in-place test procedure as well as under the newly revised test procedure. DOE also conducted simulations. Using the submitted test data and the simulation results, DOE analyzed the impact that the resulting test procedure had on the tested efficiency rating. DOE determined that a unit tested with the new procedure has a 12 percent lower efficiency rating than when tested with the in-place test procedure.

Figure 6. Slide from presentation by DOE to Working Group on November 5, 2019

AHRI Crosswalk Results

This table shows values of "Crosswalked IEER-2019" estimated by multiplying the current EER 2010 baseline by the average ratio of EER-2010 to IEER-2019 for each sample

Product Class	Number of Systems	EER 2010 Baseline	Crosswalked IEER 2019
Air-Cooled, 65-135 kBtu, Heat Pump	2	11.0	17.7
Air-Cooled, 135-240 kBtu, Heat Pump	2	10.6	17.0
Air-Cooled, 65-135 kBtu, Heat Recovery	4	10.8	17.4
Air-Cooled, 135-240 kBtu, Heat Recovery	2	10.4	16.7

- **The average reduction from IEER-2010 to IEER 2019 is 12%**
- **Sample includes mostly systems above baseline EER and higher IEER-2010 than market IEER-2010 minimum.**

During stakeholder interviews, when asked what the final Working Group term sheets would have looked like if the efficiency organizations had not been involved in the process, manufacturers and efficiency organizations alike commented that DOE would have adopted the AHRI 1230 draft at that time (8/30/2016), which had only minor revisions compared to the previously adopted version of AHRI 1230 (2010). One manufacturer specifically noted that DOE would have adopted AHRI 1230 with no amendments, as-is. Another manufacturer noted that from the manufacturer perspective (and likely DOE): "[We] were fully expecting to go into this thinking DOE could just adopt 1230 and ASHRAE levels as is." Efficiency organizations commented that the changes to the test procedure may have been primarily because of the testing that PG&E led.

Due to efficiency organizations' work, DOE and industry ultimately agreed to conduct further testing and consider substantive changes to the test procedure. Therefore, TRC ranked the efficiency organizations' effectiveness as ***very high.***

Role of Efficiency Organizations: TRC identified the efficiency organizations as being the Primary for this activity, since efficiency organizations were primarily responsible for DOE and industry even considering significant changes to the test procedure.

Influence from Activity: 31.6 percent

5.4.2 Sub-barrier: Lack of a test procedure which represented the dynamic nature of VRF systems in field operation

Activity and Significance: Initial testing done by efficiency organizations highlighted the need for a procedure that represented the dynamic nature of VRF systems in field operation. Determining this procedure was the first major task of the Test Subcommittee. The Test

Subcommittee studied the issue and ultimately developed a CVP to reflect that dynamic nature, which the Working Group then recommended.

The Test Subcommittee included efficiency organizations (including their consultants), manufacturers, and DOE. The Test Subcommittee meetings primarily consisted of meeting at test facilities and testing equipment. Documents, data, presentations, or transcripts are not available from the Test Subcommittee meetings, so TRC gathered most information on Subcommittee events from interviews. The Test Subcommittee met from February to October 2019 and presented their findings to the main Working Group in April and September 2019. In the April 2019 Working Group meeting, the Test Subcommittee acknowledgement that the Test Subcommittee did not agree on everything, but that there was 'general consensus' and that there would be no 'minority report'. The Test Subcommittee identified nine critical parameters that the manufacturer typically overrides during 1230 tests and that significantly impact performance and sought to define or bound those critical parameters. The Test Subcommittee categorized their recommendations into three main parts: the CVP, addressing dehumidification (which involves both SHR and airflow setting), and miscellaneous test procedure changes. Each of these three recommendations are represented in both the draft version of AHRI 1230 as well as the Working Group term sheet.

Because the test data that the efficiency organizations presented convinced the Working Group that some sort of dynamic test was needed for the test procedure to be representative of VRF system operation, and because the efficiency organizations' subsequent involvement in defining the tests was significant, TRC ranked the efficiency organizations' effectiveness as ***very high***.

Role of Efficiency Organizations: TRC identified the efficiency organizations as being the ***primary*** for this activity, since efficiency organizations raised this as an issue to begin with in their push for a dynamic test procedure. In the absence of efficiency organizations, there would have been no CVP. Once the Working Group realized the need for a CVP, the Working Group (efficiency organizations and manufacturers both) worked together to come to a solution.

All stakeholders interviewed stated that the efficiency organizations were instrumental in highlighting the need for some sort of a CVP and in developing it. All stakeholders noted that in the absence of efficiency organizations, the DOE or the Working Group would not have created the CVP or some version of it.

Influence from Activity: 15.8 percent

5.4.3 Sub-barrier: Max SHR in the test procedure not representative.

Activity and Significance: Efficiency organizations raised this as an issue that the Working Group should address in order to make the test procedure more representative. Efficiency organizations requested that DOE conduct analysis to determine what SHRs are typically in commercial buildings and determined that actual SHRs were lower than those allowed by the existing test procedure. Through the Test Subcommittee, efficiency organizations then worked with manufacturers and DOE to determine appropriate SHRs.

Because testing conducted by the Test Subcommittee allowed the Working Group to come to a consensus in adjusting the maximum SHR in the test procedure, TRC ranked the efficiency organizations' effectiveness as ***high***.

Role of Efficiency Organizations: TRC identified the efficiency organizations as being ***major*** for this activity since the efficiency organizations raised this as an issue and then participated in the testing that led to the resolution.

During stakeholder interviews, efficiency organizations and manufacturers alike commented that efficiency organizations were very influential in driving this issue and achieving this outcome.

Influence from Activity: 1.6 percent

5.4.4 Sub-barrier: Conditions for low-load test point in the test procedure not representative

Activity and Significance: The airflow and number of indoor units operating at the low-load test point in the existing test procedure inflated the efficiency rating compared to what would typically be seen in field operation. Efficiency organizations led testing in the Test Subcommittee to show this impact, then worked with manufacturers and DOE to develop revised conditions for the low-load test point. The AHRI 1230 committee revised the draft version to require the manufacturer to shut off half of the indoor units for the 25 percent part load test point.

Because testing conducted by the Test Subcommittee allowed the Working Group to come to a consensus on the conditions for the low-load test point in the test procedure, TRC ranked the efficiency organizations' effectiveness as ***high***.

Role of Efficiency Organizations: TRC identified the efficiency organizations as being ***major*** for this activity since the efficiency organizations raised this as an issue and then participated in the testing that led to the resolution.

In stakeholder interviews, efficiency organizations and manufacturers both noted that the efficiency organizations were very influential in this issue. One manufacturer noted that once manufacturers got over the inertia of the need to make the test procedure more representative, there was good collaboration between manufacturers and efficiency organizations. Efficiency organizations commented that this change was possible because of the testing that the Test Subcommittee conducted.

Influence from Activity: 1.6 percent

5.4.5 Sub-barrier: No standardization of what instructions to use to setup a unit for test

Activity and Significance: Efficiency organizations, manufacturers, and DOE discussed the lack of standardization in system setup instructions, in particular the lack of a hierarchy of instructions between supplemental test instructions, manufacturer installation instructions, and 'as-shipped'. The Test Subcommittee provided data that supported the development of the hierarchy.

The Working Group recommended establishing the following hierarchy of instructions for how to set up units under test: supplemental test instructions, manufacturer installation instructions, then "as-shipped".

Because testing conducted by the Test Subcommittee allowed the Working Group to come to a consensus on the hierarchy of instructions in the test procedure, TRC ranked the efficiency organizations' effectiveness as ***high***.

Role of Efficiency Organizations: TRC identified the efficiency organizations as being the ***minor*** for this activity, since DOE had a larger role in this issue.

In stakeholder interviews, multiple efficiency organizations commented that the efficiency organizations had a big influence in establishing DOE's position.

Influence from Activity: 0.2 percent

5.4.6 Sub-barrier: No standardization of how to set airflow during the test

Activity and Significance: Efficiency organizations led testing in the Test Subcommittee to show the impact, then worked together with manufacturers and DOE to develop standardization on how to set airflow during the test. The Working Group recommended a method to set airflow through field-configurable fan control settings in the manufacturer installation instructions, limits on the indoor unit airflow, and a requirement that the airflow may only change if the system fan controls automatically change airflow.

Because testing conducted by the Test Subcommittee allowed the Working Group to come to a consensus on how to set indoor unit airflow in the test procedure, TRC ranked the efficiency organizations' effectiveness as ***high***.

Role of Efficiency Organizations: TRC identified the efficiency organizations as being the ***minor*** for this activity, since it involved heavy manufacturer input as well.

During stakeholder interviews, efficiency organizations commented that efficiency organizations had a high impact on the Working Group including this term in the term sheet.

Influence from Activity: 0.2 percent

6 ADDITIONAL INFLUENCE AND OTHER FEEDBACK COLLECTED

TRC notes other activities that the efficiency organizations conducted during the VRF systems standard development that may lead to future energy savings:

- The controls verification procedure (CVP) developed is being applied now to other systems. For example, ENERGY STAR® has a rulemaking for Central Air Conditioner and Air Source Heat Pump.[9] As part of this rulemaking, the draft specification for Cold Climate Heat Pumps[10] cited the VRF systems Working Group term sheet, noting that DOE developed the procedure for commercial variable capacity products, but that ENERGY STAR® could apply those principles to residential variable capacity products.

- The program manager of DOE's Appliance and Equipment Standards Program, John Cymbalsky, presented in a webinar by the International Energy Agency on residential test methods for air conditioners.[11] In this webinar, Mr. Cymbalsky noted that the U.S. will be using CVP-type tests in future voluntary specifications.

- Efficiency organizations and manufacturers alike commented on the collaboration between efficiency organizations and manufacturers, suggesting that the sort of collaboration in the VRF systems Working Group was unprecedented and that it would set a precedent for future rulemakings.

[9] https://www.energystar.gov/products/spec/central_air_conditioner_and_air_source_heat_pump_specification_version_6_0_pd

[10] https://www.energystar.gov/sites/default/files/Draft%202%20Version%206.0%20ENERGY%20STAR%20CAC-HP%20Specification_0.pdf

[11] https://www.iea.org/events/residential-test-methods-for-air-conditioners

7 CONCLUSIONS

Based on the data collection, TRC's impact assessment was that efficiency organizations had a significant influence on the VRF systems Working Group outcomes. The influence of the efficiency organizations came from participation and leadership in the main Working Group as well as in the Test Subcommittee. In particular, the efficiency organizations caused the Working Group to recommend a different test procedure than they would have in their absence. TRC estimates that the efficiency organizations contributed about 50[12] percent of the Working Group's Terms.

Once a Final Rule is developed for VRF, the evaluator should combine the result presented here with the evaluator's estimate of the influence of the Working Group's terms on the Final Standard. Based on this, the evaluator can estimate the efficiency organizations' influence on energy savings from the VRF ASRAC Working Group process.

[12] The actual calculated results is 50.6%.

8 APPENDIX

Impact Analysis of Efficiency Organizations' contributions

Figure 7. Impact Analysis of Efficiency Organizations' Contributions

Background/Context	DOE and industry prepared to adopt test procedure with only minor revisions	Lack of a test procedure representing dynamic nature of VRF systems in field.	Max SHR in the test procedure not representative.
Barrier	**Lack of accurate test procedure to support the upcoming standard**		
Sub-barrier	DOE and industry were prepared to adopt draft version of AHRI 1230, which only had minor revisions that impact savings compared to the previously adopted version. DOE and industry had not anticipated making significant revisions to the test procedure.	The current test procedure is a steady state test procedure, which does not adequately account for the dynamic nature of VRF systems in field operation	The maximum SHR in the test procedure is not representative of field operation.
Significance	**Very High**	**High**	**Medium**
a. Significance of barrier	**42%**	**21%**	**11%**
Activities Conducted by all EE orgs	**Activities to Address Barrier** EE orgs presented test data and convinced DOE and the Working Group to pursue significant revisions to the Test Procedure.	**Activities to Address Barrier** EE orgs presented test results showing the need to have a procedure that represented the dynamic nature of VRF systems in field operation. They also worked with industry and DOE to further test systems and to define what that procedure would be.	**Activities to Address Barrier** EE orgs requested that DOE conduct analysis to determine what SHRs are typically found in commercial buildings. As suspected, actual SHRs were lower than that required in the existing test procedure. EE orgs then worked with manufacturers and DOE to determine appropriate SHRs.
Results - i.e., Working Group result	The Working Group decided to conduct further testing and consider substantive changes to the test procedure.	The Working Group recommended the inclusion of the Controls Verification Procedure (CVP), as developed by the Working Group.	The updated AHRI 1230 draft required limiting the SHR for the 100% and 75% load points.
Effectiveness of activity for addressing barrier	**Very High**	**Very High**	**High**
b. Significance for each barrier	**100%**	**100%**	**50%**
c. Significance across all barriers: *a * b*	**42.0%**	**21.0%**	**5.5%**
EE orgs' role	**Primary**	**Primary**	**Major**
d. EEs' Relative Role in activity	**75%**	**75%**	**30%**
e. Significance of EE activity relative to total influence, cxd	**31.5%**	**15.8%**	**1.7%**
Subtotal			**48.9%**

Figure 8. Impact Analysis of Efficiency Organizations' Contributions, Continued

Background/Context	Conditions for low-load test point in the test procedure not representative	No standardization of what instructions to use to setup a unit for test	No standardization of how to set airflow during the test
Barrier	**Lack of data with which to conduct the necessary analyses in a rulemaking**		
Sub-barrier	The airflow and number of indoor units operating at the low-load test point was not representative of field operation.	There was no standardization of what instructions to use to setup a unit for test: supplemental test instructions, manufacturer installation instructions, or "as-shipped".	There were not sufficient instructions on how to set airflow during the test, including how to set it and what changes would be allowed during the test.
Significance	**Medium**	**Very Low**	**Very Low**
a. Significance of barrier	**11%**	**2.5%**	**2.5%**
Activities Conducted by all EE orgs	**Activities to Address Barrier** EE orgs led testing to show impact and worked with manufacturers and DOE to develop conditions for the low-load test point.	**Activities to Address Barrier** EE orgs led testing to show impact, and. worked with manufacturers and DOE to develop a procedure.	**Activities to Address Barrier** EE orgs led testing to show impact and worked with manufacturers and DOE to develop a procedure.
Results - i.e., Working Group result	The updated AHRI 1230 draft required that half of the indoor units be shut off for the 25% part-load test point.	The Working Group recommended establishing the following hierarchy of instructions for how to set up units under test – Supplemental Test Instructions (STI), Manufacturer Installation Instructions (MII), then "as-shipped".	The Working Group recommended a set airflow through field-configurable fan control settings in the MII, limits on the indoor unit airflow, and a requirement that airflow may only change if system fan controls automatically change airflow.
Effectiveness of activity for addressing barrier	**High**	**High**	**High**
b. Significance for each barrier	**50%**	**50%**	**50%**
c. Significance across all barriers: axb	**5.3%**	**1.3%**	**1.3%**
EE orgs' role	**Major**	**Minor**	**Minor**
d. EEs' Relative Role in activity	**30%**	**15%**	**15%**
e. Significance of EE activity relative to total influence, cxd	**1.7%**	**0.2%**	**0.2%**
Total			**50.6%**