

**From:** iain walker <iswalker@lbl.gov>  
**To:** Jeff Miller <Jmiller@energy.state.ca.us>  
**CC:** Rick Chitwood <rick@chitwoodenergy.com>, Gary Flamm <gflamm@energy.state...>  
**Date:** 12/20/2011 3:56 PM  
**Subject:** Re: Proposed Flow Hood spec's in RA3 for measurement of central forced air system return grille airflow

On Dec 19, 2011, at 5:38 PM, Jeff Miller wrote:

> Re: Flow hoods  
>  
> Iain,  
> If possible, I would appreciate your review of the statements I am  
> making below in the string that are intended to provide  
> justification for the proposed 2013 RA3.3 language that eliminates  
> use of standard flow hoods for measuring airflow at the return  
> grilles of residential central forced air systems; and adds powered  
> flow hoods as an option for measuring airflow at the return grilles.  
>  
> My statements rely on what information I could find in the LBNL  
> research reports, and in Energy Conservatory product documentation.  
>  
> Would you please reply to tell me if I have (or have not) stated the  
> justifications correctly?  
>  
> Also, do you know of any commercially available powered flow hoods,  
> or flow capture attachments for the fan-powered flow meters HERS  
> Raters use for duct leakage testing?

The Energy Conservatory (EC) is just coming out with such a device. At its core is a duct blaster (like we used in our testing) that is attached to a flow capture hood + pressure sensing array. It automatically pressure compensates and uses an EC DG700 pressure/flow gauge to display flow directly. We have performed preliminary lab tests on this device and results so far indicate that it is better than our hand assembled pressure balancing technique/apparatus. It is not clear to me if EC wants to only sell complete assemblies or if it will be available as an add-on to existing equipment. Best to ask Gary Nelson directly (gnelson@energyconservatory.com). There are also several European manufacturers of powered flow hoods. We are also currently evaluating one of these (DIFF) and it performs well, also. The tricky part is that these devices have been designed to measure supply grille air flows so their capture hoods are not large enough for the returns we commonly see in CA construction. So you would be stuck with using powered flow meters and hand-made flow capture elements.

>  
> fyi I had drafted a protocol for making these airflow measurements  
> with a standard flow hood, but using the same "supply plenum to  
> house static pressure correction" that is used for the plenum  
> pressure matching (duct blaster) and flow plate methods (as you had  
> suggested to us in October). But John Proctor preferred to offer  
> only powered flow hoods which is what we have spec'd in the current  
> draft.

- >
- > See:
- >
- > [http://www.energy.ca.gov/title24/2013standards/prerulemaking/documents/current/Draft\\_Language/Staff\\_Proposed\\_Draft\\_Language-Appendices/2013\\_RA3-HERS\\_procedures.pdf](http://www.energy.ca.gov/title24/2013standards/prerulemaking/documents/current/Draft_Language/Staff_Proposed_Draft_Language-Appendices/2013_RA3-HERS_procedures.pdf)
- >
- > RA3.3.2.1.2 Powered Flow Capture Hood Measurement (pg. RA3-29)
- >
- > RA3.3.3.1.3 Diagnostic System Airflow Using Powered Flow Capture Hood (pg. RA3-31)
- >

I think these procedures are fine.

BUT

I also think the commission should consider development of a test method for approval of flow hoods for measuring return air flows. The test method would specify the construction of a return duct system with at least three branches (each with different sized grilles based on what is commonly used in CA systems) with a variable speed fan and a flow meter, and a test procedure to determine the test uncertainties. Testing would be done by a CEC approved neutral third party (this could be LBNL and/or other folks with duct labs such as PG&E, DEG or John (if you have one?)). The commission would need fund development of the test procedure and construction of a test apparatus. Either the CEC or equipment manufacturers could pay to have their devices tested and certified (sort of like we did previously with duct tape). In the future this could be part of an ASTM or ASHRAE test procedure that could also include supply air flows (I am trying to get DOE interested in this).

- iain
- >
- > thanks in advance for any feedback you can provide.
- > jeff
- >
- > Jeff Miller
- > 916-651-6182
- > Jmiller@energy.state.ca.us
- >
- >
- >
- > >>>
- > From:
- > Jeff Miller
- > To:
- > Russ King
- > CC:
- > Gary Flamm; Martha Brook; Maziar Shirakh
- > Date:
- > 12/14/2011 11:41 AM
- > Subject:
- > Re: Flow hoods
- > Russ,

> The research reports state commercially available standard flow  
> hoods are inadequate for use in estimating air handler airflow. I  
> understand your position on this point is that you do not believe  
> this means measurement of air handler airflow at the return grill,  
> thus you believe the typical 20% to 30% RMS error reported for  
> commercially available standard flow hoods does not apply to  
> measurements of airflow at the return grille.  
>  
> The error component of the air handler airflow measurement  
> introduced by return duct leakage (that you suggest may be up to  
> 40%) is common to all of the return grille measurement methods for  
> air handler airflow; but standard flow hood measurements would  
> introduce the greatest additional error in this regard as compared  
> to powered flow hood methods that eliminate the insertion loss  
> (pressure differential) with fan speed adjustment, and flow grid  
> methods that utilize a correction calculation. The standard flow  
> hood measurement inaccuracy due to the insertion loss would be most  
> significant when there are multiple returns on a system, and 2013  
> draft Standards Section 150.0(m)13 requires multiple returns for  
> systems greater than 2.5 ton.

There are also significant errors when the flow hood opening does not  
match the grille size - usually when one of the return grill  
dimensions exceeds 24 in.

>  
> In my previous message, I referenced the duct blaster instructions  
> for the powered flow hood application in order to make the point  
> that adding a flow capture attachment to a duct blaster is easy and  
> inexpensive, thus manufacturers of duct blasters such as Energy  
> Conservatory or Retrotec could probably offer such an attachment (if  
> there was a demand for such a product) at a reasonable price - most  
> likely much less than \$2,000. I am not aware of any commercially  
> available flow capture attachments for duct blasters, or  
> commercially available powered flow hood devices. I have asked the  
> consultants about this, and will do so again. But since it is so  
> easy and inexpensive to fabricate a flow capture attachment out of  
> cardboard, and there are many other aspects of setup for duct  
> diagnostics that utilize masking tape and cardboard, I do not  
> believe lack of a commercial flow capture attachment is a strong  
> justification for not adopting the powered flow hood measurement  
> method.  
>

All the above discussion is fine.

> I will continue to forward your concerns to my managers and our  
> consultants for consideration. As always feel free to write with  
> additional comments/concerns.

> jeff  
> Jeff Miller  
> 916-651-6182  
> Jmiller@energy.state.ca.us

>  
>  
>

> >>>  
> From:  
> Russ King <russ@calcerts.com>  
> To:  
> Jeff Miller <Jmiller@energy.state.ca.us>  
> CC:  
> Gary Flamm <gflamm@energy.state.ca.us>, Martha Brook <Mbrook@energy.state.ca.us  
> >, Maziar Shirakh <Mshirakh@energy.state.ca.us>  
> Date:  
> 12/13/2011 6:11 PM  
> Subject:  
> Re: Flow hoods  
> I did not say that the reports were limited to investigation of only  
> supply registers. I said the reports were primarily geared toward  
> measurements other than the specific test that we do, which is to  
> measure airflow at a return. Neither of the sections you quote  
> specifically mention inaccuracies with this type of test. I still  
> contend that the studies are not adequate grounds for removing flow  
> hoods from the protocols for measuring air flow at a return.  
>  
> You did not address my statement about the inaccuracy created by all  
> tests taken at the return due to return leakage.  
>  
> I would not advise raters to build a homemade flow capture hood.  
> Raters have a hard enough time being taken seriously by contractors,  
> but to walk in and tell a contractor that they fail an air flow test  
> and will have to perform expensive duct system modifications is  
> going to be real hard when their "precision diagnostic" tool is made  
> out of a cardboard box.  
>  
> Has staff done any research to see how many brands of powered flow  
> hoods there are? There is only one brand of flow grid that I know of.  
>  
> Russ  
>  
>  
> On 12/13/11 5:31 PM, "Jeff Miller" <Jmiller@energy.state.ca.us> wrote:  
>  
> Russ,  
> The research reports are not limited to investigation of only supply  
> register airflow measurements.  
>  
> \*\*\*\*\*  
> This is extract is from paper lbnl-47382 on page 21:  
> Key Findings  
> Extensive laboratory tests and several field tests have shown that  
> commercially available standard flow hoods do not meet the accuracy  
> criteria for many of the diagnostics that flow hoods are often used  
> for. Their RMS errors are typically in the 20% to 30% range compared  
> to accuracies of 10% or better required for most distribution system  
> diagnostics. In particular, they are inadequate for use in  
> estimating duct leakage, air handler flow and individual register  
> flows for room load and comfort. Their measurement accuracy is too  
> poor for individual registers and also over the sum of many  
> registers. The laboratory results for the reference active flow hood  
> show an RMS error of only 2%.

- >
- > Recommendations
- > Active flow hoods [powered flow hoods] should be used to measure
- > distribution system airflows if the measurements are to be used in
- > estimating duct leakage, air handler flow and individual register
- > flows for room load and comfort.
- >
- > \*\*\*\*\*
- > This is extract is from paper lbnl-45959 on page 28
- >
- > Of particular note, our laboratory and field tests indicate that
- > conventional non-powered flow
- > hoods are sometimes an order of magnitude less accurate than fan-
- > assisted flow hoods: potential
- > errors are about 20% to 30% of measured flow. As a result, these
- > hoods can be inadequate to
- > measure flows in residential systems. The measurement errors are
- > likely due to recirculation
- > regions that occur within the hood, and non-uniformity of flow at
- > the flow-hood sampling points.
- > Manufacturers recommend using a hood size close to the grille size
- > to reduce this problem.
- > However, this is often not possible, because most of these hoods are
- > intended for use in
- > commercial buildings and are much larger than most residential
- > grilles. The extent of this
- > problem also depends on flow rate, duct topology upstream of the
- > grille (e.g., nearby elbows),
- > and grille type. Grilles with more side discharge than direct
- > discharge are more likely to cause
- > recirculation regions. It is possible to obtain reasonable results
- > using some conventional flow
- > hoods if the field tests are carefully done, the grilles are
- > appropriate, and grille location does not
- > restrict flow hood placement.
- >
- > \*\*\*\*\*
- >
- > The reports also describe an insertion loss characteristic that
- > standard flow hoods exhibit (pressure drop through the flow hood
- > changing the actual flow through the grill/register). This
- > insertion loss characteristic is more significant when there are
- > multiple returns for the system airflow measurement. Powered flow
- > hoods do not exhibit this inaccuracy.
- >
- > I understand your expressed sensitivity to the situation in which a
- > rater has invested in the cost of an expensive flow hood that would
- > no longer be approved for use for the system airflow measurement (if
- > we eliminate standard flow hood use for the protocol), but that is
- > not a justification for our specification of those expensive devices
- > for use for airflow measurement if the devices are not sufficiently
- > accurate for the system airflow measurement application in RA3.3.
- >
- > question: would a powered flow hood be more difficult to use than a
- > standard flow hood?
- >

> question: do you believe a flow capture attachment for a duct  
> blaster which transforms the duct blaster into a powered flow hood,  
> would be as expensive as a standard flow hood?  
>  
> I have attached an extract from the Energy Conservatory duct blaster  
> manual that provides direction for fabricating a flow capture  
> attachment, and for use of this powered flow hood for making airflow  
> measurements. It seems to me that this powered flow hood method of  
> airflow measurement should not be considered to be much more  
> difficult than use of a standard flow hood, and the flow capture  
> attachment can be easily fabricated for little cost.  
>  
> <<PoweredFlowHood-dbmanual-2011-June.pdf>>  
>  
> I will forward your concern to my managers and our consultants for  
> consideration. As always feel free to write with additional  
> comments/concerns.  
> jeff  
>  
> Jeff Miller  
> 916-651-6182  
> Jmiller@energy.state.ca.us  
>  
>  
> >>>  
> From: Russ King <russ@calcerts.com>  
> To: Jeff Miller <Jmiller@energy.state.ca.us>  
> CC: Gary Flamm <gflamm@energy.state.ca.us>, Martha Brook <Mbrook@energy.state.ca.us  
> >, Maziar Shirakh <Mshirakh@energy.state.ca.us>  
> Date: 12/13/2011 2:16 PM  
> Subject: Re: Flow hoodsI have read those reports before and I do not  
> recall any of them stating that using a standard flow hood to  
> measure airflow at the return being an unacceptable method for  
> measuring airflow for our purposes. The primary focus of these  
> reports is on the inaccuracies of measuring supply grilles, which we  
> do not do. They also discuss using flow hoods to estimate duct  
> leakage, by comparing supply and return flows, which we do not do.  
>  
> Here is a quote from the first report:  
> There is no fundamental problem with passive hoods, and our field  
> test results showed that  
> some passive hoods can obtain good results when they are used with  
> appropriate care on the right  
> set of grille types and locations.  
>  
> I'm not debating that powered flow hoods are better in most  
> applications, but I'm not convinced that the research site is  
> specific enough to how we use flow hoods to justify raters having to  
> put away a \$2000+ piece of equipment and purchase one that takes  
> much longer to use.  
>  
> Given that these tests are all done at the return, they are off by  
> whatever return leakage there is in the system, which can be  
> substantial. I think it is unrealistic to require raters to spend  
> that much more time and money measuring something (airflow through a  
> return grille) in order to gain a few percent of accuracy, when the

> number we are extrapolating to (air flow across the coil) could be  
> off by 10%, 20%, 30%, 40%, . . .  
>  
> These same issues apply to the contractors who want to test their  
> own work.  
>  
> Russ  
>  
>  
> On 12/13/11 10:35 AM, "Jeff Miller" <Jmiller@energy.state.ca.us>  
> wrote:  
>  
> Russ,  
> Your email below is the only comment that I know of besides George  
> Nesbitt's verbal comment during the 07nov2011 workshop to the effect  
> that powered/active flow hoods are not commercially available.  
>  
> Research has determined that standard flow hoods are not an accurate  
> method for measuring these residential airflow rates, and that  
> powered flow hoods are the best method available.  
>  
> <http://epb.lbl.gov/publications/lbnl-45959.pdf>  
> <http://epb.lbl.gov/publications/lbnl-47382.pdf>  
>  
> <http://epb.lbl.gov/publications/lbnl-51551.pdf>  
>  
> I recommend that you endeavor to submit additional written  
> justification to us describing the merit of use of standard flow  
> hoods for determining residential forced air system airflow (RA3.3).  
>  
> It seems to me that further delay in elimination of use of the  
> standard flow hoods for the RA3.3 protocol will result in additional  
> Rater investment in this technology that research has determined is  
> not sufficiently accurate for the purpose of the RA3.3 protocol.  
>  
> Since all raters are likely to have duct blasters, it seems likely  
> that a specification for powered flow hoods in RA3.3 would be  
> sufficient to encourage manufacturers like Energy Conservatory or  
> Retrotec to provide a flow capture attachment (probably an  
> inexpensive attachment) for their duct blaster products so that  
> their duct blaster products could also be used as powered flow  
> hoods. What do you think about that idea?  
> jeff  
>  
> Jeff Miller  
> 916-651-6182  
> Jmiller@energy.state.ca.us  
>  
> >>>  
> From: Russ King <russ@calcerts.com>  
> To: Jeff Miller <Jmiller@energy.state.ca.us>  
> Date: 12/13/2011 8:19 AM  
> Subject: Flow hoodsHi Jeff,  
>  
> As I mentioned, I am completely buried with other things right now,  
> but one thing I wanted to make sure that I get mentioned is that I

> am strongly opposed to taking away flow hoods as a method of  
> measuring air flow.  
>  
> What is the reasoning behind not allowing them? They are a commonly  
> used device by certified air balance contractors for commercial  
> applications. I think that when you consider ease of use and how  
> complicated and prone to mistakes the other methods are, they are at  
> least as accurate.  
>  
> There are a lot of raters who have invested over \$2000 in flow  
> hoods. It would be a shame to now tell them that they can not use  
> them. I have a lot of raters that are already angry about this.  
> Staff may have already received comments.  
>  
> Thanks  
>  
> Russ  
>  
> <PoweredFlowHood-dbmanual-2011-june.pdf>  
> From: iain walker <iswalker@lbl.gov>  
> Date: October 19, 2011 11:02:59 AM PDT  
> To: Jeff Miller <Jmiller@energy.state.ca.us>  
> Cc: Bruce Wilcox <bwilcox@lmi.net>, John Proctor  
> <john@proctoreng.com>, Gary Flamm <gflamm@energy.state.ca.us>,  
> Martha Brook <Mbrook@energy.state.ca.us>, Maziar Shirakh <Mshirakh@energy.state.ca.us>  
> >  
> Subject: Re: Residential Air Conditioner Airflow Measurement for 2013  
>  
>  
> I agree with John Proctor, regarding the use of hot wires or vane  
> anemometers. They only give local velocity/flow measurements and  
> have large errors in estimating airflow in and out of HVAC grilles/  
> registers.  
>  
> There are serious problems with the discussion of errors on using  
> flow hoods for return flows. You cannot use the fan laws the way  
> they are presented because residential fans don't work that way -  
> particularly with ECM motors. In addition, the biggest errors occur  
> with multiple returns (the opposite of what is stated in the  
> comment): when you restrict one return with the flow hood you get  
> more flow in the other returns and less in the one you are trying to  
> measure. This is \*not\* accounted for with the flow hood  
> manufacturer's backpressure compensation.  
>  
> Having said that, it would be a good idea to use the same "supply  
> plenum to house static pressure correction" that is used for the  
> duct blaster and flow plate methods for the flow hood method.  
>  
> - iain  
>  
>  
> On Oct 18, 2011, at 8:27 PM, Jeff Miller wrote:  
>  
>> John,  
>> Bruce,  
>> Do you suggest that we reevaluate the airflow measurement

>> procedures in RA3.3 for the 2013 update, to address the new  
>> challenges posed by our proposed return duct sizing table in  
>> 150.0(m)13 that requires much larger return air grill sizes and  
>> generally a greater number of return grills?  
>>  
>> fyi, the attached comment letter is proposing to include rotary  
>> vane anemometer procedures for airflow measurement. I need to  
>> respond to his comment, and would be very interested if you have  
>> any new recommendations to the Commission for airflow measurement  
>> techniques.  
>>  
>> Are there any new research papers available on the topic of airflow  
>> measurement for residential HVAC systems? Are these reports (see  
>> links below) still our best reference and justification for  
>> recommending flow grid and pressure matching protocols for HERS  
>> rater verifications?  
>>  
>> <http://epb.lbl.gov/publications/lbnl-45959.pdf>  
>>  
>> <http://epb.lbl.gov/publications/lbnl-47382.pdf>  
>>  
>> I searched for a short while this eve and did not come up with hits  
>> for new research on airflow measurement. I would appreciate  
>> finding out about any new research references you know about.  
>>  
>> Flow hood measurement: my recollection is that we had proposed for  
>> 2008 Standards to disallow use of flow hoods, but got push-back, so  
>> allowed flow hood use only at the return grill. Do you have any  
>> new thoughts on that topic for 2013?  
>>  
>>  
>>  
>> Please note the following and provide us with your comment:  
>>  
>> The information in the attached files was sent to us by Carl J  
>> Gasper a HERS rater who is also a TAB contractor. He is  
>> recommending that we change our airflow measurement protocols. He  
>> states: ..."Starting with the next CEC Title 24 Standards change (I  
>> believe in 2013), implement a rotating vane or hot wire anemometer  
>> traverse for use in determining Minimum Airflow. This traverse  
>> takes place at the return grill. These devices can be bought for as  
>> little as \$200 and are highly accurate."...  
>>  
>> Carl J Gasper letter titled Problems with Establishing Total  
>> Minimum Airflow dated 29sep2011: <<Establishing Minimum  
>> Airflow.pdf>>  
>>  
>>  
>> <<Flowhood Procedure.pdf>>  
>>  
>> <<NEBBTotalFanFlow.pdf>>  
>>  
>>  
>>  
>> >>>  
>> From:

>> Eurlyne Geiszler  
>> To:  
>> Gary Flamm; Jeff Miller; Maziar Shirakh; Tav Commins  
>> CC:  
>> Bill Pennington; Pedro Gomez  
>> Date:  
>> 10/4/2011 7:29 AM  
>> Subject:  
>> Re: Fwd: Issues with CEC Minimum Airflow Procedure  
>> Jeff:  
>>  
>> Please see the attached and email string below.  
>>  
>> >>> Maziar Shirakh 10/3/2011 12:58 PM >>>  
>> you need to work with Jeff to get these in the standards; I am  
>> swamped at the moment with the other stuff.  
>>  
>> >>> Eurlyne Geiszler 10/3/2011 10:30 AM >>>  
>> Look like good comments, how should he be advised to have his  
>> comments and suggestions considered in the current proceedings?  
>> Does he need to have these comments docketed? Should he be  
>> encouraged to attend any workshops/hearings?  
>>  
>> >>> Tav Commins 10/3/2011 8:53 AM >>>  
>> Attached is a report form a HERS rater/balancer on verifying proper  
>> air flow.  
>>  
>> He is making recommendations for changes to the code.  
>>  
>> Tav  
>>  
>> >>> "Carl J Gasper (GasperAir, Inc.)" <carl.gasperair@yahoo.com>  
>> 9/29/2011 2:38 PM >>>  
>>  
>>  
>> Hello Tav,  
>>  
>> Please see attachments regarding Establishing Minimum Airflow.  
>> These are the concerns and problems that are popping up in the field.  
>> Hope all is well.  
>>  
>> Please call with any questions.  
>>  
>>  
>> Thank you,  
>>  
>>  
>>  
>> Carl J Gasper  
>> President  
>> GasperAir, Inc.  
>> HERS Verification & Air Balancing Services  
>> A NEBB Certified TAB Company  
>> www.gasperair.com  
>>

>>  
>> D-62 (#810216)  
>> NEBB (#3465)  
>> CalCERTS (#CC2005644)  
>> CHEERS (#CCNCG514816)  
>> EPA (Universal)  
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>> Office - 626-599-9099  
>> Mobile - 626-236-0268  
>> Fax - 626-737-8370  
>>  
>>  
>> Email - carl.gasperair@yahoo.com  
>> <Establishing Minimum Airflow.pdf><Flowhood  
>> Procedure.pdf><NEBBTotalFanFlow.pdf>  
>  
> —  
>  
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