Does TDE have any value?

Ending the Thermal Distribution Efficiency Discussion

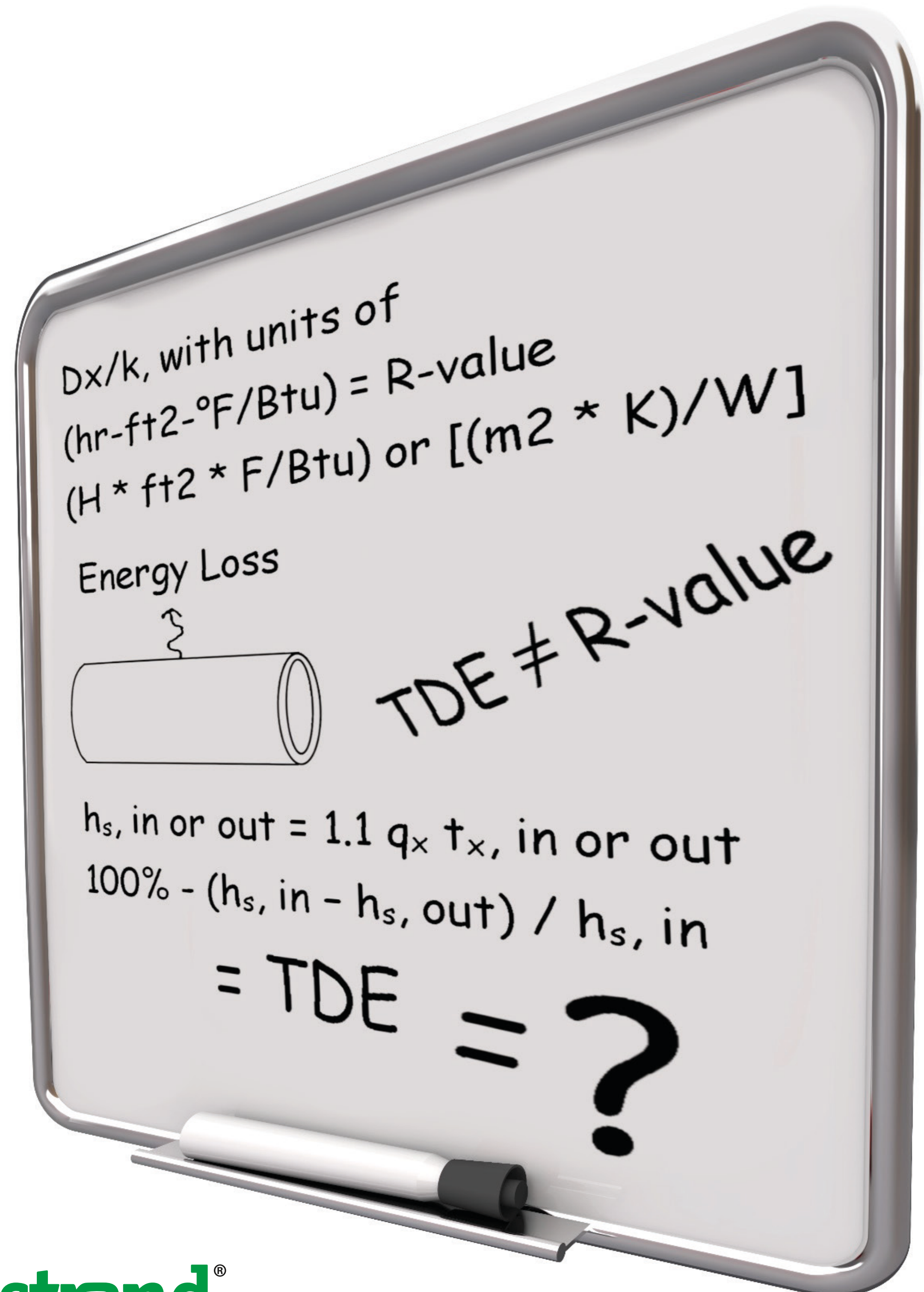

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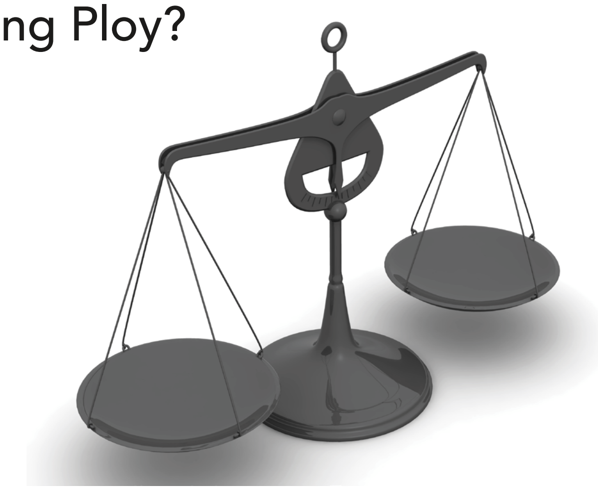
TABLE OF CONTENTS

Legal Disclaimer: This paper was commissioned by Spunstrand Inc. to investigate the topics covered and is intended to express the Company's opinion of the relatively limited value and merit of Thermal Distribution Efficiency, or "TDE" and how it pertains to R-value insulation ratings and underground HVAC ductwork.

TDE: Engineering Tool or Marketing Ploy?



If you are a product lister, design engineer, inspector or building owner, you may be aware of the debate surrounding Thermal Distribution Efficiency (TDE) and R-value as it applies to underground ductwork.

Recently, ICC-ES made a delineation between R-value and TDE, stating the ASTM C518 standard should be used to evaluate a product's R-value capabilities while NSF P374 should be used for determining a TDE value.

Despite the recent ICC-ES delineation in the product listing requirements, a much more fundamental problem with TDE has not yet been addressed by ICC-ES and other trusted listing agencies and that is the fact that TDE has no value as it stands.

TDE, in fact, offers no value to design engineers, inspectors or owners for making real decisions because, for one, it is not comparable to R-value and is not determinate of a product's Energy Conservation Capability. Several questions should help to show why TDE should not be a trusted value, let alone an approved listing option. We invite readers to consider the following:

- What is the definition of TDE?
- Code officials and inspectors - As trusted third party product evaluators, you understand why R-value is in the code. Do you specifically understand why TDE is in the listing criteria? Could TDE lead to liability in the future?
- Listing agencies and code committees - What is the precise value of thermal distribution efficiency (TDE) and what does it contribute to a listing criteria or a code?
- Designers - Does TDE provide a mathematical value? In other words, has a design engineer ever used TDE in a design calculation?
- Inspectors - Is there a TDE box to check off on your inspection sheet?
- Owners - How is a known R1 product certified and sold as an R10 equivalent product? What are you getting? How much money are you losing because of this difference?

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[1] PMG LISTING CRITERIA FOR UNDERGROUND PLASTIC AIR DUCTS LC1014 (Reference EG290) Approved June 2008 (Revised March 2011, March 2016), retrieved 7.25.16 from: www.icc-es-pmg.org/Criteria/Approved/PDF/LC1014.pdf

- What is the definition for Energy Conservation Capability? Can it be evaluated or determined effectively by a comparison test like NSF P374?

A current lack of awareness or misinterpretation of the recent ICC-ES listing update may still be causing some to specify, approve or purchase underground ductwork with only a TDE listing when they require R-value. However, the more fundamental fact about TDE is its total lack of value, which must be understood in order for R-value compliance to take firm root entirely and prevent future liability.

A single manufacturer has represented and promoted the TDE listing as equivalent to an R-value rated product, stating a TDE listed product may be deemed equivalent or comparable to a product with a proven R-value rating. The same manufacturer also claims that TDE determines Energy Conservation Capability and is therefore a more complete evaluation for how a duct will perform to save energy.

These claims cannot be substantiated. This White Paper intends to convince any with a vested interest that, when it comes to TDE, there is no "there" there.

To begin, TDE is not an actionable material property. There is no recognized definition and no design method or calculation that uses TDE. In addition, NSF's Protocol P374 is not a consensus based testing protocol. It possesses numerous potential areas for error and easily manipulated parameters.[2]

This, in part, may be why ICC-ES made the delineation indicating the ASTM C518 standard must be used to determine insulation characteristics of duct materials.

But does ICC-ES's update delineating the NSF and ASTM standards substantially change anything?

Despite the update, the debate continues around TDE as a potential R-value equivalent and whether or not TDE is a viable measure of a product's performance or capabilities to "conserve energy". This means underground ductwork with a known R1 rating is still being promoted and sold as an R10 "equivalent".

Consider: ICC-ES PMG LISTING CRITERIA FOR UNDERGROUND PLASTIC AIR DUCTS states the following:

[2] Thermal Performance of Buried Ducts, July 19, 2016, Professor Ralph Budwig, Ph.D., P.E.

4.4 Determination of Thermal Resistance Values (R-Value) for Ducting Systems: Thermal resistance value of insulation should be determined by ASTM C 518.

Determination of Thermal Distribution Efficiency (TDE) for Ducting Systems: Thermal distribution efficiency of air ducts should be determined by NSF Protocol 374.

Has a product with only a TDE rating been purchased and installed where an R-value product was required or specified? If so, the specification has not been satisfied.

Regardless, the final step to be taken is to remove TDE as an approved listing option, stop it from being included in code language, and eliminate it from the underground duct discussion.

[2] Thermal Performance of Buried Ducts, July 19, 2016, Professor Ralph Budwig, Ph.D., P.E.

Objective Comparison of NSF P374 to ASTM C518

To dispel any myths about the one and only product certified and sold with a TDE listing, two additional un-insulated, R-value rated, underground duct products were recently tested according to NSF Protocol P374 at the QAI Laboratories in Tulsa, Oklahoma. This provided a solid understanding about the testing process and helped to reveal the flaws in the Thermal Distribution Efficiency (TDE) outcome.

Particularly, the test was intended to confirm whether the two products' TDE could be found as equivalent to the R10 control , which, despite the ICC-ES update, would seem to allow them to be promoted and sold as "R10 equivalent" products, even when the product materials were never tested to the ASTM C518 standard.

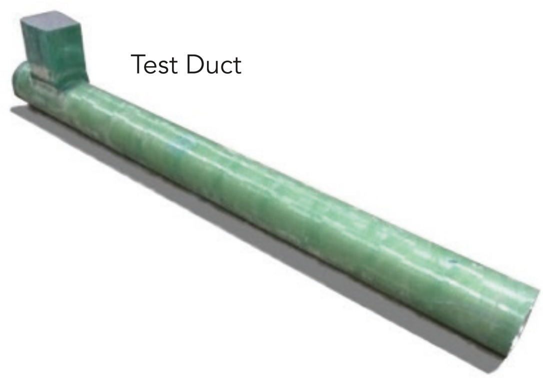
Both products were tested by manufacturers with the understanding that their respective product materials are below an R2 rating according to the actual ASTM C518 standard. Neither is intended to be promoted or sold as an insulated product.

Prior to this recent test, only one known product had ever been evaluated in the attempt to show its equivalence to the ASTM C518 R10 rating by using the NSF Protocol P374. Of course, many thousands of products have been tested and approved with an ASTM C518 R-value rating.

To perform the NSF test on their own products, Spunstrand and another competing manufacturer each submitted a single wall uninsulated 10" fiberglass piece of duct, viewed as their equivalent to that of the "only NSF P374 certified product", which is described in its own NSF test as a "low density self insulating nature material". (Note: While the Spunstrand product and competitor product are both plastic resin duct products, the Spunstrand product has an FRP outer layer for water and corrosion resistance and has a unique inner liner that meets Class 1 flame and smoke. The only NSF certified TDE competitor product is merely a foamed plastic or polyethylene product and lacks any formal density designations).

- Control Duct Before Adding Insulation
[3]QAI Laboratories Testing Inspection - Test Report No: TJ3708-1 Date: May 17, 2016

Control Duct Before Adding Insulation



Test Duct

"A control duct was constructed by surrounding a 10" spiral steel duct 10 feet in length with insulation known to be rated as R10. This assembly was then placed in a trough and backfilled with aggregate as required by the standard. The test sample was placed in an identical trough and backfilled with the same aggregate. Each duct was supplied with hot air supplied by the same heat source and the inlet and outlet temperatures were measured in each duct every 15 seconds for the duration of the test. Air duct surface temperature and aggregate temperature were measured at the beginning of the test. Air flow velocity was measured frequently throughout the test, an average speed determined, and volumetric flow rate calculated based on the average measured velocity. This data was then used to calculate the Thermal Distribution Efficiency for the control and test sample for comparison."

Despite the fact the NSF P374 test does not focus on proving heat loss through the wall of the ductwork at any effective level, but rather tests airflow temperatures in and out in a short period of time, Spunstrand's "FSK" product, which is rated below R1, was determined to have a TDE rating equivalent to the TDE of an R10 product. In fact, the test results determined Spunstrand's FSK to be superior to the tested R10 control product.

How can this be? An uninsulated product was tested against an insulated product.

It is known with certainty that Spunstrand's FSK and its R10 insulated products are neither comparable nor used in the same applications, yet according to the NSF test, FSK has the same TDE, and subsequently the same "Energy Conservation Capabilities", as an R10 insulated product. Does this mean FSK should be viewed as having an R10 "equivalency" or an R10 rating?

How can a duct product with a known R-Value below R1 be promoted and sold as an R10 equivalent? It is confusing and concerning that Spunstrand could now promote and sell FSK as an "R10 equivalent" so long as it uses the NSF test and ignores the ASTM test. This is a clear cut example of fuzzy math and calls into question the value of a TDE rating.

[4] QAI Laboratories Testing Inspection - Test Report No: TJ3708-1 Date: May 17, 2016

These findings force a crucial ethical question: is NSF Protocol P374 an engineering tool or is it only serving a marketing purpose?

The competing manufacturer promotes TDE as "equivalent" to R-value and as a “superior evaluation of duct performance”. By virtue of the test run on Spunstrand’s FSK, it is evident TDE is in fact inadequate at best and deceptive at worst. Could these circumstances confuse end users and even designers and inspectors who specify and approve such product installations? Yes, because ASTM C518 and NSF Protocol P374 do not test the same product properties yet somehow an uninsulated product continues to be promoted and sold with the “R10 equivalent” label, easily leaving an end user with the sense he has an R10 rated product functioning in his home or building.

At the end of the day, or year, the math would right any misconceptions in the form of a negative financial correction for the end user who would have a clear right to question why the “R10 equivalent” product did not do the job of an R10 rated product, particularly if that is what they believe was promoted and sold to them.

All parties look to the code officials, ICC and IAPMO, along with the code listing agencies, ICC-ES and Uniform ES, to determine what is acceptable and which direction manufacturers must go.

Are manufacturers to create new innovative products that meet existing code requirements and address real problems or should difficulty with compliance and cost enable them to resort to looking for weaknesses in the listing requirements and Codes and knowingly or unknowingly exploit a lack of clarity in order to sell underperforming products on the market?

Could such an approach set a precedence for manipulation of code interpretation and create a demand to influence future code changes negatively? If so, the result could easily be a race to the bottom when it comes to product performance. As trusted sources, ICC, IAPMO, ICC-ES, and Uniform ES must end the debate and draw the line by recalling TDE as an item in the listing criteria without delay and stop the addition of TDE or NSF P374 to any trusted codes.

Observed Problems with NSF P374, TDE Testing

Whether TDE is ultimately removed from the listing criteria, it is clear that NSF Protocol P374 attempts to examine Air Duct Thermal Efficiency Performance and not R-value. It is purported to generate a TDE rating of a product but, again, what is TDE and what is its value?

Jessica Evans, Director of Standards Development at NSF states: "NSF P374 is not an equivalent test to ASTM C518 for testing R-value. NSF P374 is not a protocol to determine R-value".

Problem 1

Not every industry professional is aware of this fact, so a concern is: When R-value is being specified, products without an appropriate R-value rating are being approved and installed. For example, after ICC-ES clarified the requirement for ASTM C518, the competing manufacturer has continued to promote TDE with quotes such as the following:

"Fact # 1: The International Code Council (ICC) recently revised their LC1014 listing criteria for underground plastic air ducts. The revision enhances the NSF Protocol P374 from an exception to its own section. ***This move is intended to validate the NSF Protocol P374 as an equivalent to R-Value*** for determining energy performance versus the old version."

Basic research shows that NSF Protocol P374 is one of the least 'real life' representative standards that can be tested to, because it doesn't tell a story that will be backed up in the real world. There is no real world application for what is being tested.

Consider the scope of the protocol and testing procedure:

The NSF Protocol seeks to rate the energy performance of a duct system, not insulation properties of a duct wall, to produce a value defined as thermal distribution efficiency (TDE). TDE is an energy loss calculation evaluating the difference in the temperature of the air between the air duct inlet and outlet caused by differences between the air in the duct and the duct material. With little or no recognition in accepted HVAC design approaches, it is not clear how TDE quantity, energy loss calculations of a specific duct system, could be performed by a designer provided only with the TDE value from the NSF protocol. Designers require accurate duct wall R-values in order to perform energy loss calculations for the specific duct systems they design.

[5] AQC Industries, The Blue Duct & The 2016 ICC LC1014 Update, http://files.ctctcdn.com/4eeca6bf401/c1481bd7-87bb-44bd-b06c-f244338cf27a.pdf

The NSF P374 test procedure is said to determine the TDE of air duct constructed of different materials, insulated with different types or thicknesses of insulating materials, or installed under different conditions, such as buried or exposed.

TDE is expressed as a percent difference between the inlet and outlet temperature in the duct. This is impacted by variables such as backfill differences, the locations of temperature probes, length and diameter of duct, duct material surface characteristics, air velocity, ambient temperature and volumetric flow rate, all of which are not properly accounted for in NSF P374.

During Spunstrand's TDE test, a control duct was constructed by surrounding a 10 inch spiral steel duct 10 feet in length with insulation known to be rated as R10. This assembly was then placed in a trough and backfilled with aggregate as required by the standard. The test sample was placed in an identical trough and backfilled with the same aggregate. Each duct was supplied with hot air from the same heat source and the inlet and outlet temperatures were measured in each duct every 15 seconds for the duration of the test. Air duct surface temperature and aggregate temperature were measured at the beginning of the test. Air flow velocity was measured frequently throughout the test, an average speed determined, and volumetric flow rate calculated based on the average measured velocity. This data was then used to calculate the Thermal Distribution Efficiency for the control and test sample for comparison.

Currently, if the output is within 10% of the control pipe then it is said to have a TDE equal to that of the pipe with R10 insulation. In this case, the Spunstrand FSK sample was within 1% of the control duct throughout the duration of the test and determined to be equivalent. But what does this have to do with the thickness and insulating properties of the duct wall?

Problem 2

Per NSF P374, TDE is determined with the following two equations:

1. Hs, in or out = 1.1 qx tx, in or out

2. TDE = 100% - (hs, in – hs, out) / hs, in

When completed, this equation cancels out Q (Volumetric Flow Rate) mathematically.

Does this indicate that Volumetric Flow Rate is somehow irrelevant? No.

But the way the TDE equation is set up, Q is irrelevant mathematically, and yet Volumetric Flow Rate is not irrelevant.

For example, if a test is flowing 100 cfm through a 10" duct, the air will move through the duct at twice the velocity of the same duct flowing 50 cfm. The longer it takes the air to traverse the ten feet of duct, the bigger the temperature difference in the duct will be because there is more time for the temperature to change. Essentially, this means the test can be manipulated to achieve any result that may be desired.

Consider that Manufacturer A wants to match a pipe made by Manufacturer B. MB's testing of the pipe shows it had an inlet temperature of 110 degrees and an outlet temperature of 100 degrees with an unknown flow rate. When MB tests its pipe, it has an inlet temperature of 110 degrees and an outlet temperature of 97 degrees. For MB to match MA's results, it could simply speed up the airflow through its pipe and the change in the air velocity would not show up in the test.

Any engineer can see the Q term means nothing in the equation, enabling an easily manipulated test result.

So this is a test that must be based on the integrity of those doing the testing and the presumption that they will maintain all variables as standards, a notion that would seem to preclude the need for standards and codes. Otherwise, using this test allows any manufacturer to claim equivalency to any R factor desired.

Problem 3

Based on the fact that TDE should only apply to a system, simply using a length of duct will not produce meaningful results. More intense parameters, where R-value is taken into consideration, and a stronger protocol are essential.

On its face, NSF Protocol P374 does not consider or test a closed system where the air is flowing through and the duct is under a load, whether heating or cooling. Load must be accounted for in order to evaluate energy loss accurately.

Problem 4

However, even if NSF Protocol P374 were enhanced to properly test a system, one would have to take the same approach as that used to measure building energy performance, it would involve testing an entire building with a specified configuration under specified conditions.

The ability to transfer these kinds of test results to other buildings would be difficult or impossible. In addition, measurement-based protocols that are used to evaluate more complex systems typically involve several types of measurements at many locations. The potential for the propagation of experimental uncertainty is therefore a valid concern for these kinds of protocols.

What then is the value of the TDE test? How can a single length of duct represent an entire duct system? What is the impact of using different backfills in the test than in the actual application, especially for uninsulated products? For that matter, what is the value of the more recent Spunstrand TDE test which replicated the same testing scenario?

How is it reasonable to link any of this to R-value? Does TDE evaluate a duct product's capability to conserve energy?

It bears repeating that, with no specified units, a weak protocol and no agreed upon definition -- TDE has no value for the design engineer.

The ASTM C518 and NSF P374 tests are not equivalent, and do not produce comparable results so it is reasonable that the NSF P374 tested product would not be promoted as equivalent to an R10 rated product. But further than this, it is reasonable to eliminate the use of TDE as a standard because it is not determinant of Energy Conservation Capability.

[6] Thermal Performance of Buried Ducts, July 19, 2016, Professor Ralph Budwig, Ph.D., P.E.

What is Energy Conservation Capability?

The competing manufacturer has admitted, at times, that TDE does not determine R-value but also alludes to the idea that a TDE shows a product's Energy Conservation Capability and is therefore a more complete evaluation for how a duct should be expected to save energy. The indication is that TDE is actually a better test than the ASTM C518 standard, despite NSF stating the tests are not comparable nor executed for the same purpose.

To define Energy Conservation Capability, the *California Energy Commission* points to the International Code Council (ICC) Evaluation Service PMG listing 4.6 which states: Energy Conservation Characteristics: **Chapter 4 of the IECC should be used to determine the energy conservation capabilities of the duct system.**

As described by the CEC, *"Chapter 4 of the IECC addresses commercial energy efficiency, and contains a section that sets minimum efficiency requirements for duct systems. These requirements are minimum insulation and sealing levels. This leads me to interpret what is meant by the term 'energy conservation capability' as the set of minimum requirements imposed on the duct system."*

Looking to *Chapter 4 [CE] Commercial Energy Efficiency*, it is inescapable that R-value insulation is mandated to determine Energy Conservation Capability.

Taken from the IECC - 2015 International Energy Conservation Code:

C403.2.9 Duct and plenum insulation and sealing.
Supply and return air ducts and plenums shall be insulated with a minimum of R6 insulation where located in unconditioned spaces and where located outside the building with a minimum of R8 insulation in *Climate Zones* 1 through 4 and a minimum of R12 insulation in *Climate Zones* 5 through 8. Where located within a building envelope assembly, the duct or plenum shall be separated from the building exterior or unconditioned or exempt spaces by a minimum of R8 insulation in *Climate Zones* 1 through 4 and a minimum of R12 insulation in *Climate Zones* 5 through 8.

And further, the IECC defines R-value as thermal resistance. "The inverse of the time rate of heat flow through a body from one of its founding services to the other surface for a unit temperature difference between the two surfaces, under steady-state conditions, per unit area: (H * ft2 * F/Btu) or [(m2 * K)/W]."

[7] California Energy Commission, July 12, 2016

[8] IECC - 2015 International Energy Conservation Code, retrieved 7.25.16 from: http://codes.iccsafe.org/app/book/content/2015-I-Codes/2015%20IECC%20HTML/Chapter%204%20%5bCE%5d.html

Why then does the competing manufacturer claim that TDE determines Energy Efficiency Capability? Clearly it is R-value which is required.

Additionally, an actual energy company states:

"There is no standard definition for 'energy conservation capabilities' with regards to HVAC ductwork. While HVAC ducts can be made from a variety of materials (including sheet metal, fiberglass, or flex-duct) the primary energy conservation strategy for HVAC ducts is through sealing and insulation."

Energy companies use only one way to find the energy conservation capability of a product used underground and that is with an R-value evaluation. In fact, energy companies assess payments credited back to customers for energy improvement based on R-value improvement and this is done based on running counts for the amount of heat loss and money lost based on the R-value improvement.

As stated previously, it is a known that NSF Protocol P374 attempts to examine Air Duct Thermal Efficiency Performance and not R-value. Yet, despite what actual energy companies use to determine thermal efficiency and even how they base making payments back to customers for energy efficiency, namely R-value, an underground duct product with an ASTM C518 rating of roughly R1 is stated to be equivalent to R10 and the test is described as superior and more complete in determining energy conservation capability.

The competing manufacturer indicates that it uses the term Energy Conservation Capability when referring to maintaining energy in the airflow in the duct. In conjunction with this, there may also be claims that a small diameter, high velocity duct design will positively influence a total energy budget.

In performing its own TDE test with a third party agency according to the NSF Protocol P374 standard, Spunstrand notes for the record that the current test method does not and cannot measure the small diameter, high velocity theory effectively or in a manner that would allow one to draw a direct line between TDE and a true R-value rating, due to factors it does not account for. The only way to do this is with ASTM C518.

[9] ICF International, Email Communique, July 7, 2016

[10] IECC Code Change Proposal CE147-16, Part I and Part II, Jay Peters, representing AQC Industries/The Blue Duct

High Velocity Duct Design and Energy Efficiency

Because some duct products fail to meet current R-value requirements, it may be suggested that a designer could utilize a smaller diameter duct (yielding a higher velocity) and thus claim that losses due to poor R-value are negated.

This is partially correct. After a volume flow rate has been determined, a smaller diameter, higher velocity design will drive higher pressure and will influence the relative amount of heat lost through the duct wall. For example, if a high velocity duct is half the diameter of a comparable low velocity duct, the high velocity duct will have half the energy loss through the wall.

However, a designer must also consider the extra energy required to move air at higher velocity through a smaller duct, since it must deliver the same sensible heating as the low velocity duct. Staying with our comparable products noted above, and after calculating for volume flow rate and then using the Darcy-Weisbach equation to calculate frictional loss in the duct, we see that the blower power in the smaller diameter, higher velocity duct will need to be approximately 32 times greater to supply the required air flow rate in the duct.

The designer will need to consider both of these energy streams over the lifecycle of the HVAC system, as well as the original costs of the blower and ductwork.

Also, when considering any design with an uninsulated duct, which the competing manufacturer's product is, it will be necessary to consider the potential for condensation on the wall of the duct. The designer will need to evaluate the anticipated range of saturation temperatures of the moist air to be carried by the duct as well as the anticipated duct wall temperatures.

The uninsulated or under-insulated buried duct will more closely track the temperature of the substrate around the duct. Thus for climate zones that have a cold and wet season, the potential for condensation must be considered. Designs that result in condensation should be avoided as they may lead to the growth of mold in the duct.

[11] Thermal Performance of Buried Ducts, July 19, 2016, Professor Ralph Budwig, Ph.D., P.E.
[12] Thermal Performance of Buried Ducts, July 19, 2016, Professor Ralph Budwig, Ph.D., P.E.

What are the Risks of Relying on TDE

In conclusion, a basic question remains. What are the consequences of taking TDE at face value?

1. Even before considering that TDE should be removed from the listing criteria, there is a void of awareness regarding the recent ICC-ES listing update and this is causing some to specify, approve or purchase underground ductwork with only a TDE listing when they desire, require, specify, or intend to specify R-value. This presents legal and liability issues.

2. What is happening when a design engineer cannot enter a mathematical value for TDE in a design calculation? This question is not often considered, even as TDE becomes an accepted norm in the listing criteria and potentially heads toward being entered into the code, and this threatens the calculable reliability of R-value in the present and future.

3. The current TDE equation and testing process are flawed in and of themselves, and the present result is a sliding scale that enables a finding for any R Value desired, and the selling of a product that cannot deliver what is promised. For instance, R-value is a defined material property, with established units easily used in calculations but TDE has no specified units and no agreed upon definition and its equation cancels out Q (volumetric flow rate). What value does TDE have for the design engineer?

4. The industry lack of awareness and understanding enables a single manufacturer to represent and promote the TDE listing as equivalent to an R-value rated product, stating a TDE listed product may be deemed "equivalent or comparable" to a product with a proven R-value rating. This sets a precedent for completely avoiding code requirements and hurts the industry in a number of ways as it overlooks the protected needs and expectations of end users.

5. Uninsulated products tested for TDE can be found as equivalent to R10, which, despite the ICC-ES recent delineation, allows them to be promoted and sold as "R10 equivalent" products, despite the fact the product materials were never tested to the ASTM C518 standard and despite the fact NSF states "NSF P374 is not an equivalent test to ASTM C518 for testing R-value. NSF P374 is not a protocol to determine R-value".

6. According to the lowering of standards that results with TDE in the listing criteria, manufacturers seemingly may resort to looking for weaknesses in the listing requirements and Codes and knowingly or unknowingly exploit a lack of clarity in order to sell other underperforming products on the market.

7. A competing manufacturer has floated the idea that by simply decreasing the duct size and subsequently increasing the velocity of the duct that it would be logical that the losses due to their lack of R-value might be negated. Even if a small diameter, high velocity duct design positively influences an energy budget, a designer must consider the additional energy required to move air at higher velocity through a smaller duct. This is calculated to be approximately 32 times greater energy to supply the required air flow rate in the duct. Is this in the best interest of the end user?

Clarification & Reform Needed

To say Thermal Distribution Efficiency is equivalent to R-value is to say the two standards are equal in value, amount or function. This is not possible. The two standards are apples and oranges.

To say that Thermal Distribution Efficiency is determinate of Energy Conservation Capability is to leave out the fact that Energy Conservation Capability is based on R-value. (It begs the question, what would TDE be without R-value?)

R-value for insulated underground duct is determined by one code-approved testing method, ASTM C518. This time-tested and trusted standard is used by everyone from manufacturers to energy companies to determine the important performance characteristics of a product.

Home or building owners, as the end users of underground duct products requiring an R-value, still have the right to understand clearly what they are buying and what the functional expectations are according to industry and legal standards. Today, they are unable to do this due to the lack of clarity within LC1014, even after the recent delineation of ASTM C518 and NSF P374, updated by ICC-ES.

One uninsulated underground duct product that cannot comply with existing, long standing code requirements for underground duct, must not prevent the removal of NSF P374 as a listing criteria. Any product that is promoted as "new and innovative" must be able to meet the standing codes while pushing performance; not create a slippery slope that dilutes the code in order to achieve so called compliance.

At best, NSF Protocol P374, its purpose and methodology, presently causes confusion in the industry for many, which is evident by the facts that:

- ICC publicly states it does not recognize that the NSF P374 test determines R-value
- The NSF publicly states it does not recognize the NSF P374 as an equivalent test to ASTM C518 for testing R-value

The disparity between these two very different industry standards ultimately affects the welfare of the public. With information, such as that presented in this White Paper, an objective consensus and conclusion may be reached for the good of the industry and its customers.

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