



NSF Protocol P374

Air Duct Thermal Efficiency Performance



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NSF International
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Phone: (734) 769-8010 Telex: 753215 NSF INTL
FAX: (734)769-0109 E-mail: info@nsf.org
Web: <http://www.nsf.org>

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Air Duct Thermal Efficiency Performance

NSF International
Engineering & Research Services

Prepared by NSF Engineering & Research Services staff with assistance from NSF Protocol Development Panel members shown below:

- Sal Aridi, P.E., NSF International
- Richard Beck, P.E., CBO, MCP, ICC-ES
- John Clark, P.E., Karges-Falconbridge, Inc.
- Chris Jacques, Laars Heating Systems
- Jon Jungers, CDC Enterprises, Inc.
- John Thelen, Jr., Thelen Heating & Roofing

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Air Duct Thermal Efficiency Performance

1 General

1.1 Purpose

This protocol establishes a test procedure to compare thermal efficiency performance of air ducts constructed of different materials, insulated using various insulation procedures, or installed under different conditions.

1.2 Scope

This test procedure is to determine the thermal distribution efficiency (TDE) of air ducts constructed of different materials, insulated with different types or thicknesses of insulating materials, or installed under different conditions, such as burial or exposed. TDE is a heat loss calculation evaluating the difference in the heat of the air between the air duct inlet and outlet caused by differences in temperatures between the air in the duct and the duct material. TDE is expressed as a percent difference between the inlet and outlet heat in the duct.

The intent of this scope of testing is to compare the TDE of an air duct constructed of a new or innovative material against the TDE of an air duct constructed of a reference material, such as a PVC or PVS duct wrapped on four sides with foam insulation to achieve an R-10 energy rating.

1.3 Limitations

The requirements of this protocol are limited to comparative TDE evaluations for different air duct conditions. This protocol does not set guidelines for the configuration, materials of construction, or performance requirements for air ducts. The product manufacturer shall be responsible for determining compliance with appropriate building and mechanical codes related to the air duct products.

2 Normative References

The following documents contain provisions that, through reference in this text, constitute provisions of this protocol. At the time of publication, the indicated revisions were valid. All standards are subject to revision, and parties are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

- American Society for Testing and Materials (ASTM) D2412-02. Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
- American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) ANSI/ASHRAE 41.2-1987 (RA 92). Standard Methods for Laboratory Airflow Measurement.
- International Association of Plumbing and Mechanical Officials. 2009 Uniform Mechanical Code.

- ICC Evaluation Service, Inc. Evaluation Guide for Underground Plastic Air Ducts, EG290, Approved March 2005.
- International Code Council. 2009 International Mechanical Code®.
- International Code Council. 2009 International Residential Code® For One- and Two-Family Dwellings.

3 Definitions

Terms used in this protocol that have a specific technical meaning are defined here.

- 3.1 Air Duct:** A pipe, tube, or channel designed to convey heated or cooled air from a heating or air conditioning unit to a location inside a building.
- 3.2 Sensible Heat Flow:** Dry heat causing changes in temperature but not in the moisture content.
- 3.3 Thermal Distribution Efficiency:** The resistance to changes in air heat as air is conveyed through a distance of air duct.

4 Test Procedure

This test is to determine the thermal distribution efficiency (TDE) of air ducts constructed of different materials and insulated with different types or thicknesses of insulating materials. TDE is the difference in the heat of the air between the air duct inlet and outlet caused by differences in temperatures between the air in the duct and the duct material. TDE is expressed as a percent difference between the inlet and outlet heat in the duct.

4.1 Test Summary

Two identical lengths of different air duct materials will be constructed in two or more identically sized troughs and backfilled with the identical type of aggregate fill material. One of the air ducts will be considered the control, with the other air ducts evaluated against the control air duct. The inner diameter of the different test air duct materials shall be as close to the same as practical to minimize the potential impacts of differing pipe diameters on test results.

The test air duct materials shall be connected to a furnace and air conditioning air duct system. The test air ducts shall discharge to the open atmosphere. The test shall include measuring the inlet and outlet temperatures and air flows at identical times in all of the test air ducts during heating and air conditioning events while the heater or air conditioner is operating.

For each paired set of inlet and outlet temperature data for each test air duct, the thermal distribution efficiency (TDE) of the air ducts will be calculated, and the TDE of the two air ducts will be compared.

4.2 Sample Identification / Test Set-Up and Parameters

Each test trough shall be equipped with equal lengths of test air duct with a minimum length of 10 ft. The troughs shall be sufficiently large so that the air duct is covered with a minimum of 3 in. of aggregate between insulated air duct and trough walls, and is covered with a minimum of 3 in. of aggregate. Figure 1 is a schematic diagram of a typical test setup. Testing should be conducted in a laboratory or other controlled setting at a temperature of 55-95°F (13-35°C) and a relative humidity range of 35%-65%.

The air flow to the inlets to the duct systems shall be supplied through duct work with an inside diameter at least as large as the larger of the test or control air ducts. A pressure gauge shall be installed in this air duct to measure the static air pressure inside the duct. Air stream temperatures shall be measured in the center of the ducts at the beginning of each test or control air duct section. The duct outlet surface temperatures shall be measured a minimum of 12 in. in from the outlets on the top centerline. The aggregate material temperatures shall be measured at equivalent locations in each air duct trough.

The surface temperature of each air duct material and the aggregate fill materials shall also be measured. At the start of the test, the aggregate material and air duct temperature shall be at an equilibrium state of within $\pm 5.0^{\circ}\text{F}$ (2.8°C) of each other, when aggregate material temperatures in each test trough are measured a minimum of 2 in. depth in the aggregate. The test shall run for a minimum of 1 hr, with the furnace or air conditioning system cycling through a minimum of two on/off cycles through the duration of the test; however, the blower shall run continuously through the test. In order to challenge the air duct materials at a wide variety of temperatures, the inlet air temperature must reach a temperature of at least 40.0°F (22.2°C) warmer than the aggregate temperature during the heating test and at least 20.0°F (11.1°C) cooler than the aggregate temperature during the cooling test for at least one data point during each respective test. Data shall be recorded from the test air ducts at the same time. A minimum of 10 sets of air duct temperature and air flow readings in all test air duct materials shall be recorded.

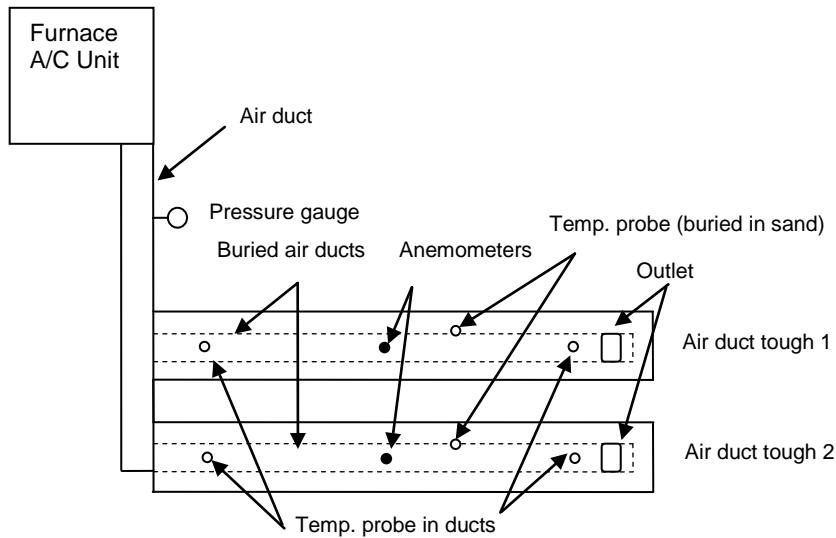


Figure 1. Example of test setup

4.3 Test Verification Equipment

The following equipment will need to be procured and utilized for testing. The testing organization shall be responsible for equipment maintenance and calibrations, as required by the equipment manufacturer. Test verification equipment shall be NIST-traceable and calibrated as recommended by the equipment manufacturer:

- Micromanometer, transducer, pitot tubes, or equivalent devices to measure air pressure;
- Anemometer or equivalent devices to measure air flow and velocity;
- Thermometer to measure air temperatures inside the air ducts and aggregate materials;
- Other test equipment, as appropriate; and
- Computer, worksheets, or laboratory notebook to record test results.

For all test verification equipment, calibration, precision, accuracy, and resolution must be in conformance with Section 6 of ANSI/ASHRAE 41.2-1987 (RA 92), *Standard Methods for Laboratory Airflow Measurement*.

4.4 Data Collection and Calculation

The following data shall be recorded at each sampling interval:

- Air duct surface temperature at the beginning of each test;
- Aggregate temperature at the beginning of each test;
- Sample Time/Elapsed Test Time;
- Air Volume or Flow through each air duct;
- Inlet Air Temperature in each air duct; and
- Outlet Air Temperature in each air duct.

4.4.1 Calculation

For each time interval, the following calculation shall be made, using the data collected:

1. The sensible heat will be calculated for both the inlet and outlet temperature in each air duct using the following equation:

$$h_{s, \text{ in or out}} = 1.1 q_x t_{x, \text{ in or out}} \quad (1)$$

Where:

- $h_{s, \text{ in or out}}$ = Sensible heat (BTU/hr) calculated at pipe inlet or outlet
1.1 = constant based on specific heat and air density at 114°F
 q_x = Air flow in duct x, cfm
 $t_{x, \text{ in or out}}$ = Temperature (°F) measured at pipe inlet or outlet

2. The TDE for each air duct will be calculated using the following equation:

$$\text{TDE} = 100\% - (h_{s, \text{ in}} - h_{s, \text{ out}}) / h_{s, \text{ in}} \quad (2)$$

Where:

- $h_{s, \text{ in}}$ = Sensible heat (BTU/hr) calculated at pipe inlet
 $h_{s, \text{ out}}$ = Sensible heat (BTU/hr) calculated at pipe outlet

4.5 Acceptance Criteria

The test pipe shall be considered to exhibit equivalent TDE to the control pipe if the TDE for the test pipe is within $\pm 10\%$ of the control pipe at each test interval.

Annex A

Program Specific Policies

A.1 Marking

In addition to the requirements outlined in the NSF Certification Policies for NSF Protocols and Non-NSF Standards, certified individual products, packaging materials, or product promotional information should bear the following information:



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A.2 Audits / Re-testing

NSF shall conduct audits of all production locations at least annually. Audits will cover the following basic items, at a minimum:

- No process or product changes have been made that could affect the thermal distribution efficiency without prior approval of NSF.
- Labeling shall be consistent with the requirements described in this protocol.
- Product data and records, along with nonconformance records, are maintained at the facility and are available for inspection. Records shall be maintained for a minimum of the preceding three year period.