Table 55A.1
Tape dimensions and properties (average values)

Tape property	Tape No. 3	Tape No. 2	Tape No. 1
Thickness	0.045 – 0.080 inch (1.14 – 2.03 mm)	0.025 – 0.040 inch (0.64 – 1.02 mm)	Total: 0.0045 inch (0.114 mm) Backing: 0.0025 – 0.0035 inch (0.064 – 0.089 mm)
Density	16 lbs/cubic foot (256 kg/cubic meter)	14 lbs/cubic foot (224 kg/cubic meter)	–
Tensile strength	110 lbs/inch^2 (758 kN/m^2) (ASTM D 412-97[a], Die A)	55 lbs/inch^2 (379 kN/m^2) [″T″ Block, Jaw 12 inches/ minute (305 mm/minute)]	16 lbs/inch^2 (110 kN/m^2) (ASTM D 1000-93[b])
Elongation, percent	370 (ASTM D 412-97[a], Die A)	–	275 (ASTM D 1000-93[b])
Temperature Resistance (continuous)	175°F (80°C)	150°F (65°C)	356°F (180°C)
Compression Deflection at 25 percent (ASTM D 1056-91[c])	13 psi (90 kN/m^2)	–	–
Compression Modules at 25 percent	–	8.5 psi (59 kN/m^2)	–
Compression Set percent loss of original height:			
In accordance with ASTM D 1056-91[c]	3 percent	–	–
In accordance with ASTM D 1667-76(1990)[d]	–	3.9 percent	–

[a] Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers – Tension.
[b] Test Methods for Pressure-Sensitive Adhesive Coated Tapes for Electrical and Electronic Insulation.
[c] Specifications for Flexible Cellular Materials – Sponge or Expanded Rubber.
[d] Specifications for Flexible Cellular Materials – Vinyl Chloride Polymers and Copolymers (Closed – Cell Vinyl).

55A.6 The lance or wand is to be held with the nozzle tip in contact with Tape No. 1 (outer layer) of the test fixture without applying pressure. The unit is then to be operated at maximum pressure for 5 seconds.

56 Switches, Controls, and Interlocks

56.1 A product shall be constructed so as to reduce the possibility of unexpected operation of a part capable of causing injury to persons.

56.2 Each function of a multiple-function product is to be taken into consideration in determining whether the product complies with the requirement in 56.1.

56.3 A motor control switch, other than a momentary-contact switch, on the product shall have a plainly marked off position.

56.4 If unintentional operation of a control can result in a risk of injury to persons, the actuator of the control shall be located or guarded so that such operation is unlikely. The actuator of a control may be guarded by recessing, ribs, barriers, or similar obstruction.

56.5 The gun control on a Type 2 and 3 cleaning machine shall be equipped with an automatic or visible manual safety device which will preclude pulling of the trigger and release of the fluid until the safety device is manually released.

56.6 The actuator of an interlock switch shall be located so that unintentional operation is unlikely.

56.7 A device that automatically starts a product, such as a timer, an automatically reset overload-protective device, or similar device, shall not be employed unless it can be demonstrated that automatic starting will not result in a risk of injury to persons.

56.8 The requirement in 56.7 will necessitate the use of an interlock if moving parts, high pressure fluid, or similar materials could result in a risk of injury to persons upon automatic starting or restarting of a motor.

56.9 Operation of an interlock in normal use shall not inconvenience the operator so as to encourage deliberate defeat of the interlock.

56.10 An interlock shall be such that it cannot be defeated readily:

a) Without damaging the product,

b) Without making wiring connections or alterations,

c) By using readily available materials, or

d) By materials that could accumulate in normal use.

56.11 If an interlock is actuated by movement of a guard, the arrangement shall be such that the guard is in place when the interlock is in the position that permits operation of the part being guarded. With the guard removed, the interlock shall comply with the requirement in 56.6.

56.12 A floor- or ground-supported product that can travel or rotate to an extent that could result in a risk of injury to persons if left unattended shall be provided with a momentary contact switch that cannot be locked in the on position.

57 Strength of Support Handles

57.1 A support handle or similar means provided to support or carry a product shall comply with the requirements of the Test for Strength of Support Handles, Section 73.

58 Stability

58.1 A portable product shall comply with the requirements of the Stability Test, Section 101.

58.2 A product provided with casters or wheels shall have at least two locking casters or other means to restrict movement.

58.3 A product not intended to move from its de-energized position to perform its intended function but that may move from its de-energized position when operated – such as from vibration – shall be provided with locking wheels or other means to restrict movement.

59 Strength of Mounting

59.1 A product intended to be mounted on a wall or ceiling shall withstand a force of four times the weight of the product without malfunction of or damage to the mounting bracket, its securing means, or that portion of the product to which it is attached. Provision shall be included to accommodate any excessive vibration of the product.

59.2 To determine whether a product complies with the requirement in 59.1, it is to be mounted in accordance with the installation instructions provided by the manufacturer – on a surface of the construction specified using the parts provided. If no surface construction is specified, 3/8-inch-thick plasterboard (dry wall) on nominal 2- by 4-inch (actual 1-5/8- by 3-5/8-inch– 41- by 92-mm) wood studs spaced on 16-inch (406-mm) centers is to be used as the supporting surface. The mounting parts are to be used as specified in the instruction; and, if not otherwise indicated, the securing screws are to be located between the studs and secured in the plasterboard. An adjustable product is to be adjusted to the position that will give the maximum projection from the wall. The force is to be applied through a 3-inch (76-mm) wide strap at the dimensional center of the product and is to be increased during a 5- to 10-second interval, until a load equal to the weight of the product plus a force of three times the weight of the product, is applied to the mounting system. The load is to be maintained for 1 minute.

59.3 Nonmetallic mounting means shall comply with the tests specified in the Tests for Nonmetallic Enclosures and Guards of Moving or Hot Parts, Section 71.

60 Discharge-Fluid Temperature

60.1 A product intended to be connected to other than a cold water source and a product employing means to heat the water shall be provided with:

a) A lance or wand having the trigger mechanism located at least 3 feet (0.9 m) from the discharge nozzle;

b) A manually operated control (deadman control), the actuator of which shall be located or guarded to prevent unintentional operation; and

c) A cautionary marking. See 113.1.10.

61 Surface Temperatures

61.1 The temperatures on a surface that may be contacted during intended operation shall comply with the requirements in Subsection 67.2.

PERFORMANCE – GENERAL

62 Details

62.1 All products

62.1.1 If tests indicate that a product may not continue to comply with the applicable requirements during intended use, supplementary tests are to be conducted, as necessary.

62.1.2 During the tests, a flexible polymeric or elastomeric boot that covers a switch and that is flexed when the switch is operated is to be removed, and a part that can be opened or removed without the use of a tool is to be removed or placed in the most adverse position for the test being conducted.

Exception: A boot that is momentarily flexed and not held in the flexed position when the switch is operated and that meets the following conditions is not required to be removed:

a) The boot shall be mechanically secured by fastening means, such as screws;

b) The boot shall not be able to be removed by hand, or depend upon friction for securement; and

c) The boot shall comply with the Aging Test described in 70.2.

d) For portable equipment for use outdoors, but intended to be stored indoors, and marked in accordance with 112.1.5 and for stationary and fixed equipment intended for indoor installation and marked in accordance with 112.1.5, the boot shall be cold-conditioned at 0.0 +2.0°C (32.0 +3.6° F) for 3 hours. For equipment not marked for storage in accordance with 112.1.5, the boot shall be cold-conditioned at –35.0 +2.0°C (–31.0 +3.6°F) for 3 hours. Immediately after the conditioning, and with the temperature maintained, the boot shall be hand-flexed, with gloves worn to inhibit heat transfer to the boot. The boot shall not harden or otherwise deteriorate to a degree that will impair its sealing properties.

62.2 Electrical systems

62.2.1 Unless otherwise specified, all tests are to be conducted with the product connected to a supply circuit of the frequency specified in 62.2.2. The voltage of the supply circuit is to be as specified in Table 62.1.

Table 62.1
Test voltages

Rated voltage	Undervoltage[a]	Test voltage	Overvoltage
110 – 120	102	120	132
200 – 208	177	208	229
220 – 240	204	240	264
254 – 277	235	277	305
440 – 480	408	480	528
550 – 600	510	600	660
Other	85 percent of rated	rated	110 percent of rated

[a] Values in this column are applicable to alternating-current potentials. Undervoltage tests for a direct-current burner or component are to be conducted at 80 percent of rated voltage.

62.2.2 A product having a single frequency rating is to be tested at that frequency. A product rated both 60 hertz and dc is to be tested on direct current or 60-hertz alternating current, whichever results in higher temperatures. A product rated 50 – 60 hertz is to be tested on 60-hertz alternating current.

62.3 Fuel-fired products

62.3.1 A product with a fuel-fired water-heating system shall comply with the applicable performance requirements when tested with each grade or type of fuel recommended by the manufacturer of the product.

62.3.2 A product intended for fixed installation is to be tested on a noncombustible construction. At the manufacturer's request, the product may be tested for installation on a combustible floor.

62.3.3 During the applicable tests, an oil burner shall operate uniformly and reliably, and following the tests shall not exhibit excessive carbonization or other characteristics that may adversely affect the intended operation of the burner.

62.3.4 An oil burner equipped, or intended to be equipped in the field, with preheaters to heat the fuel oil before it is delivered for combustion is to be tested using fuel oil that has been heated to the intended temperature.

63 Instrumentation

63.1 Temperature measurement

63.1.1 Ordinarily, coil or winding temperatures are to be measured by thermocouples, except that temperatures are to be measured by the change-of-resistance method if:

a) The coil is inaccessible for mounting of these devices – for example, a coil immersed in sealing compound;

b) The coil wrap includes thermal insulation or more than two layers [1/32 inch (0.8 mm) maximum] of cotton, paper, rayon, or similar materials.

63.1.2 Thermocouples used to measure temperatures on motor coil windings are to be located either on the windings or on the integrally applied insulation on the windings. If a coil wrap other than as described in 63.1.1(b) is employed, thermocouples are to be placed under the wrap. For a thermocouple-measured temperature of a coil of an alternating-current motor, other than a universal motor, having a diameter of 7 inches (178 mm) or less – items 7 and 9 in Table 67.1 – the thermocouple is to be mounted on the integrally applied insulation on the conductor.

63.1.3 Thermocouples are to consist of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2). The thermocouple wire is to conform with the requirements listed in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M.

63.1.4 Whenever referee temperature measurements by thermocouples are necessary, thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wire and a potentiometer-type instrument are to be used.

63.1.5 Each thermocouple junction and adjacent thermocouple lead wire are to be securely held in thermal contact with the surface of the material whose temperature is being measured. In most cases, thermal contact will result from taping or cementing the thermocouple in place; but if a metal surface is involved, brazing or soldering the thermocouple to the metal may be necessary.

63.1.6 Thermocouples are to be secured to wood surfaces by staples over the insulated portion of the wire and with the tip held in thermal contact with the surface by pressure-sensitive tape; except that for zero clearance, the thermocouples are to be applied to surfaces of the representative product at points of zero clearance.

63.1.7 In using the change-of-resistance method, the windings are to be at room temperature at the start of the test. The temperature rise of a winding is to be calculated from the formula:

$$\Delta t = \frac{R}{r}(k + t_1) - (k + t_2)$$

in which:

Δt is the temperature rise in °C;

R is resistance of the coil in ohms at the end of the test;

r is resistance of the coil in ohms at the beginning of the test;

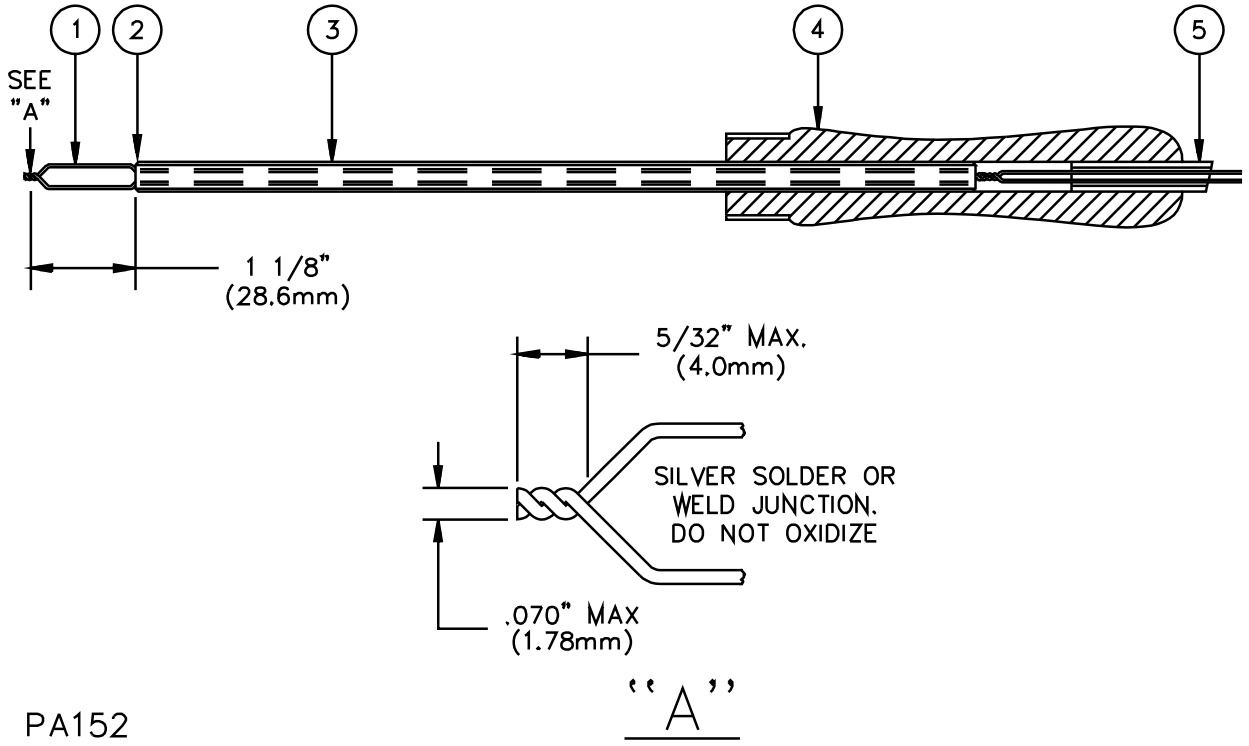
t_1 is room temperature in °C at the beginning of the test;

t_2 is room temperature in °C at the end of the test; and

k is 234.5 for copper and 225.0 for electrical conductor grade (EC) aluminum. Values of the constant k for other grades must be determined.

63.1.8 The flue-gas temperature is to be measured by a thermocouple, such as illustrated by Figure 63.1, inserted into the chimney connector as shown on Figure 63.2. There is to be no draft control between the product and the point where the flue-gas temperature is measured. If a draft control is incorporated in the product, it is to be fixed in the position allowing maximum draft during all tests.

Figure 63.1
Standard thermocouple for flue-gas temperature



1. 20 AWG (0.51 mm^2) iron-constantan, asbestos, or woven-glass-covered thermocouple wires extending from hot junction to potentiometer or reference junction.

2. 1 – Leeds & Northrup Standard 714B, or equal, 1/4 inch (6.4 mm) outside diameter of two-hole porcelain insulator cut to length and ends beveled on two sides.

3. 1 – 5/16 inch (7.9 mm) outside diameter by 0.032 inch (0.81 mm) wall tubing. Ream, if necessary, to fit over insulator; then crimp ends over beveled ends of insulator.

4. 1 – Small wooden handle.

5. 1 – Piece of rubber tubing, approximately 5/16 by 3/32 by 2 inches long (7.9 by 2.4 by 50.8 mm long).

6. In lieu of individual components described in items 1, 2 and 3 above, any combination of preassembled parts of tubing, insulators and thermocouples may be used.

63.2 Draft

63.2.1 Draft is to be measured by a draft gauge which may be read directly to 0.005 inch (0.13 mm) water column and that has an accuracy of ±0.0025 inch (0.064 mm).

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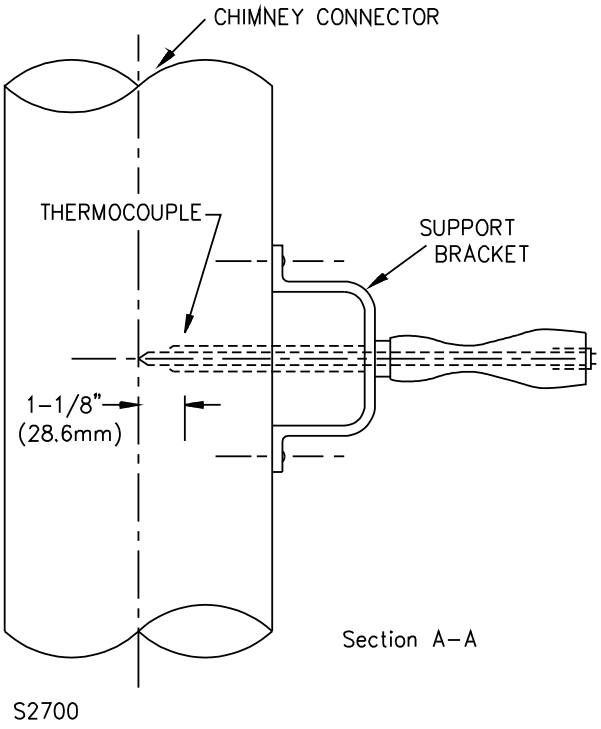
Figure 63.2
Flue gas thermocouple and support bracket



63.3 Fuel input

63.3.1 The fuel input rate to an oil-fired burner is to be determined by a scale accurate to 0.01 pound (4 g) or a burette having equivalent accuracy.

63.3.2 The fuel input rate to a gas-fired burner is to be determined by a laboratory-type gas meter.

64 Installation

64.1 Fixed products – corner installation

64.1.1 The representative product is to be placed in a test enclosure as specified in 64.1.2 – 64.1.4. The sides of the product that result in the highest enclosure wall temperatures are to be located nearest to the enclosure walls.

64.1.2 The product is to be leveled prior to testing. Leveling means are to be removed if possible; otherwise they are to be adjusted so that the base of the product is at the minimum distance from the floor.

64.1.3 The test enclosure is to be formed by two walls constructed of not less than 1/2-inch trade size [nominal 1/2 inch (12.7 mm) thick] wood boards, or 1/2-inch thick plywood, set at right angles and painted flat black. See Figure 64.1. A ceiling of equivalent construction is to be placed above the product and in contact with the enclosure walls. All joints in the test enclosure are to be tight or sealed. The walls and ceiling of the enclosure are to:

a) Extend 3 feet (0.91 m) beyond the ends of the product, and