UL 378

STANDARD FOR SAFETY

Draft Equipment

UL Standard for Safety for Draft Equipment, UL 378

Fourth Edition, Dated October 27, 2006

Summary of Topics

This revision to UL 378 is being issued to remove the reference to the withdrawal date of UL 873 and to address universal upkeep of UL Standards for Safety. These revisions are considered to be non-substantive and not subject to UL's STP process.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

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UL 378

Standard for Draft Equipment

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Fourth Edition

October 27, 2006

This UL Standard for Safety consists of the Fourth Edition including revisions through September 17, 2013.

The Department of Defense (DoD) has adopted UL 378 on June 20, 1994. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at http://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements apply to the design and construction of draft equipment intended to assist in maintaining the desired combustion chamber draft in heating appliances. Draft equipment classifications include draft regulators, automatic damper controls, and draft fans for inducing draft.

1.2 Draft regulators are intended for installation in the breeching or flue pipe of heating appliances where a constant draft is desired, but function to regulate draft only when the draft in the chimney is greater than the draft for which the automatic damper is adjusted.

1.3 Draft regulators intended for use with liquid, combination gas-liquid, or solid fuel-burning equipment, which provide means for the relief of positive pressures in the flue pipe into the adjoining space, provide arrangements for the installer to interlock the assembly with automatic fuel-burning equipment in a manner which will prevent the continued operation of the fuel-burning equipment for more than a brief period of time under conditions of sustained positive draft.

1.4 Draft regulators which provide means for the relief of positive pressures in the flue pipe into the adjoining space and which do not provide means for interlock as described above are intended for use only with commercial-industrial gas-burning equipment not ordinarily equipped with a draft hood.

1.5 Automatic damper controls are designed to automatically regulate the position of dampers installed in the flue pipe or combustion air intake of heating appliances to regulate available draft or combustion air supply to desired values.

1.6 Draft fans are intended for installation in the flue pipe or breeching adjacent to heating appliances or to chimneys to induce or create a draft to supplement the natural draft created by the chimney. Fan units may include automatic dampers or automatic damper controls.

1.7 Requirements for the installation and use of draft equipment are included in the Standards of the National Fire Protection Association for the Installation of Oil-Burning Equipment, NFPA No. 31, and for the National Fuel Gas Code, NFPA No. 54.

1.8 A product that contains features, characteristics, components, materials, or systems new or different from those in use when the standard was developed, and that involves a risk of fire, electric shock, or injury to persons, shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the level of safety for the user of the product as originally anticipated by the intent of this standard.

2 Components

2.1 Components of draft equipment, such as manual or electrically operated valves, etc, electrical components and materials such as attachment plugs, industrial control equipment, switches, transformers, wires, etc., shall comply with the requirements for such components, except that such requirements may be modified if appropriate for the particular application.

CONSTRUCTION

3 General

3.1 A draft regulator intended for use with liquid, combination gas-liquid, or solid fuel-burning appliances, shall provide means for the relief of positive pressures in the flue pipe into the adjoining space, shall be equipped with a switch or other interlocking arrangement which can be practically employed by the installer to prevent continued operation of the fuel-burning equipment under conditions of sustained positive draft in excess of 0.02 inch water column. Such switch or interlocking arrangement shall function to stop the fuel-burning equipment under the above condition in not less than 5 seconds and not more than 10 seconds under situations providing normal ambient room temperatures and normal voltages impressed on any electrical parts. The arrangement shall function in not less than 3 seconds and not more than 15 seconds when voltages of 110 percent and 85 percent of normal are impressed on electrical parts and when ambient temperatures are maintained at 57.5°C (135°F), simultaneously.

3.2 A draft regulator intended for use with liquid, combination gas-liquid, or solid fuel-burning equipment and not provided with means for interlock as described in 3.1, shall substantially prevent the relief of flue gases from the flue pipe when under positive pressure into an adjoining space.

3.3 A draft regulator providing means for the relief of positive pressures in the flue pipe into the adjoining space and not equipped with a switch or other interlocking arrangement as described in 3.1 and 3.2 shall be for use only with gas-fired commercial-industrial fuel-burning equipment and be so marked on its assembly.

3.4 Automatic damper controls intended to regulate the position of dampers installed in the flue pipe shall provide adjustable means for connection to such dampers.

3.5 An automatic damper control shall be designed to maintain a safe damper opening at all times and be arranged to prevent starting of the heating equipment until such damper is opened to a safe position.

3.6 Interlocks provided for compliance with 3.1 and 3.5 shall be considered as a safety control.

4 Assembly

4.1 A draft equipment assembly shall include all the components necessary for its normal function.

4.2 The construction of draft equipment shall be such that parts can be readily reassembled in a proper manner after being dismantled to the extent needed for normal care.

4.3 The assembly of a diaphragm-operated mechanism shall be such that positive motion of the mechanism will follow as a result of diaphragm movements.

4.4 All metal parts of a diaphragm-type mechanism coming in contact with the diaphragm shall have no sharp edges, burrs, projections, etc., which might chafe or abrade the diaphragm.

4.5 Convenient means shall be provided for the purpose of making any necessary field adjustment.

4.6 Screws or bolts used to attach parts which are detached for normal care or servicing of the equipment shall be capable of holding, upon the application of the torques indicated in Table 4.1 after removal and replacement.

Table 4.1
Maximum torque requirements for screws

Screw size	Torque, pound-inches
No. 8	20
No. 10	25
1/4 inch	100
5/16 inch	200
3/8 inch	350
7/16 inch	550
1/2 inch	800
9/16 inch	1200

4.7 The device shall incorporate adequate provisions for support or attachment to a flue pipe, foundation, or wall surface independent of piping, tubing, or conduit that may be connected thereto.

5 Materials

5.1 Draft equipment parts for conveying or in direct contact with flue gases shall be made of noncombustible corrosion resistant materials. Such parts shall be made of material having durability and resistance to corrosion, fire, and heat equivalent to suitable stainless steel, cast-iron, or hot-rolled steel.

5.2 The minimum thickness, with a minus tolerance of zero, of sheet metal, including coatings where shown, for compliance with 5.1 as follows:

Stainless steel	0.012 inch
Aluminum-coated steel	0.053 inch
Hot-rolled steel	0.053 inch

5.3 A part made of drawn brass or machined from brass rod shall be capable of withstanding, without cracking, a mercurous-nitrate test for copper and copper alloys. See 22.1 – 22.4.

6 Springs

6.1 A spring shall be protected against abrasion and corrosion.

6.2 The design and application of a spring employed in a safety mechanism shall be such that it is not likely to fail because of corrosion, fatigue, overstress, wear, etc., if failure of the spring will allow unsafe operation of the device.

7 Diaphragms

7.1 A diaphragm or bellows shall be designed to withstand the conditions of extended service without failure and shall be protected from physical damage.

8 General

8.1 A low-voltage safety control circuit shall be wired by the manufacturer as required for Class 1 low-voltage circuits.

8.2 Electrical equipment and wire shall be suitable for the particular application.

8.3 Draft equipment shall be constructed so that the enclosure, frame, and similar noncurrent carrying parts of all high-voltage electrical equipment are bonded adequately to the means for connecting the metal-clad cable or conduit of the supply circuit. An insulated conductor provided for such purpose shall show a green color with or without one or more yellow stripes.

8.4 Attachment plugs or separable connectors shall not be used in circuits if the breaking or making of the circuit by such devices may allow unsafe operation of the system served by the draft equipment.

8.5 All electrical circuits of each assembly to which connections are to be made in the field shall terminate at suitable boxes or enclosures in which connections to the circuit can be made. The boxes and enclosures shall permit the proper connection of metal-clad cable or conduit.

8.6 A box or enclosure included as part of the assembly and in which a branch circuit supplying power to the equipment is to be connected, shall not require that it be moved for normal care of the unit.

8.7 A box or enclosure in which field-installation conductors are to be connected shall be so located that the temperature of conductors within the box or surfaces of the box likely to be in contact with the conductors will not exceed that specified for Type R wire when the draft equipment is tested in accordance with these requirements.

8.8 The size of a junction box in which field-installed conductors are to be connected by splicing shall be not less than that indicated in Table 8.1. A conductor passing through the box is counted as one conductor, and each conductor terminating in the box is also counted as one conductor. A field-furnished conductor for high-voltage circuits is considered to be not smaller than 14 AWG.

8.8 revised September 17, 2013

Table 8.1
Size of junction boxes

Size of conductor, AWG	Free spaces within box for each conductor, cubic inches
16 or smaller	1.5
14	2.0
12	2.25
10	2.5
8	3.0

8.9 Conductors intended for connection to a grounded neutral line shall be identified, i.e., finished a white or gray color. All other conductors shall be finished in colors other than white or gray. A terminal for connection of a grounded conductor shall be identified by a metallic-plated coating, substantially white in color, and shall be readily distinguishable from other terminals, or it shall be clearly identified in some other manner, such as on an attached wiring diagram.

8.9 revised September 17, 2013

9 Uninsulated Live Parts

9.1 Uninsulated live parts shall be enclosed, guarded, or located to prevent accidental contact by persons during normal usage of the equipment. This applied to such parts located in a compartment into which access is required for normal care of the equipment, such as resetting controls, lubrication, cleaning, etc.

9.2 A cover or access panel of an enclosure for uninsulated live parts shall be provided with means for firmly securing it in place.

9.3 An overall enclosure for uninsulated live parts shall have no openings which are not closed when the equipment is installed, except that an enclosure for parts other than a fuse or thermal cutout may have openings as needed for ventilation or for the device to function. Such openings shall prevent the entrance of a rod of the diameter specified herein. The diameter of the rod is to be equivalent to the distance measured from a straight edge placed across the outer face of the opening to be checked to the nearest uninsulated live part within the enclosure, but the diameter of the rod shall be not larger than 33/64 inch unless the distance is 4 inches or more, in which case the diameter of the rod may be 49/64 inch.

9.4 Terminals of a low-voltage safety device within a compartment or cavity to which factory wiring is connected need not be otherwise enclosed if such terminals are recessed and located so that the terminals are shielded from accidental shorting or damage.

10 Motors

10.1 A motor shall be designed for continuous duty as indicated by the designation CONTINUOUS or CONT on the nameplate.

10.2 A motor shall be provided with suitable overcurrent protection.

10.3 Motor protection in accordance with the 10.2 may be accomplished by the following means:

a) An acceptable integral protective device suitable for the motor which it protects.

b) The impedance of the motor being sufficient to prevent overheating due to failure to start or run, in which case the designation HIGH IMPEDANCE PROTECTED is to be included with the motor nameplate data.

c) The stipulated manual reset overcurrent protection included in a motor controller furnished with the assembly.

d) A separate overcurrent device rated or set at not more than 125 percent of the motor full-load current rating for a motor marked to have a temperature rise not over 40°C (104°F) and at not more than 115 percent for other types of motors. Such separate overcurrent devices are to be assembled as part of the equipment and be readily identifiable as such after assembly to the equipment.

Exception No. 1: Values not corresponding to the standard size or rating of a non adjustable circuit-breaker, thermal cutout, thermal relay, the heating element of a thermal trip motor switch, or possible setting of an adjustable circuit-breaker adequate to carry the load, the next higher size, rating, or setting may be used, but not higher than 140 percent of the full-load current rating of a motor marked to have a temperature rise of not over 40°C (104°F) and not higher than 130 percent of the full-load current rating for all other motors.

Exception No. 2: Devices included as part of a magnetic motor controller need not be assembled.

10.4 A motor shall have no openings permitting a drop of liquid or a particle falling vertically onto the motor to enter the motor as applied to the assembly.

10.5 Conformance to 10.4 may be provided by the motor frame or by other enclosure, structure, or shield, or by a combination of two or more such items, and is to be determined with the motor applied to the assembled equipment and with the equipment placed in any allowable installed position.

10.6 A motor shall have no openings from which a drop of liquid or solid particles dropping from electrical parts located within the motor, i.e., windings, brushes, switches, etc., may fall to the floor.

10.7 Conformance to 10.6 may be obtained if a motor is placed directly upon a structure which serves as a pan that will collect and retain drops of liquids or particles dropping from openings in the bottom half of the motor or that will prevent them from dropping to the floor when the equipment is placed in any allowable installed position.

10.8 Openings in a motor frame in locations permitted by 10.4 and 10.6 shall be of such size or shape or so situated that a rod of the diameter specified herein is prevented from entering the motor. The diameter of the rod shall be equivalent to the distance measured from a straight edge placed across the outer face of the opening to be checked to the nearest uninsulated live part or enameled wire in the motor but not larger than 33/64 inch, unless the distance is 4 inches or more, in which case the diameter of the rod may be 49/64 inch.

10.9 Conformance to 10.8 may be provided by the motor frame or by other enclosure, shield, or structure, or a combination of two or more such items, and is to be determined with the motor assembled to the equipment. When a motor is within another enclosure, attempts to insert the rod are to be made from the exterior of such enclosure, the size of the rod being governed by the openings in such enclosure; but uninsulated live parts in a compartment into which access is required for normal care of the equipment are to be guarded or located to prevent accidental contact by persons during normal usage of the equipment.

10.10 If a motor is supported in a manner permitting placement of the motor frame in various positions, conformance to these requirements is to be obtained with the motor frame in any operating position allowed by the method of support, attached wiring, or other features of the equipment structure.

11 Wiring Methods

11.1 The wiring of high-voltage and safety-control circuits shall conform to the requirements in this section.

11.2 Suitably insulated conductors having adequate current carrying capacity for the service shall be used. A conductor shall be not smaller than 18 AWG.

11.2 revised September 17, 2013

11.3 Some types of insulated conductors are suitable as indicated in Table 16.2.

11.4 Where insulated conductors suitable for use at temperatures in excess of 60°C (140°F) are required for conformance with these requirements, such wiring shall be furnished by the manufacturer as part of the equipment, and the devices to be connected by such wiring shall be factory-located on the assembly.

11.5 Electrical wiring to a part which must be moved for normal care shall be arranged so that the parts may be moved without breaking soldered connections or disconnecting conduit. Conductors to be disconnected from terminals of such part shall terminate in eyelets or connectors. If the wiring to a part which functions also as an access plate or cover is not readily detachable, the assembly shall include provision for support of that part by means other than the wiring when the part is moved for servicing. Any allowable movement of such part shall not unduly twist, bend, or pull the wiring.

11.6 Conductors shall be enclosed within conduit, electrical metallic tubing, metal raceways, electrical enclosures, or metal-clad cable. Suitable fittings shall be used.

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11.7 Splices in wiring shall be located only in accessible junction boxes. Splices shall be made mechanically secure, soldered, and insulated with tape; or suitable wire connectors may be employed. The insulation on the splice shall be equivalent to that required on the conductors.

11.8 At all points where conduit or cable terminates, the conductors shall be protected from abrasion unless the design of the boxes or fittings is such as to afford such protection. In addition, in the case of metal-clad cable, an insulating bushing or its equivalent shall be provided between the conductors and the cable. The connector or clamp by which metal-clad cable is fastened to boxes or devices shall be of such design that the insulating bushing or its equivalent will be visible for inspection.

11.9 The design of a wireway shall be such that the interconnection of sections and fittings will provide a rigid mechanical assembly and insure adequate electrical conductivity. The interior of the wireway shall be free from burrs, and sharp corners or edges which might cause injury to the insulation on wires. Screws and bolts, however used, shall not project into the wireway unless sharp ends and threaded sections, other than the threaded sections of machine screws or bolts which do not project into the wireway more than 1/32 inch are covered or otherwise prevented from coming in contact with wires.

11.10 Wiring within an enclosure, such as an electrical cabinet or cutout box, shall be arranged to avoid being physically damaged, such as by closely following surfaces, and be supported.

11.11 Unless supplied with insulation suitable for the highest voltage involved, factory-wired insulated conductors of circuits of one voltage shall be separated by barriers or shall be segregated from conductors of circuits of another voltage; and shall, in any case, be so separated or segregated from uninsulated current carrying parts connected to circuits of another voltage.

11.12 Segregation of insulated conductors may be accomplished by clamping, routing, or equivalent means which insures permanent separation as stipulated in 11.11.

11.13 Holes in metal walls through which insulated wires not enclosed in conduit pass, shall be provided with smoothly rounded bushings, or shall have smooth, rounded surfaces, to prevent abrasion of the insulation. Bushings shall be phenolic, porcelain, or hard fiber.

11.14 A hole in porcelain, phenolic composition, or other suitable nonconducting material and having a smoothly rounded surface is considered to be the equivalent of a bushing.

11.15 Ceramic materials and some molded compositions are acceptable generally for insulating bushings; but bushings of wood or so-called hot-molded shellac and tar compositions are not acceptable.

11.16 A fiber bushing shall be not less than 1/16 inch in thickness (with a minus tolerance of 1/64 inch for manufacturing variations), shall be so formed and secured in place that it will not be affected adversely by conditions of ordinary moisture, and shall not be employed where it will be subjected to a temperature higher than 90°C (194°F) under normal operating conditions.

11.17 To provide an acceptable unbushed opening in sheet metal usually requires rolling and/or extrusion of the metal around the opening, or the insertion of an acceptable grommet.

11.18 Field-installed conductors of a circuit shall be segregated or separated by barriers from field-installed and factory-installed conductors connected to a circuit of another voltage, unless the conductors of both circuits are or will be insulated for the maximum voltage of either circuit.

11.19 Field-installed conductors of a low-voltage circuit shall be segregated or separated by barriers from uninsulated live parts to be connected to a high-voltage circuit and from any safety-control circuit wiring terminals and any other uninsulated live parts whose short-circuiting or grounding may result in unsafe operation of the equipment.

12 Spacings

12.1 The spacings in a device (such as a control, receptacle, relay, snap switch, terminal block, etc.) supplied as part of the equipment other than a device in a safety-control circuit, are to be not less than the minimum spacings required for the class of device in question, or not less than the spacings required for temperature-indicating and -regulating equipment, whichever are smaller. In a device which is part of a safety-control circuit, spacings are judged under the requirements for safety controls in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873. Compliance with the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills these requirements.

12.1 revised September 17, 2013

12.2 The electrical clearance resulting from the assembly of parts into the complete equipment, including clearance to grounded metal or enclosure, are judged under the spacing requirements of the Standard for Temperature-Indicating and -Regulating Equipment, UL 873. Compliance with the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills these requirements.

12.2 revised September 17, 2013

PERFORMANCE

13 General

13.1 Representative samples of draft equipment are to be subjected to the following tests. Samples of parts, such as drawn brass or machined rod-brass parts, floats, springs, diaphragms, switches, etc., may be required for the investigation.

13.2 The performance of draft equipment shall meet the applicable requirements when tested as described herein. If any indications are observed during the tests that the equipment will not continue to meet the requirements in normal usage, such supplementary tests as deemed necessary to assure safe performance shall be conducted.

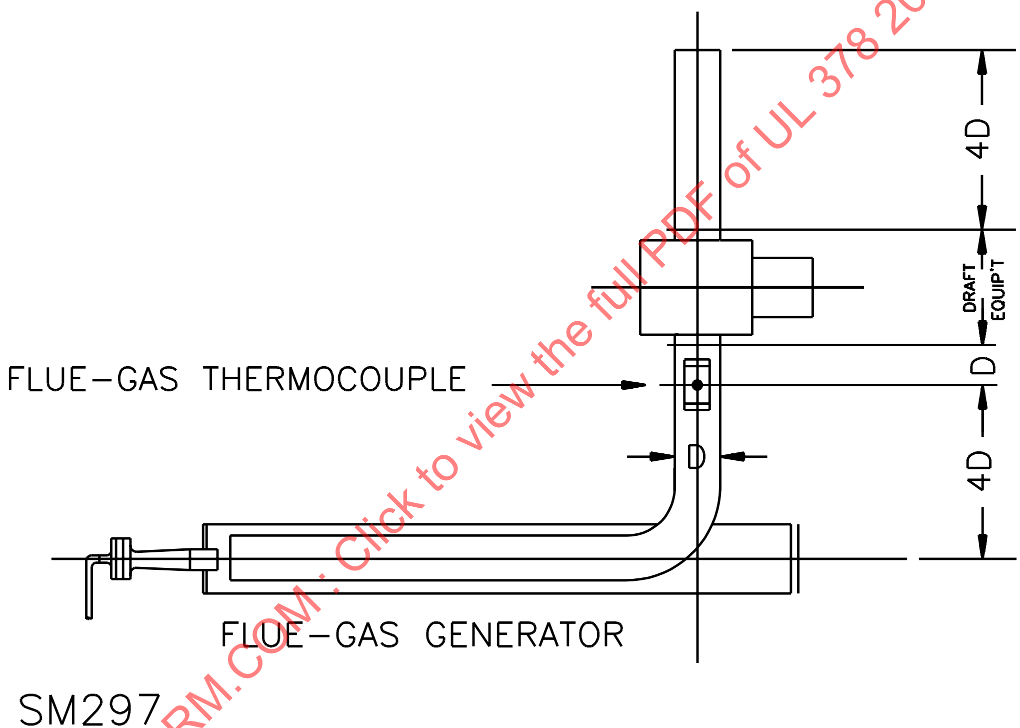
13.3 When draft equipment is tested in accordance with these requirements, no part shall attain a temperature sufficient to damage required corrosion protection, to adversely affect operation of safety controls, to impair the value of required thermal or electrical insulation, nor to cause creeping, distortion, sagging, or similar damage when such damage to the material or part may cause the equipment to become unsafe for use.

14 Installation for Temperature Tests

14.1 The draft equipment is to be inserted as part of a vertical flue-pipe assembly as shown by Figure 14.1. The diameter of the flue pipe is to be consistent with the size of the flue-pipe connections of the test device or to be approximately sized to simulate conditions of radiation to the draft equipment which would be expected in use.

14.2 A gas-fired flue-gas generator as illustrated by Figure 14.1 is to be used to supply flue gases to the vertical flue-pipe assembly. The heater is to be capable of producing flue gases at the specified test temperatures when fired at the test inputs specified hereafter.

Figure 14.1
Installation for temperature tests



14.3 The flue-gas generator outlet is to be connected to the inlet of the vertical flue-pipe assembly by means of a 90-degree ell at the generator. The ell and the flue pipe are to be uninsulated.

14.4 Tests for temperature rise on parts of draft equipment are to be connected in an enclosure sufficient only to shield the equipment from drafts and other sources of radiation. Such tests, when performed on draft fans, are to be conducted both with the fan in operation and with the power supply to the fan interrupted.

14.5 Plywood used for the test enclosure is to be at least 5 ply, sound two sides (SO2S grade), moisture resistant, sanded two sides to not less than 3/4 inch thickness. Enclosures constructed from 1 inch nominal thickness finished lumber are to be considered equivalent.

15 Temperature Measurement

15.1 The flue-gas temperature is to be measured by a thermocouple, such as illustrated by Figure 15.1, inserted into the vertical section of flue pipe as shown in Figures 14.1 and 15.2 at a level one flue-pipe diameter below the connection to the test device.

Figure 15.1
Standard thermocouple for flue-gas temperature

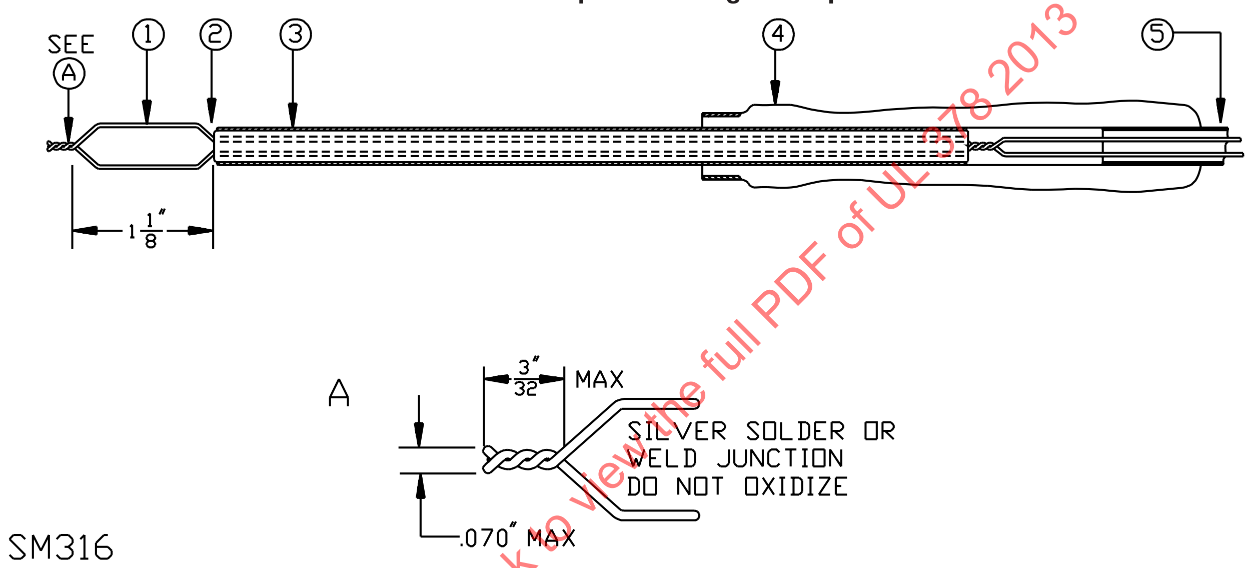
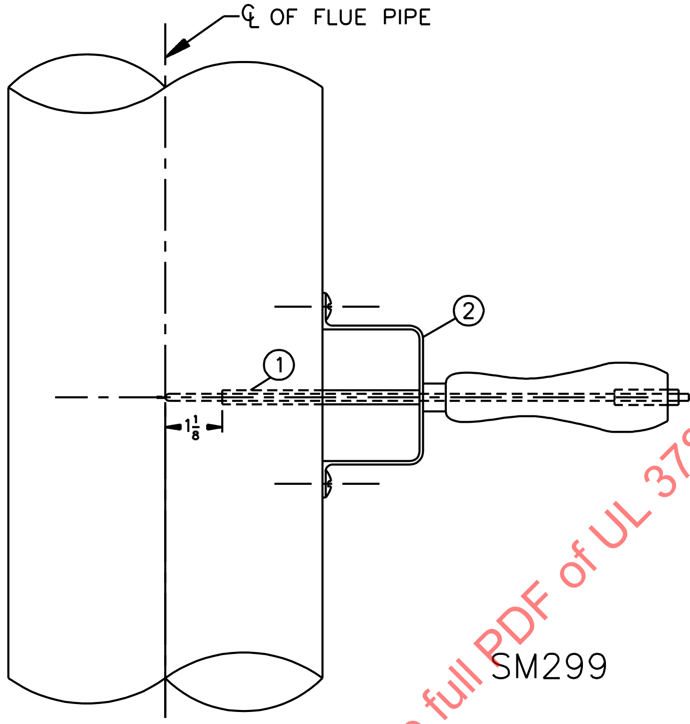


Figure 15.2
Flue-gas thermocouple and support bracket



15.2 Temperatures other than flue-gas temperatures are to be measured by thermocouples not heavier than 24 AWG. The temperatures attained by parts of the draft equipment are to be obtained by means of thermocouples applied to assure good thermal contact with the parts. Such thermocouples are to be located at points attaining maximum temperatures. Additional couples may be placed at other locations as deemed necessary.

15.2 revised September 17, 2013

15.3 The room or ambient temperature is to be obtained by a shielded thermocouple located at the elevation of the horizontal axis of the flue-gas generator and to be on a vertical line located 24 inches horizontally from one wall of the test structure.

16 Normal Temperature Test

16.1 Draft equipment employing electrical moving, or other parts subject to temperature rise as the result of their normal placement in contact with flue gases or radiation from parts conducting flue gases, are to be tested as chimney parts.

16.2 The flue-gas generator is to be fired to at least the specified minimum input. The temperature of the flue gases entering the vertical flue-pipe assembly is to be regulated by the quantity of primary and secondary air induced into the generator. Combustion shall be complete within the combustion chamber of the flue-gas generator.

16.3 The test is to be started with the draft equipment and the test structure at room temperature. The flue-gas generator is to be fired to at least an input as given in Column 1, Table 16.1, and regulated to produce flue gases at a temperature 499°C (930°F) above room temperature at the location specified by 15.1. The test is to continue until equilibrium temperatures are attained.

Table 16.1
Flue-gas generator inputs

Equivalent nominal diameter of flue pipe (inches)	Minimum input to flue-gas generator (BTU per hour)	
	Column 1	Column 2
4	28,800	43,200
5	45,000	67,500
6	64,800	97,200
7	88,200	132,300
8	115,200	172,800
9	145,800	218,700
10	180,000	270,000

16.4 The flue-gas generator inputs specified in Table 16.1 are based on an input consistent with the heat carried away by a flue pipe of a given size. The values for flue pipes having equivalent nominal diameters of from 4 to 10 inches are provided.

16.5 When the flue-gas temperature is maintained as described in 16.3, the temperature of any part of the draft equipment shall not exceed the maximum temperature specified for the materials used. See Table 16.2, Column 1, and 13.3

Table 16.2
Maximum temperature rises for some items[a]
(The inclusion of a temperature limit for a material in this Table is not indicative of the acceptability of the material if it does not otherwise conform to these requirements.)

Items	Maximum rise above inlet-air temperature			
	Column 1		Column 2	
	Degrees		Degrees	
	C	F	C	F
Carbon steel sheet, cast iron	517	930	683	1230
Aluminum alloys		330	239	430
1100	183			
3003	239	430	294	530
2014, 2017, 2024, 5052	294	530	350	630
Aluminum-coated steel[b]	656	1180	767	1380
Stainless steel		1235	767	1380
Types 302, 303, 304, 321, 347	686			
Type 316	711	1280	795	1430
Type 309S	861	1550	961	1730
Types 310, 310B	911	1640	1017	1830
Type 446	911	1640	1072	1930
Galvanized steel[c]	267	480	350	630
Carbon steel – coated with Type A19 ceramic	572	1030	683	1230
Conductors of field-wired circuits connected to device and surfaces on which they may bear	35	63	60	108
Wire, code[d]		63	60	108
Types R, RF, FF, RW, RU	35			
Types RH, RFH, FFH	50	90	75	135
Types T, TF, TFF, TW	35	63	60	108
Type TA	65	117	90	162
Appliance wiring material		99	70	126
Thermoplastic, 80°C rating	55			
Thermoplastic, 90°C rating	65	117	80	144
Thermoplastic, 105°C rating	80	144	95	171
200°C rating	175	315	200	360
250°C rating	225	405	250	450
Flexible cord – Types SO, ST, SJO, SJT	35	63	60	108
Other types of insulated wire[e]		117	100	180
Class A (Class 105) insulation on coil windings				
In open motors				
Thermocouple method	65			
Resistance method	75	135	100	180
In totally enclosed motors				180
Thermocouple method	70	126	100	
Resistance method	80	144	100	180
In other coils				180
Thermocouple method	65	117	100	
Resistance method	85	153	100	180
Class B (Class 130) insulation	85	153	110	198
Class C insulation	not specified as determined by test			
Class H (Class 180) insulation				

Table 16.2 Continued on Next Page

Table 16.2 Continued

Items	Maximum rise above inlet-air temperature			
	Column 1		Column 2	
	Degrees		Degrees	
	C	F	C	F
Varnished cloth insulation	60	108	85	153
Phenolic composition employed as electrical insulation or as a part whose failure would result in unsafe operation[d]	125	225	150	270
Fiber employed as electrical insulation	65	117	90	162
Class 2 transformer enclosure	60	108	85	153
Power and ignition transformer enclosure	65	117	90	162
Sealing compounds	Maximum temperature 15°C (27°F) less than melting point			
Capacitors –				
Electrolytic types	40	72	not specified	
Other types	65	117	not specified	

[a] The specified maximum temperature rises apply to parts whose failure may cause the draft equipment to be unsafe for use.

[b] When the reflectivity of aluminum-coated steel is utilized to reduce fire hazard, the maximum allowable temperature rise is (461°C) 830°F.

[c] The specified maximum temperature rises apply when the galvanizing is required as a protective coating or the reflectivity of the surface is utilized to reduce fire hazard.

[d] The limitations on rubber and thermoplastic insulation and on phenolic composition do not apply to compounds which have been investigated and recognized as having special heat resistant properties. Thermoplastics are in no case to attain temperatures at which the material begins to flow.

[e] For standard insulated conductors other than those mentioned, reference should be made to the National Electrical Code and the maximum allowable temperature rise is 25°C (77°F) less than the recognized temperature limit of the wire in question where Column 1 temperature rises are specified, and the maximum allowable temperature rise where Column 2 rises are specified is to be based on the heat resistant properties of the insulation.

[f] The classes of material used for electrical insulation referred to include materials as follows:

Class A (Class 105) – Cotton, silk, paper, and similar organic materials when impregnated, enamel as applied to conductors.

Class B (Class 130) – Inorganic materials, such as mica and asbestos, in built-up form combined with binding substances.

Class C – Inorganic materials, such as pure mica, porcelain, quartz, etc.

Class H (Class 180) – Mica, asbestos, fiberglass, and similar inorganic materials in built-up form with binding substances composed of silicone compounds or materials with equivalent properties; silicone compounds in rubbery or resinous forms or materials with equivalent properties (the electrical and mechanical properties of an insulated winding or conductor must not be impaired by the application of the temperature permitted for Class H insulation).