



UL 710

STANDARD FOR SAFETY

Exhaust Hoods for Commercial Cooking Equipment

ULNORM.COM : Click to view the full PDF of UL 710 2024

ULNORM.COM : Click to view the full PDF of UL 710 2024

UL Standard for Safety for Exhaust Hoods for Commercial Cooking Equipment, UL 710

Seventh Edition, Dated April 29, 2024

Summary of Topics

This new Seventh Edition of ANSI/UL 710 dated April 29, 2024 is being issued as a binational joint standard and incorporates changes from proposal dated October 27, 2023.

The new requirements are substantially in accordance with Proposal(s) on this subject dated October 27, 2023.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of ULSE Inc. (ULSE).

ULSE provides this Standard "as is" without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will ULSE be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if ULSE or an authorized ULSE representative has been advised of the possibility of such damage. In no event shall ULSE's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

Users of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold ULSE harmless from and against any loss, expense, liability, damage, claim, or judgment (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

ULNORM.COM : Click to view the full text of UL 710 2024

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 710 2024



ULC Standards
Normes ULC

ULC Standards
CAN/ULC 646:2024
Fourth Edition



ULSE Inc.
ANSI/UL 710
Seventh Edition

Exhaust Hoods for Commercial Cooking Equipment

April 29, 2024

ULNORM.COM : Click to view the full PDF of UL 710:2024



ANSI/UL 710-2024



Commitment for Amendments

This Standard is issued jointly by ULSE Inc. (ULSE) and ULC Standards. Amendments to this Standard will be made only after processing according to the Standards writing procedures by ULSE and ULC Standards.

ISSN 0317-526X Copyright © 2024 ULC Standards

All rights reserved.

All rights reserved.

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, whatsoever without the prior permission of the publisher.

Comments or proposals for revisions on any part of the Standard may be submitted at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

Copyright © 2024 ULSE INC.

Our Standards for Safety are copyrighted by ULSE Inc. Neither a printed nor electronic copy of a Standard should be altered in any way. All of our Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of ULSE Inc.

This ANSI/UL Standard for Safety consists of the Seventh Edition. The most recent designation of ANSI/UL 710 as an American National Standard (ANSI) occurred on April 29, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

For information on ULSE Standards, visit <http://www.shopulstandards.com>, call toll free 1-888-853-3503 or email us at ClientService@shopULStandards.com.

CONTENTS

Preface7

INTRODUCTION

1 Scope9
2 Units of Measurement 10
3 Components 10
4 Referenced Publications 10
5 Glossary..... 15

CONSTRUCTION

6 Assembly 17
7 Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts 18
8 Materials 22
9 Protection Against Corrosion..... 22
10 Grease Removal Devices and Grease Filters 23
11 Secondary Filters 23
12 Blankoffs 24
13 Fire Actuated Damper Assemblies 24
14 Duct Collars 35
15 Controls..... 35
 15.1 Manual controls 35
 15.2 Limit controls 36
16 Electrical Enclosure 37
 16.1 General..... 37
 16.2 Transparent covers 37
 16.3 Battery storage compartments 38
 16.4 Ventilation openings 38
17 Field-Wiring Connections 42
 17.1 General..... 42
 17.2 Grounding 42
18 Internal Wiring 43
 18.1 General..... 43
 18.2 Wiring methods 45
19 Separation of Circuits 46
20 Bonding For Grounding 46
 20.1 General..... 46
 20.2 Conductors 47
21 Capacitors 48
22 Overcurrent Protection..... 48
23 Luminaires for Use Above Cooking Equipment 49
24 Transformers 50
25 Switches and Controllers 50
26 Electrical Spacings – High-Voltage Circuits 51
27 Electrical Spacing – Low-Voltage Circuits 52
28 Exhaust Hoods with Integral Power Ventilators 53

PERFORMANCE

29 General 53
30 Sample Selection 54
31 Test Installation 55

32	Instrumentation	59
33	Cooking Appliances	62
34	Thermostat Calibration Test	63
35	Temperature Test	64
36	Cooking Smoke and Flare-Up Test	67
37	Abnormal Flare-Up Test	69
38	Fan-Failure Test	70
39	Fire Test	70
40	Abnormal Water Supply Test	71
41	Burnout Test	71
42	Pressure Test	71
43	Damper Tests	72
	43.1 General	72
	43.2 Cycling test	72
	43.3 Closure test	72
44	Gasket and Sealant, Physical and Immersion Tests	72
	44.1 Tensile strength and elongation	72
	44.2 Aging and immersion	73
	44.3 Volume change	73
45	Fire and Leakage Test of Fittings, Seams, Joints, or Hood Penetrations	74
46	Tension Test for Adjustable/Telescoping Duct Collar	75
47	Rain Test	75

ELECTRICAL TESTS

48	Overvoltage and Undervoltage Operation Test	78
49	Dielectric Voltage-Withstand Test	79
50	Short-Circuit Test	79

CONTROL UNIT TESTS

51	General	80
52	Heating Test	82

MARKING TEST

53	Permanence of Marking Test	85
----	----------------------------------	----

MARKINGS

54	General	86
55	Elevated Air Temperature	89
56	Cautionary Markings	89

INSTALLATION AND OPERATING INSTRUCTIONS

57	General	89
----	---------------	----

ANNEX A (Normative) Ultraviolet Radiation Systems for Use in the Ventilation Control of Commercial Cooking Operations

INTRODUCTION

A1	Scope	91
A2	General	91

A3	Glossary.....	91
----	---------------	----

CONSTRUCTION

A4	Assembly	92
A5	Electrical Insulation	94
A6	Water Wash Hoods	94
A7	Moisture Condensation	94
A8	Materials	94

PERFORMANCE

A9	Ultraviolet (UV) Irradiance Test.....	94
A10	Temperature Tests	95
A11	Water Wash Spray Test.....	95
	A11.1 General.....	95
A12	Endurance Test for Interlock Devices	96
A13	Test for Pressure Interlock Devices.....	96

MARKINGS

A14	General	96
-----	---------------	----

INSTRUCTIONS

A15	Installation Instructions	98
-----	---------------------------------	----

ULNORM.COM : Click to view the full PDF of UL 710 2024

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 710 2024

Preface

This is the common ULSE and ULC Standard for Exhaust Hoods for Commercial Cooking Equipment. It is the Fourth edition of CAN/ULC 646 and the Seventh edition of UL 710.

This common Standard was prepared by UL Standards & Engagement Inc. (ULSE), ULC Standards, and the Joint UL/ULC Task Group. The efforts and support of the Joint Task Group are gratefully acknowledged.

This Standard was formally approved by the ULC Standards Committee on Kitchen Exhaust Equipment and Systems and ULSE Technical Committee on Grease Filters.

Only metric SI units of measurement are used in this Standard. If a value for measurement is followed by a value in other units in parentheses, the second value may be approximate. The first stated value is the requirement.

In Canada, there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

Annex [A](#), identified as Normative, forms a mandatory part of this Standard.

NOTE: Although the intended primary application of this Standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.

ULNORM.COM : Click to view the full PDF of CAN/ULC 646:2024 / ANSI/UL 710:2024

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 710 2024

INTRODUCTION

1 Scope

1.1 These requirements cover Type I commercial kitchen exhaust hoods intended for placement over commercial cooking equipment. Exhaust hoods with and without exhaust dampers are covered by these requirements.

1.2 Exhaust hoods with and without exhaust fire actuated fire dampers are covered by these requirements.

1.3 Exhaust hoods are evaluated relative to minimum exhaust air flow required and maximum supply air flow allowed for capture and containment of cooking effluents under laboratory conditions.

1.4 Exhaust hoods may incorporate non-continuous welded joints, seams, and penetrations when evaluated by these requirements.

1.5 Exhaust hoods with fire actuated fire exhaust dampers are intended to have the exhaust fire actuated dampers automatically close to prevent exhaust duct gas temperatures from exceeding 191 °C (375 °F).

1.6 These requirements do not cover fire-extinguishing systems.

NOTE: All exhaust hoods are intended for use with fire extinguishing system units.

1.7 These requirements cover exhaust hoods provided with manually or automatically operated cleaning or washing systems. These requirements do not cover the fire extinguishing aspects of such systems.

1.8 These requirements do not cover evaluation of Ultraviolet (UV) systems for use in commercial kitchen exhaust systems. Annex A covers the requirements of these products.

1.9 These requirements do not cover evaluation of Electrostatic Precipitators (ESP's) for use in commercial kitchen ventilation. Electrostatic Precipitators (ESP's) are covered under the Standard for Electrostatic Air Cleaners, UL 867.

1.10 These requirements do not cover evaluation of commercial electric cooking appliances provided with integral recirculating systems (previously referred to as ductless hoods) and nonintegral recirculating systems, both of which are intended for installation in commercial establishments for the preparation of food. The Standard for Recirculating Systems, UL 710B, covers these products.

1.11 Exhaust hoods covered by these requirements are intended for installation in accordance with the following:

- a) The Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations, NFPA 96;
- b) The National Electrical Code, NFPA 70, in the United States, and Canadian Electrical Code, Part I, CSA C22.1, in Canada; and/or
- c) Other codes such as the International Mechanical Code (IMC), National Building Code of Canada (NBC), and the Uniform Mechanical Code (UMC).

1.12 These requirements cover products rated 600 volts or less.

1.13 These requirements do not cover evaluation of the exhaust hoods with respect to their grease extraction efficiency.

NOTE: Capture efficiency of a kitchen hood filter can be measured using ASTM F2519, Standard Test Method for Grease Particle Capture Efficiency of Commercial Kitchen Filters and Extractors.

2 Units of Measurement

2.1 The metric unit shall be designated as the official unit for purposes of this Standard. Where values of measurement are specified in both SI and U.S. Customary units, either unit is used. In cases of dispute, the metric unit shall be used.

3 Components

3.1 Except as indicated in [3.2](#), a component of a product covered by this Standard shall comply with the requirements for that component.

3.2 A component is not required to comply with a requirement specified in its specific standard when it:

- a) Involves a feature or characteristic not required in the application of the component in the product covered by this Standard; or
- b) Is superseded by a requirement in this Standard.

3.3 A component shall be used in accordance with its recognized rating established for the intended conditions of use.

3.4 Specific components are recognized as being incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions for which they have been recognized.

4 Referenced Publications

4.1 Any undated reference to a code or standard appearing in the requirements of this Standard shall be interpreted as referring to the latest edition of that code or standard.

4.2 The following publications are referenced in this Standard:

ASTM A90, *Standard Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles*

ASTM A313/A313M, *Specification for Stainless Steel Spring Wire*

ASTM A653/A653M, *Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process*

ASTM B555, *Standard for Measurement of Electrodeposited Metallic Coating Thicknesses by the Dropping Test*

ASTM D3183, *Practice for Rubber – Preparation of Pieces for Test Purposes from Products*

ASTM D3767, *Practice for Rubber Measurement of Dimensions*

ASTM D412 REV A, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers Tension*

ASTM D573, *Standard Test Method for Rubber Deterioration in an Air Oven*

ASTM E230/E230M, *Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples*

ASTM F2519, *Standard Test Method for Grease Particle Capture Efficiency of Commercial Kitchen Filters and Extractors*

CSA C22.1, *Canadian Electrical Code, Part I*

CSA C22.2 No. 0, *General Requirements – Canadian Electrical Code, Part II*

CSA C22.2 No. 0.17, *Evaluation of Properties of Polymeric Materials*

CSA C22.2 No. 4-04, *Enclosed and Dead-Front Switches*

CSA C22.2 No. 5, *Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures*

CSA C22.2 No. 14, *Industrial Control Equipment*

CSA C22.2 No. 18.3, *Conduit, Tubing, and Cable Fittings*

CSA C22.2 No. 66.1, *Low Voltage Transformers – Part 1: General Requirements*

CSA C22.2 No. 66.3, *Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers*

CSA C22.2 No. 68, *Motor-Operated Appliances (Household and Commercial)*

CSA C22.2 No. 77, *Motors with Inherent Overheating Protection*

CSA C22.2 No. 94.1, *Enclosures for Electrical Equipment, Non-Environmental Considerations*

CSA C22.2 No. 94.2, *Enclosures for Electrical Equipment, Environmental Considerations*

CSA C22.2 No. 177, *Clock-Operated Switches*

CSA C22.2 No. 248.1, *Low-Voltage Fuses – Part 1: General Requirements*

CSA C22.2 No. 248.2, *Low-Voltage Fuses – Part 2: Class C Fuses*

CSA C22.2 No. 248.3, *Low-Voltage Fuses – Part 3: Class CA and CB Fuses*

CSA C22.2 No. 248.4, *Low-Voltage Fuses – Part 4: Class CC Fuses*

CSA C22.2 No. 248.5, *Low-Voltage Fuses – Part 5: Class G Fuses*

CSA C22.2 No. 248.6, *Low-Voltage Fuses – Part 6: Class H Non-Renewable Fuses*

CSA C22.2 No. 248.7, *Low-Voltage Fuses – Part 7: Class H Renewable Fuses*

CSA C22.2 No. 248.8, *Low-Voltage Fuses – Part 8: Class J Fuses*

CSA C22.2 No. 248.9, *Low-Voltage Fuses – Part 9: Class K Fuses*

CSA C22.2 No. 248.10, *Low-voltage Fuses – Part 10: Class L Fuses*

CSA C22.2 No. 248.11, *Low-Voltage Fuses – Part 11: Plug Fuses*

CSA C22.2 No. 248.12, *Low-Voltage Fuses – Part 12: Class R Fuses*

CSA C22.2 No. 248.13, *Low-Voltage Fuses – Part 13: Semiconductor Fuses*

CSA C22.2 No. 248.14, *Low-Voltage Fuses – Part 14: Supplemental Fuses*

CSA C22.2 No. 248.15, *Low-Voltage Fuses – Part 15: Class T Fuses*

CSA C22.2 No. 248.16, *Low-Voltage Fuses – Part 16: Test Limiters*

CSA C22.2 No. 250.0, *Standard for Luminaires*

CSA C22.2 No. 4248-1, *Fuseholders – Part 5: Class G*

CSA E60730-1, *Automatic Electrical Controls – Part 1: General Requirements*

CSA E60730-2-9, *Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls*

CSA E730-2-7, *Automatic Electrical Controls for Household and Similar Use – Part 2-7: Particular Requirements for Timers and Time Switches*

IAPMO, *Uniform Mechanical Code*

ICC, *I-Codes: International Mechanical Code*

IEC 61000-4-5, *Electromagnetic Compatibility (EMC) – Part 4-5: Testing and Measurement Techniques – Surge Immunity Test*

NFPA 70, *National Electrical Code*

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*

NRC, *National Building Code of Canada*

RAC, *RDH 376 – Reliability Design Handbook*

UL/ULC 33, *Heat Responsive Links for Fire-Protection Service*

UL 50, *Enclosures for Electrical Equipment, Non-Environmental Considerations*

UL 50E, *Enclosures for Electrical Equipment, Environmental Considerations*

UL 94, *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*

UL 98, *Enclosed and Dead-Front Switches*

UL 248-1, *Low-Voltage Fuses – Part 1: General Requirements*

UL 248-2, *Low-Voltage Fuses – Part 2: Class C Fuses*

UL 248-3, *Low-Voltage Fuses – Part 3: Class CA and CB Fuses*

UL 248-4, *Low-Voltage Fuses – Part 4: Class CC Fuses*

UL 248-5, *Low-Voltage Fuses – Part 5: Class G Fuses*

UL 248-6, *Low-Voltage Fuses – Part 6: Class H Non-Renewable Fuse*

UL 248-7, *Low-Voltage Fuses – Part 7: Class H Renewable Fuses*

UL 248-8, *Low-Voltage Fuses – Part 8: Class J Fuses*

UL 248-9, *Low-Voltage Fuses – Part 9: Class K Fuses*

UL 248-10, *Low-Voltage Fuses – Part 10: Class L Fuses*

UL 248-11, *Low-Voltage Fuses – Part 11: Plug Fuses*

UL 248-12, *Low-Voltage Fuses – Part 12: Class R Fuses*

UL 248-13, *Low-Voltage Fuses – Part 13: Semiconductor Fuses*

UL 248-14, *Low-Voltage Fuses – Part 14: Supplemental Fuses*

UL 248-15, *Low-Voltage Fuses – Part 15: Class T Fuses*

UL 248-16, *Low-Voltage Fuses – Part 16: Test Limiters*

UL 353, *Limit Controls*

UL 489, *Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures*

UL 508, *Industrial Control Equipment*

UL 514B, *Conduit, Tubing, and Cable Fittings*

UL 555, *Fire Dampers*

UL 705, *Power Ventilators*

UL 710, *Exhaust Hoods for Commercial Cooking Equipment*

UL 710B, *Recirculating Systems*

UL 723, *Test for Surface Burning Characteristics of Building Materials*

UL 746A, *Polymeric Materials – Short Term Property Evaluations*

UL 864, *Control Units and Accessories for Fire Alarm Systems*

UL 867, *Electrostatic Air Cleaners*

UL 917, *Clock-Operated Switches*

UL 935, *Fluorescent-Lamp Ballasts*

UL 969, *Marking and Labeling Systems*

UL 991, *Safety Tests for Safety-Related Controls Employing Solid-State Devices*

UL 1004-1, *Rotating Electrical Machines – General Requirements*

UL 1004-2, *Impedance Protected Motors*

UL 1004-3, *Thermally Protected Motors*

UL 1004-7, *Electronically Protected Motors*

UL 1029, *High-Intensity-Discharge Lamp Ballasts*

UL 1046, *Grease Filters for Exhaust Ducts*

UL 1598, *Luminaires*

UL 1995, *Heating and Cooling Equipment*

UL 1998, *Software in Programmable Components*

UL 2111, *Overheating Protection for Motors*

UL 2395, *Adhesives for Use in Heating and Cooling Appliances to Secure Thermal Insulation Materials*

UL 4248-5, *Fuseholders – Part 5: Class G*

UL 5085-1, *Low Voltage Transformers – Part 1: General Requirements*

UL 5085-3, *Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers*

UL 60730-1, *Automatic Electrical Controls – Part 1: General Requirements*

UL 60730-2-7, *Automatic Electrical Controls – Part 2-7: Particular Requirements for Timers and Time Switches*

UL 60730-2-9, *Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls*

ULC 102, *Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies*

ULC 102.2, *Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Covering and Miscellaneous Materials and Assemblies*

ULC-S112, *Standard Method of Fire Test of Fire-Damper Assemblies*

ULC 527, *Control Units for Fire Alarm Systems*

ULC-S645, *Power Roof Ventilators for Commercial and Institutional Kitchen Exhaust Systems*

ULC-S649, *Grease Filter for Commercial and Institutional Kitchen Exhaust Systems*

5 Glossary

5.1 For the purpose of this Standard the following definitions apply.

5.2 CIRCUIT, HIGH-VOLTAGE – A circuit having characteristics in excess of those of a low-voltage circuit. See [5.3](#).

5.3 CIRCUIT, LOW-VOLTAGE – A circuit involving a potential of not more than 30 volts rms alternating-current (42.4 volts peak or direct current), and supplied by a primary battery or by a Class 2 transformer or by a combination of transformer and fixed impedance which, as a unit, complies with all the performance requirements for a Class 2 transformer.

5.4 COMBUSTIBLE MATERIAL – Material made of or surfaced with wood, compressed paper, plain fibers, or other material that will ignite and burn, as applied to materials adjacent to or in contact with heat-producing appliances, grease duct and vent connectors, steam and hot water pipes, and warm air ducts. Such material shall be considered as combustible even though flame proofed, fire-retardant treated, or plastered.

5.5 COOKING APPLIANCE – Cooking device used in kitchen operated by gas and/or electricity.

a) APPLIANCE, LIGHT-DUTY – Appliance with a light duty rating. Light-duty cooking appliances, as defined in the IMC, includes gas and electric ovens (including standard, bake, roasting, revolving, retherm, convection, combination convection/steamer, countertop conveyORIZED baking/finishing, deck, and pastry), electric and gas steam-jacketed kettles, electric and gas pasta cookers, electric and gas compartment steamers (both pressure and atmospheric) and electric and gas cheesemelters.

b) APPLIANCE, MEDIUM-DUTY – Appliance with a medium duty rating. Medium-duty cooking appliances, as defined in the IMC, includes electric discrete element ranges (with or without oven), electric and gas hot-top ranges, electric and gas griddles, electric and gas double-sided griddles, electric and gas fryers (including open deep fat fryers, donut fryers, kettle fryers and pressure fryers), electric and gas conveyor pizza ovens, electric and gas tilting skillets (braising pans) and electric and gas rotisseries.

c) APPLIANCE, HEAVY-DUTY – Appliance with an heavy duty rating. Heavy-duty cooking appliances, as defined in the IMC, includes electric under-fired broilers, electric chain (conveyor) broilers, gas under-fired broilers, gas chain (conveyor) broilers, gas open-burner ranges (with or without oven), electric and gas wok ranges, and electric and gas over-fired (upright) broilers and salamanders.

d) APPLIANCE, EXTRA HEAVY-DUTY – Appliance with an extra heavy-duty rating. Extra heavy-duty cooking appliances, as defined in the IMC, includes appliances utilizing solid fuel such as wood, charcoal, briquettes, and mesquite to provide all or part of the heat source for cooking.

5.6 **FILTER BLANKS** – A solid panel that is used in place of a grease filter to eliminate airflow through a section of hood.

5.7 **FITTING** – A device intended to provide a liquid tight seal around penetrations.

5.8 **GREASE FILTER** – A removable component of the grease removal system intended to capture grease and direct it to a safe collection point.

5.9 **GREASE REMOVAL DEVICE** – A product or system of components designed and installed in a Type 1 hood intended to process vapors, gases, and/or air as it is drawn through such device(s) by collecting the airborne grease particles and concentrating them for further action at some future time, leaving the exiting air with a lower amount of combustible matter.

5.10 **HOOD** – A device designed to capture and contain cooking effluent which includes grease, smoke, steam, heat, and vapor for exhausting through a grease duct. Hoods are divided between Type I and Type II.

5.11 **HOOD – TYPE I** – A hood for collecting and removing grease effluents and smoke. The following styles are commonly available:

a) **BACKSHELF OR PROXIMITY HOOD** – A wall mounted hood with its front lower lip in low proximity over the appliance(s) and the hood is typically set back from the front edge of the cooking appliance(s).

b) **COMPENSATING HOOD** – A Hood having integral (built-in) make-up air supply. The make-up air supply is supplied from one or more of the following: short-circuit flow inside the hood, air curtain flow from the bottom of the front face, the rear or side of the hood, or the rear, front, or sides of the cooking equipment.

c) **DOUBLE ISLAND CANOPY HOOD** – A hood over back-to-back appliances or appliance lines. The hood is suspended such that it abuts no walls and overhangs both the fronts and the sides of the appliance(s).

d) **EYEBROW HOOD** – A hood mounted directly to the top/front of an appliance above the opening(s) or door(s) from which effluent is emitted.

e) **PASS-OVER HOOD** – A hood that is a form of a backshelf hood constructed low enough to pass food over the top.

f) **SINGLE ISLAND CANOPY HOOD** – A hood placed over a single appliance or single appliance line. The hood abuts no walls and overhangs both the fronts and the sides of the appliance(s).

g) **WALL CANOPY HOOD** – A hood mounted against a wall above a single appliance or line of appliance(s) and overhangs the front and the sides of the appliance(s).

h) **VENTILATED CEILING** – A ventilated ceiling is a hood which is typically installed so that the bottom edge of the hood is flush with the ceiling height.

5.12 **HOOD – TYPE II** – A hood for collecting and removing steam, vapor, heat and odors.

5.13 **LUMINAIRE (FIXTURE)** – A complete lighting unit consisting of a lamp or lamps, together with the parts designed to distribute the light, to position and protect the lamps and ballast (where applicable), and to connect the lamps to the power supply.

5.14 **PENETRATIONS** – The routing of metallic piping into or through exhaust hoods or ducts for connection to a fire extinguishing system or waterwash system.

5.15 PRIMARY FILTER – A filter that is installed in the aperture of an exhaust hood and provides a flame barrier.

5.16 SECONDARY FILTER – A filter that is not the primary filter and is used in addition to, and in conjunction with, the primary filter.

5.17 WATERWASH – A system of nozzles built into a hood for cleaning the grease removal device and/or the hood plenum.

CONSTRUCTION

6 Assembly

6.1 An exhaust hood shall include all the essential parts required for its intended function when installed as intended. The equipment shall be shipped as subassemblies.

6.2 An exhaust hood that is not assembled by the manufacturer as a unit shall be constructed so that each subassembly is capable of being incorporated into the final assembly without requiring alteration by the installer. Subassemblies that must bear a definite relationship to each other for the intended operation of the product shall be arranged and constructed to permit them to be incorporated into the complete assembly only in the correct relationship with each other, without requiring for alteration or realignment.

6.3 A part that comes in contact with the operator during intended usage shall be free from sharp edges or projections.

6.4 An adjustable part shall be provided with a locking device to reduce unintentional shifting.

6.5 A screw or bolt used to attach a part that is intended to be detached for care or servicing shall function as intended following the application of the torque specified in [Table 6.1](#) and after removal and replacement.

Table 6.1
Maximum Torque Requirements for Screws

Screw size mm	(inch)	Torque	
		N·m	(Pound-inches)
4.2	(No. 8)	2.3	(20)
4.8	(No. 10)	2.8	(25)
6.4	(1/4 inch)	11.3	(100)
7.9	(5/16 inch)	22.6	(200)
9.5	(3/8 inch)	39.5	(350)
11.1	(7/16 inch)	62.1	(550)
12.7	(1/2 inch)	90.3	(800)
14.3	(9/16 inch)	135.5	(1200)

6.6 All parts, controls, and devices requiring maintenance shall be accessible. Parts intended to be removed for maintenance shall not require realignment following removal and restoration to secure their intended relationship with other parts of the product. Special tools or equipment required for maintenance by the operator shall accompany the product to the user.

6.7 The product shall incorporate provisions for support or attachment to the building structure.

6.8 Joints between parts that confine a washing agent shall be mechanically secured and sealed.

6.9 External seams, joints, and penetrations; or that portion of the hood that captures grease laden vapors and exhaust gases shall have a liquid-tight continuous weld to the lower outermost edges of the entire hood assembly.

Exception No. 1: Seams and joints made with a fastening means other than a liquidtight continuous weld shall be employed in hoods that have been subjected to the Abnormal Flare-Up, Fan Failure, Fire, and Burnout Tests, Sections 37 – 41, with no evidence of the passage of smoke, flame, or vapor through the joint. Such evaluations are to be made with the fire sources located at positions which are critical for the purpose of evaluating the joint or seam.

Exception No. 2: Penetrations sealed by fittings and seam/joints subjected to the Fire and Leakage Tests of Fittings, Seams, Joints, or Hood Penetrations, Section 45.

7 Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts

7.1 Each uninsulated live part or moving part, such as a belt, coupling, fan, gear, pulley, and shaft that results in risk of electric shock or injury to persons shall be located, guarded, or enclosed so as to reduce unintentional contact by service personnel or other persons performing mechanical or electrical service functions that are to be performed while the product is energized. Parts or assemblies which can be removed without the use of tools are not to be considered a guard.

7.2 A hinged or pivoted panel or cover shall be positioned or arranged so that it does not fall or swing due to gravity or vibration in such a manner as to increase the risk of unintentional contact with the panel or cover, a moving part or an uninsulated live part that results in injury to persons.

7.3 With reference to 7.1 for guarding of moving parts, a rod of a diameter larger than that specified in Table 7.1 shall not enter the opening in an enclosure.

Table 7.1
Maximum Permissible Test Rod Diameters for Enclosure Openings

Straight line distance to moving part from external plane of opening, mm (in)	Maximum diameter rod that is capable of passing through the opening	
	mm	(inch)
Less than 50.8 (2)	6.4	(1/4)
At least 50.8 (2) and less than 152 (6)	12.7	(1/2)
At least 152 (6) and less than 381 (15)	25.4	(1)

7.4 Compliance with 7.3 is to be determined by attempting to insert a rod 76.2 mm (3 inch) long and of the diameter specified in Table 7.1 into the openings.

7.5 It shall not be required to remove a permanently attached guard to lubricate the equipment.

7.6 With reference to 7.1 and 7.2, the following are not determined to be uninsulated live parts:

- a) Coils of controllers, relays, solenoids, and transformer windings, when the coils and windings are provided with insulating overwraps;
- b) Enclosed motor windings;

- c) Insulated terminals and splices; and
- d) Insulated wire.

7.7 An electrical control component that requires examination, adjustment, servicing, or maintenance while energized, excluding voltage measurements, shall be located and mounted with respect to other components and with respect to grounded metal parts so that it is accessible for electrical service functions without subjecting the service personnel to the risk of electric shock from adjacent uninsulated live parts or to risk of injury from adjacent moving parts.

7.8 Electrical components with electrical connections shall be readily inspectable after installation of the exhaust hood.

7.9 An enclosure opening shall not permit entrance of a rod of 19 mm (3/4 inch) diameter unless:

- a) A probe as illustrated in [Figure 7.1](#) is capable of being made to touch an uninsulated live part when inserted through the opening; and
- b) A probe as illustrated in [Figure 7.2](#) is capable of being made to touch film-coated wire when inserted through the opening.

7.10 An opening that permits entrance of a 19 mm (3/4 inch) diameter rod is capable of being used under the conditions illustrated in [Figure 7.3](#).

Figure 7.1

Probe for Uninsulated Live Parts

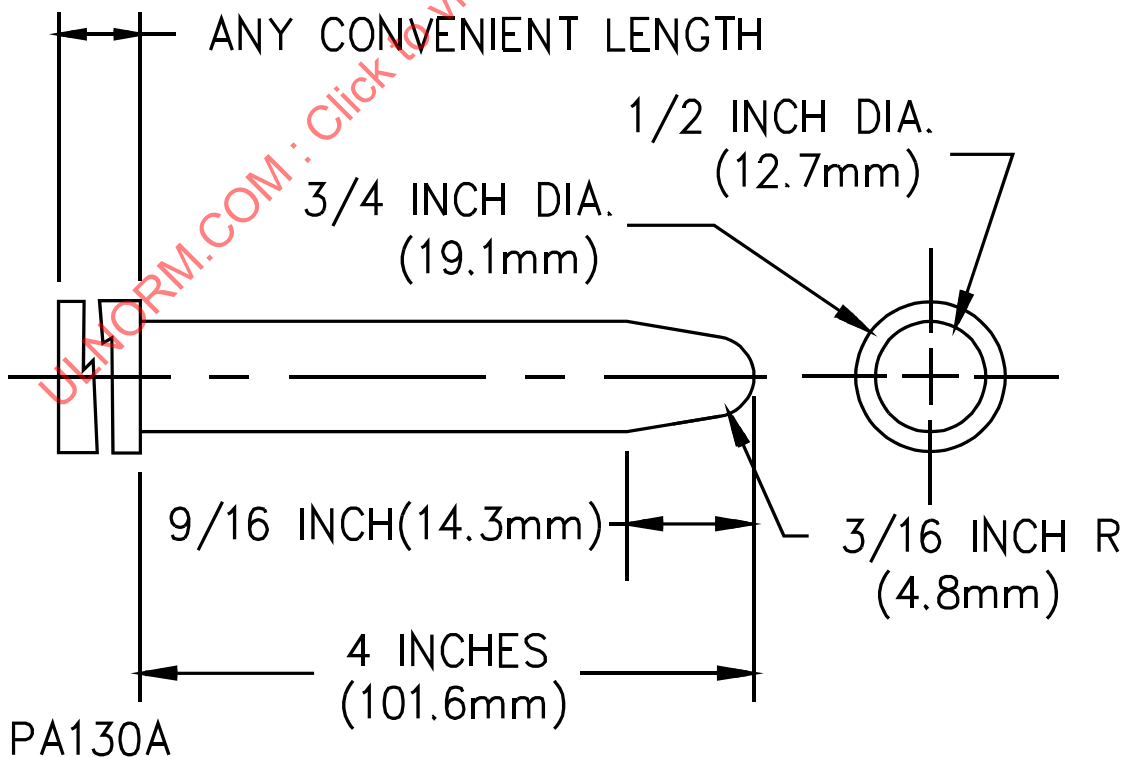


Figure 7.2
Probe for Film-Coated Wire

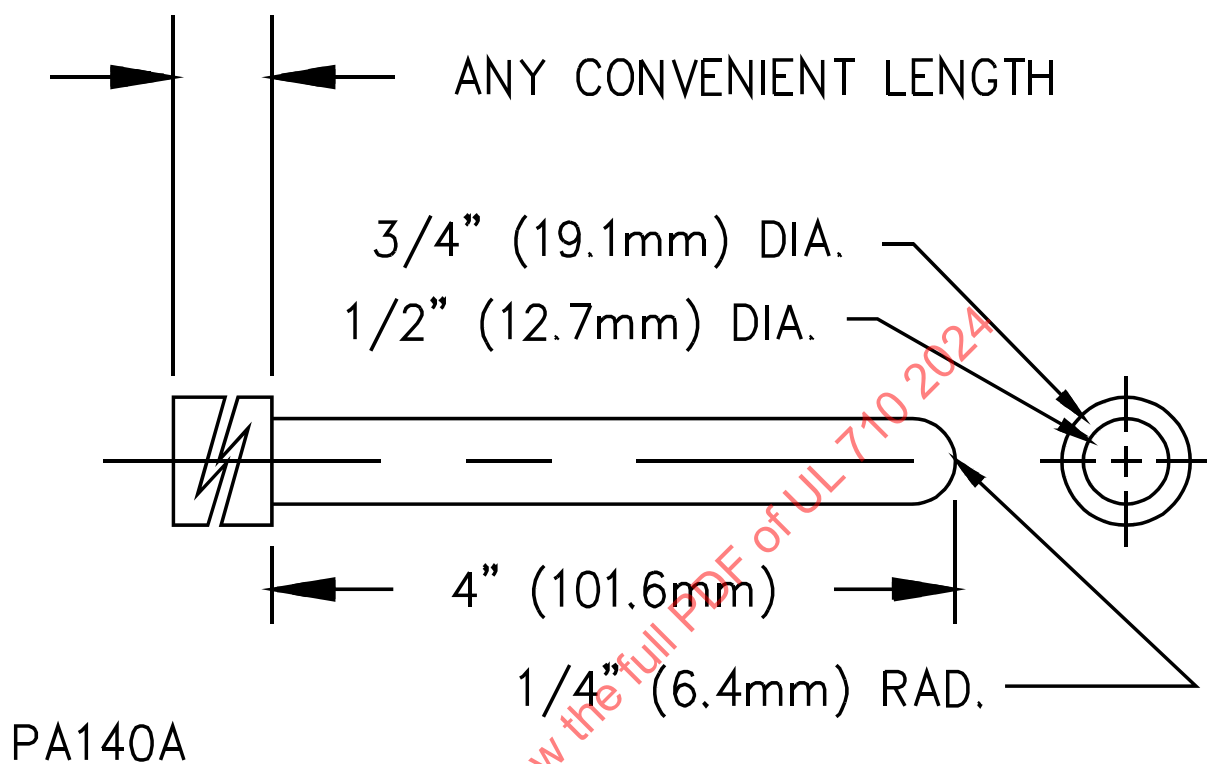
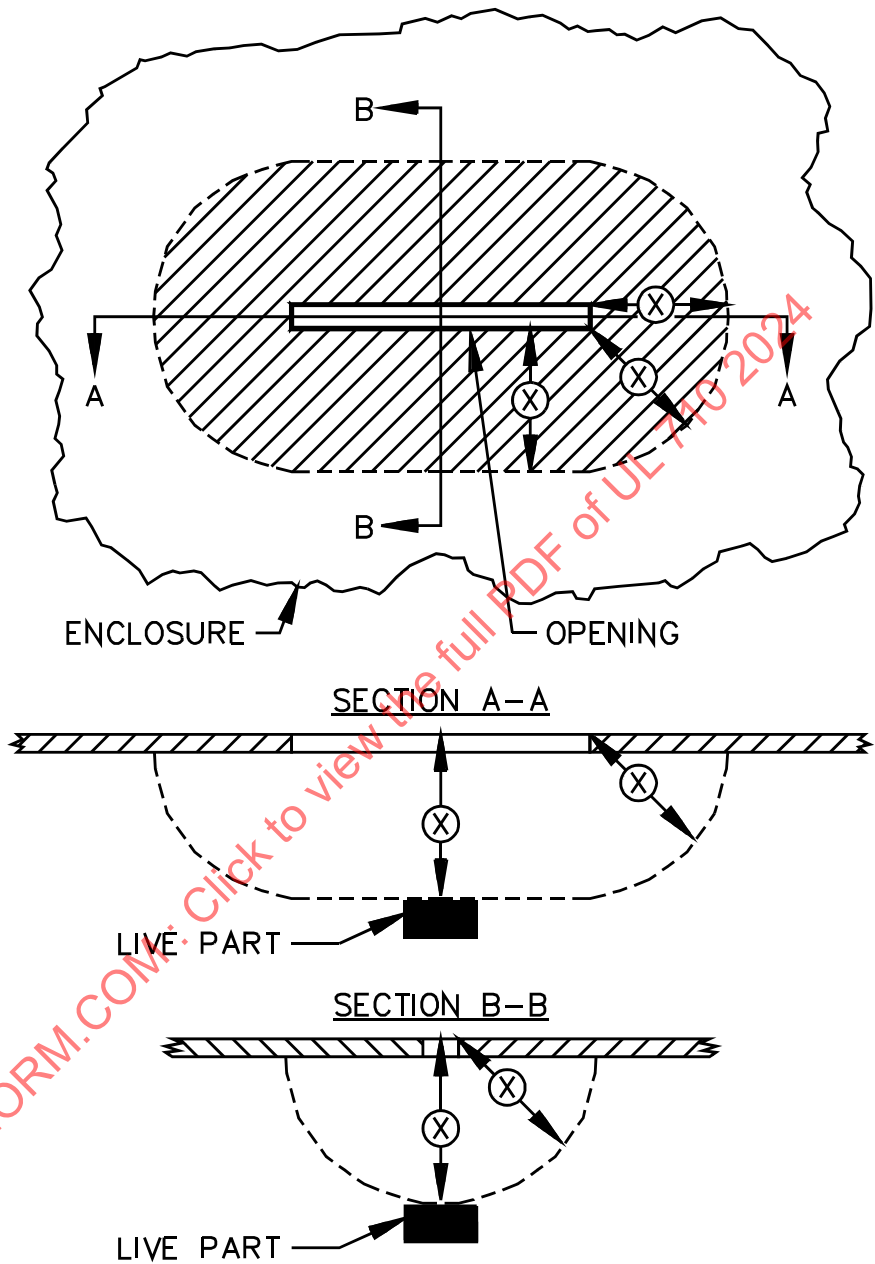


Figure 7.3
Opening in Enclosure



EC100B

The opening and the enclosure shall have no uninsulated live metal part or film-coated wire:

- a) Less than X mm (inches) from the perimeter of the opening; as well as
- b) Within the volume generated by projecting the perimeter X mm (inches) normal to its plane.

X equals five times the diameter of the largest diameter rod which is capable of being inserted through the opening, and not less than 102 mm (4 inch).

7.11 A part of an outer enclosure that is capable of being removed without the use of a tool, or part of an outer enclosure that is capable of being removed by the user for access to an operating adjustment is to be disregarded; that is, it is not to be assumed that the part in question reduces the risk of electric shock.

8 Materials

8.1 The hood and other parts of an exhaust hood that serve to confine or convey the exhaust products, including any dampers and structural parts, shall be made of steel not less than 1.09 mm (0.043 inch) (No. 18 MSG) in thickness, stainless steel not less than 0.94 mm (0.037 inch) (No. 20 MSG) in thickness, or other approved material of equivalent strength and fire resistance.

8.2 Internal ferrous metal parts, except pipe and associated fittings subject to a washing agent, shall be made of stainless steel as specified in [8.1](#) or provided with corrosion protection as specified in Protection Against Corrosion, Section [9](#). Other ferrous metal parts shall be plain cold-rolled steel not less than 1.1 mm (0.042 inch) thick.

8.3 Any insulation material installed within an exhaust hood shall not be exposed to cooking vapors.

8.4 Insulation materials other than electrical insulation shall have a flame spread rating of 25 or less when tested in accordance with UL 723, in the United States, and ULC 102 in Canada. Adhesives or cements used in the installation of insulating materials shall comply with the above requirements when tested with the specific insulating material.

8.5 Insulation materials installed within the supply air plenums of exhaust hoods shall be provided with a nonabsorptive facing and shall be secured so as not to sag or interfere with the intended passage of air.

8.6 An adhesive provided to secure insulating material, in accordance with [8.5](#), shall comply with the conditioning environments as specified in UL 2395. When applied at the thickness intended for use, the adhesive shall remain affixed to the substrate when positioned in the vertical plane.

8.7 Asbestos material shall not be used.

8.8 Gasket and sealant materials used in an exhaust hood, as well as in duct collars, damper assemblies, and fittings for hood penetrations, that are exposed to cooking smoke and vapor shall be subjected to Gasket and Sealant, Physical and Immersion Tests, Section [44](#).

Exception: Sealants used for aesthetics and/or cleanability purposes.

9 Protection Against Corrosion

9.1 A ferrous metal part required to be provided with corrosion protection shall be provided with one of the following corrosion-protection systems:

- a) A zinc coating complying with the coating Designation G60 or A60 in Table I of ASTM A653/A653M, with not less than 40 of the zinc on any side, based on the minimum single spot test requirement in this ASTM Designation. The weight of the zinc coating is to be determined by any method; in case of question shall be established in accordance with the test method in ASTM A90.
- b) A zinc coating, other than that specified in (a), uniformly applied to an average thickness of not less than 0.0104 mm (0.00041 inch) on each surface with a minimum thickness of 0.00864 mm (0.00034 inch). The thickness of the coating is to be established in accordance with ASTM B555.

10 Grease Removal Devices and Grease Filters

10.1 Exhaust hoods shall include means for removal of grease and other cooking process contaminants.

10.2 Internal parts of the product shall be accessible for inspection and repair, without the use of special tools.

10.3 Primary grease removal devices shall be provided with all exhaust hoods.

a) When grease filters are provided, the filters shall comply with UL 1046 in the United States, and ULC-S649 in Canada.

NOTE: Grease extraction devices integral to the exhaust hoods in which they are installed, and other filter devices designed to be used only in specific hoods are not covered by UL 1046 or ULC-S649 but covered under this Standard.

b) When grease removal devices integral to the exhaust hood are provided, the grease removal device shall comply with the construction requirements of this Standard and [29.4](#).

10.4 Grease filters complying with UL 1046 or ULC-S649 shall be installed at an angle not less than 45° from the horizontal and shall be tight-fitting.

10.5 Grease removal devices shall be accessible and removable for cleaning or replacement without the use of special tools.

Exception: Grease removal devices used with exhaust hoods that utilize integral water-wash systems do not require removal when they are subjected to regular cleanings from the water-wash system as specified in the manufacturer's instructions, and do not inhibit the accessibility of any internal parts.

10.6 All exhaust hoods shall be equipped with a drip tray or trough beneath the lower edge of the grease removal devices. The tray or trough shall be kept to the minimum size required to collect the grease and be pitched to drain to a removable enclosed metal container having a capacity not exceeding 1 gallon (3.785 L).

Exception: Exhaust hoods provided with water-wash systems or provided with a drain connection do not require a removable, enclosed metal container for collection of grease.

11 Secondary Filters

11.1 An exhaust hood incorporating secondary filters shall be provided with a grease removal device which complies with Grease Removal Devices and Grease Filters in Section [10](#).

11.2 Secondary filters shall only be installed downstream from a grease removal device complying with Section [10](#) and prior to the connection to the grease duct.

11.3 Secondary grease filters shall be accessible for service and replacement. The hood shall be marked in accordance with [54.1\(j\)](#) to indicate the replacement secondary filter to be used.

11.4 The exhaust hood with secondary filters shall be subjected to the tests described in Sections [35](#) – [41](#) (the Temperature, Cooking Smoke and Flare-Up, Abnormal Flare-Up, Fan-Failure, Fire, Abnormal Water Supply, and Burnout Tests, respectively). These tests shall also be conducted with the primary filter removed if the secondary filter can be installed and the hood operated without the adjacent primary filter installed as intended.

Exception: The exhaust hood with secondary filters shall not be subjected to these tests if the secondary filter complies with UL 1046 or ULC-S649 and has been evaluated in conjunction with the primary filter in accordance with UL 1046 or ULC-S649.

11.5 Integral secondary grease removal devices employing UV features shall also be evaluated in accordance with Annex [A](#).

12 Blankoffs

12.1 When blankoffs are used in accordance with [30.10](#), their size and relative position shall be specified in the Installation and Operation Instructions.

13 Fire Actuated Damper Assemblies

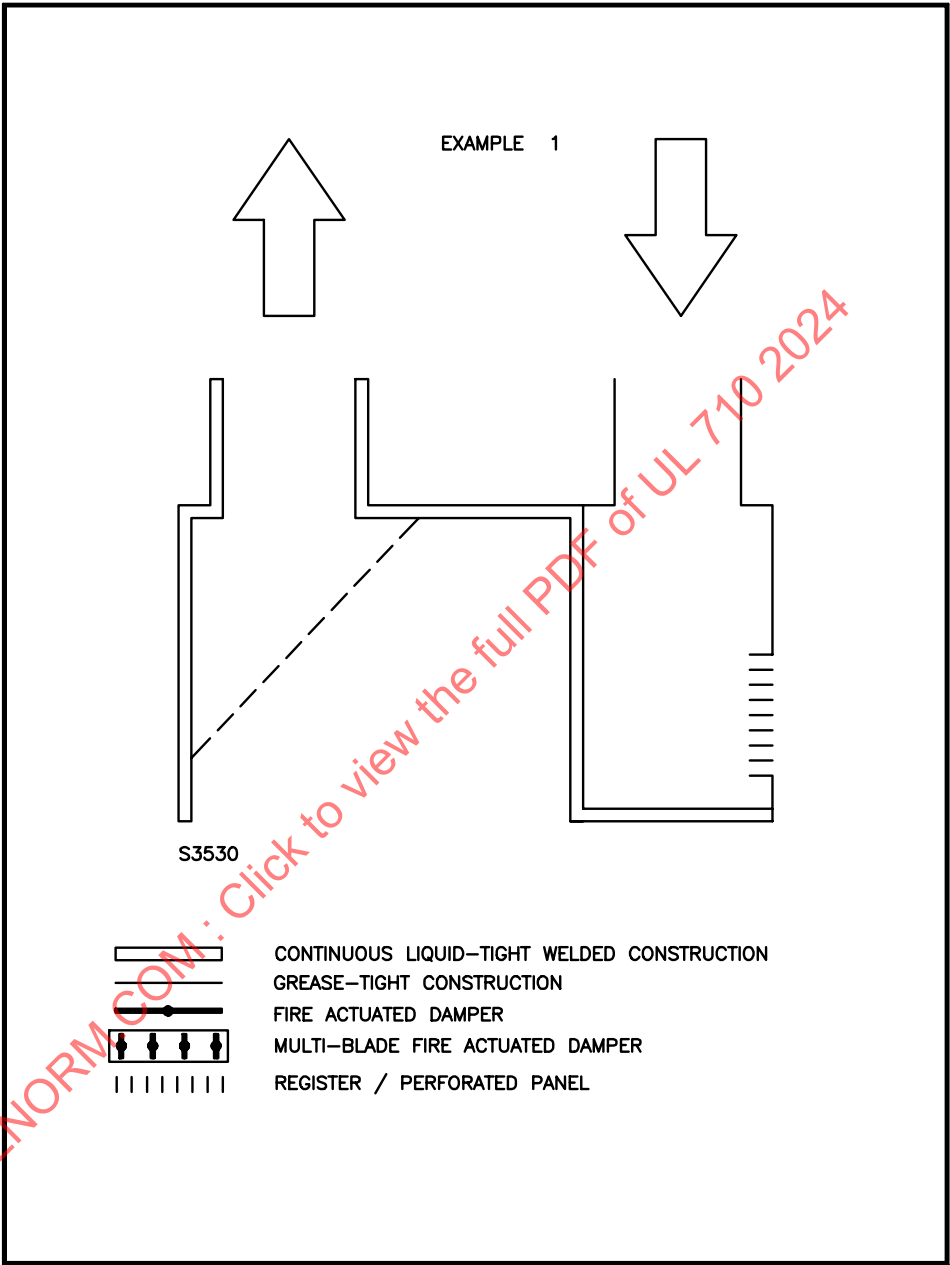
13.1 Fire actuated exhaust dampers provided as part of an exhaust hood shall comply with all the following requirements:

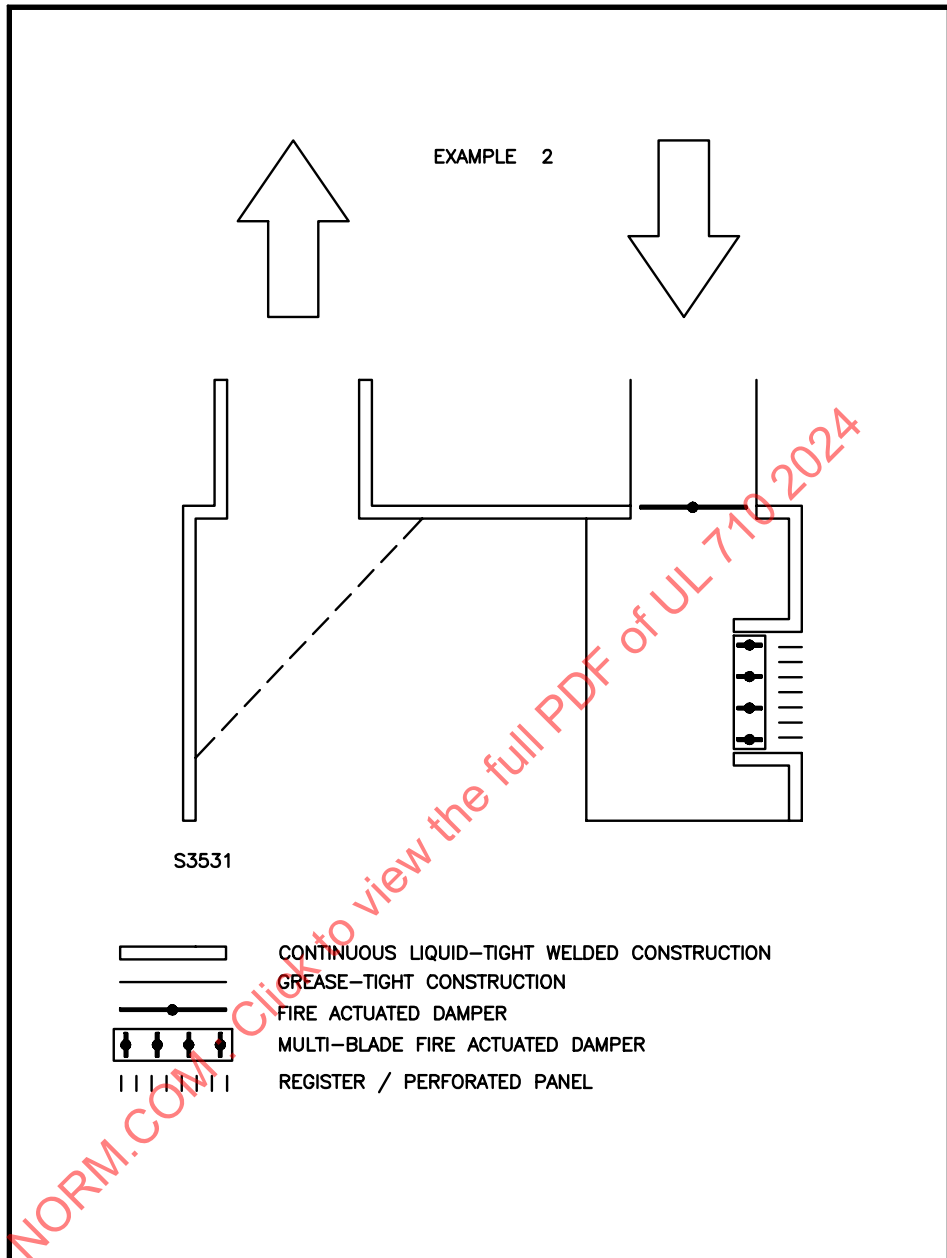
- a) Fire actuated dampers shall be provided with a heat-responsive device. Heat-responsive devices shall comply with UL/ULC 33.
- b) Fire actuated damper assemblies employing replacement parts, such as fusible links, shall be accessible without the use of special tools.
- c) The load on a fusible link used in a fire actuated damper assembly shall be in accordance with the intended use of the fusible link.
- d) A manual- or automatic-reset damper operating mechanism shall be capable of closing the fire actuated damper after being subjected to the cycling test specified in Damper Tests, Section [43](#). A manual-reset damper operating mechanism is one that is required to be manually reset after excessive temperature in the exhaust hood has resulted in the damper closing. All other damper operating mechanisms are to be automatic reset.
- e) A fire actuated damper shall remain closed when subjected to the test specified in Damper Tests, Section [43](#).
- f) A spring and a bearing used in the assembly of a fire actuated damper shall be of material having strength and resistance to atmospheric corrosion equivalent to an alloy containing not less than 85 % copper or Type 302 or 430 stainless steel. In addition a spring shall be of a material having spring properties equivalent to stainless steel conforming to ASTM A313.
- g) The materials used in fire actuated damper assemblies shall comply with [8.1](#) and [8.2](#). The combination of metals used in the assembly of a damper shall not result in galvanic action that impairs the function of any part of the assembly.

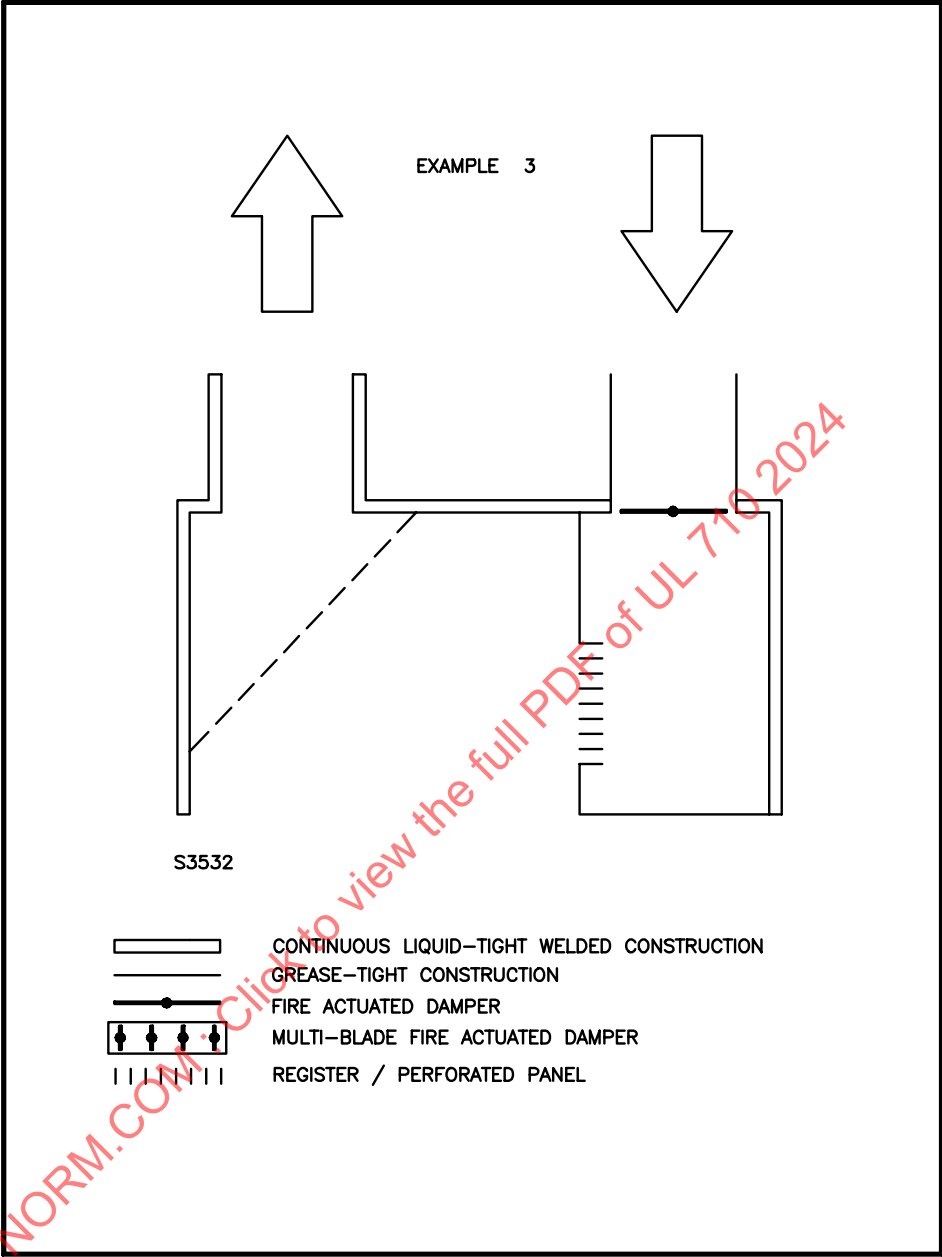
Exception: The materials used for the dampers are not required to comply with [8.1](#) and [8.2](#) when the damper complies with UL 555, in the United States and ULC-S112, in Canada.

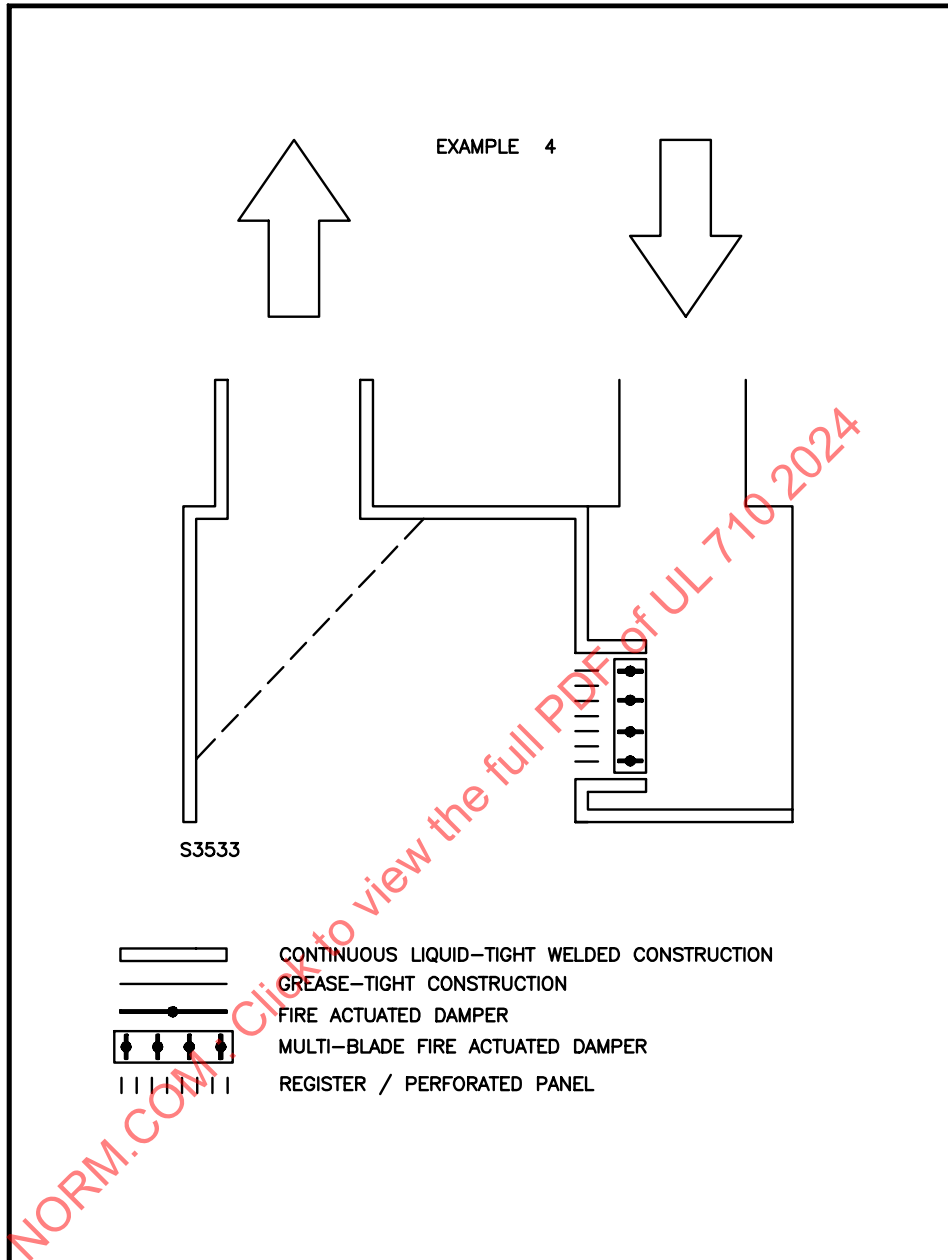
13.2 A fire actuated damper shall be installed in the supply air plenum at each point where a supply air duct inlet or a supply air outlet penetrates the continuously welded shell of the assembly. The damper shall be constructed of at least the same gage as the shell. The actuation device shall have a maximum temperature rating of 141 °C (285 °F). Supply air plenums that discharge air out their face, rather than out the bottom or into the exhaust hood, and which are isolated from the exhaust hood by the continuously welded shell extending to the lower outermost perimeter of the entire hood assembly, do not require a fire actuated damper. See [Figure 13.1](#) for some examples.

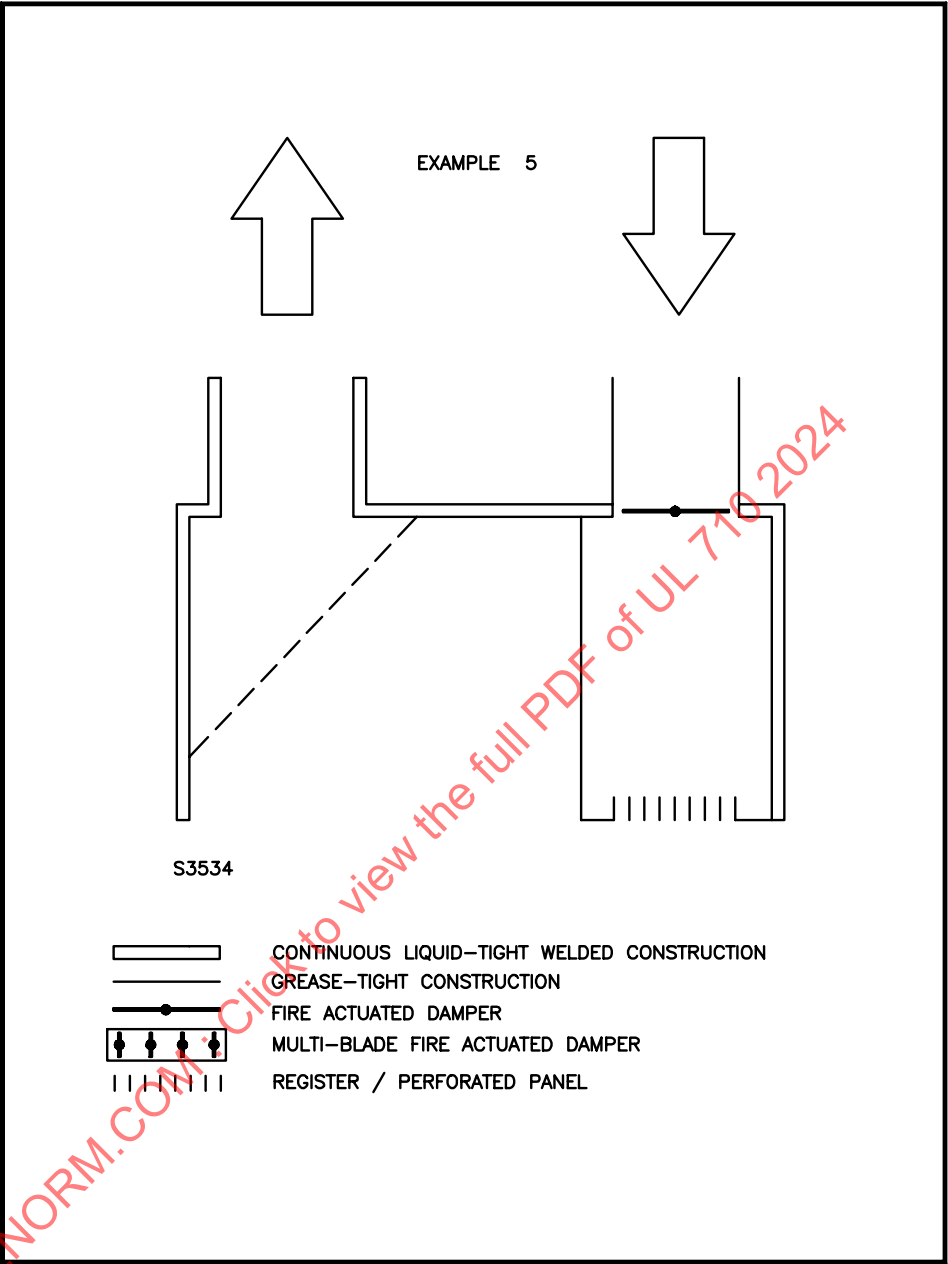
Figure 13.1
Examples of Supply Air Plenums Showing Where Dampers are Required

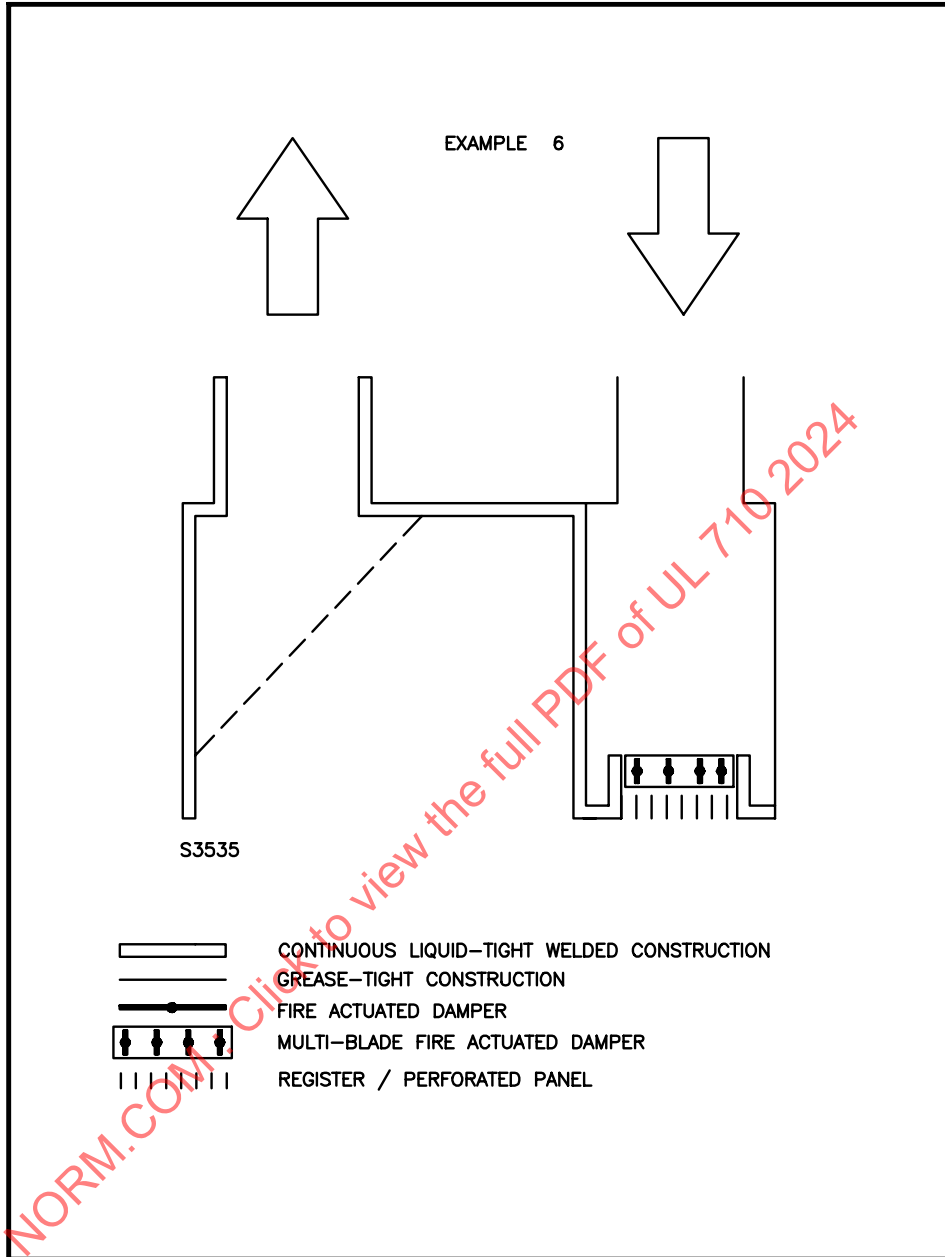


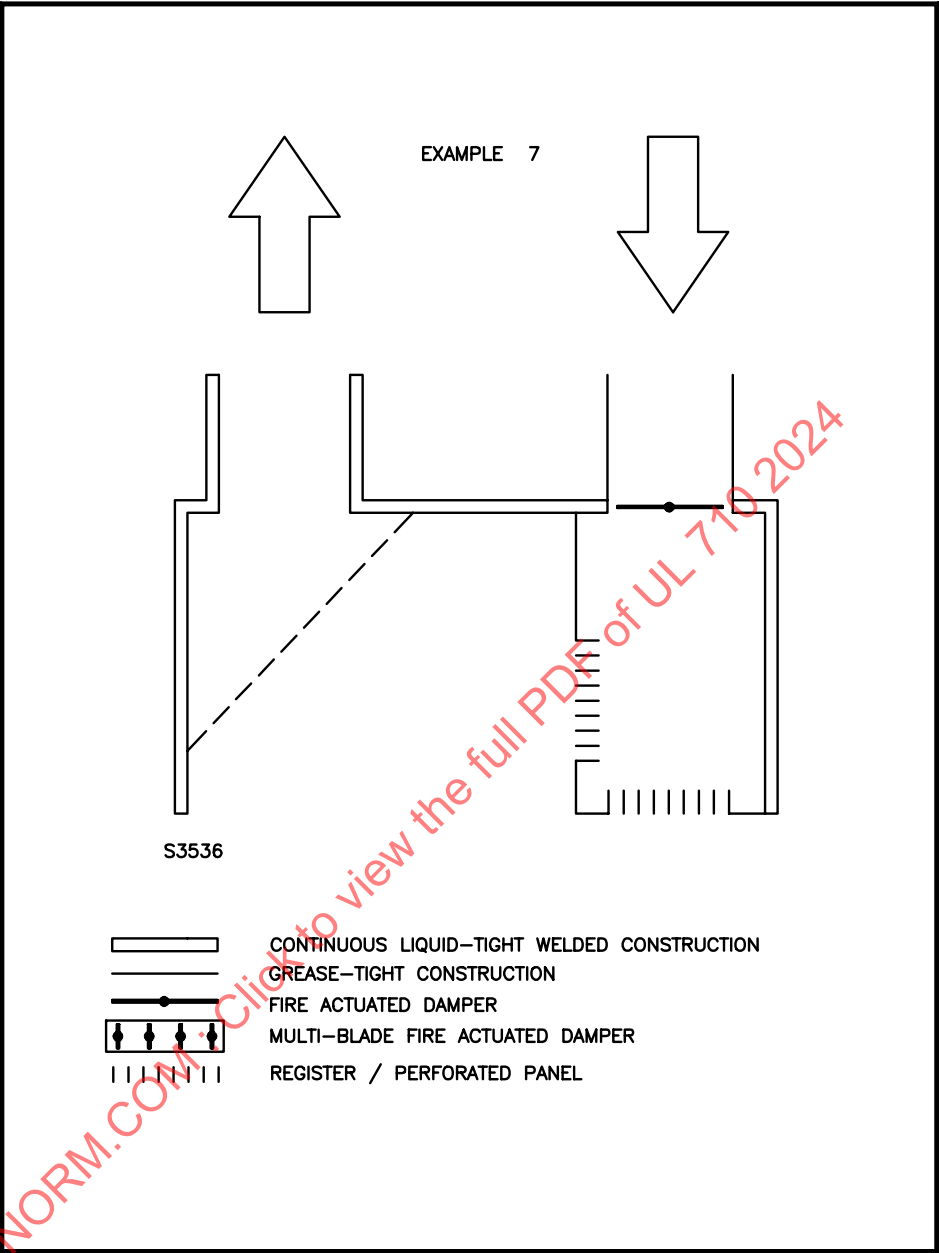


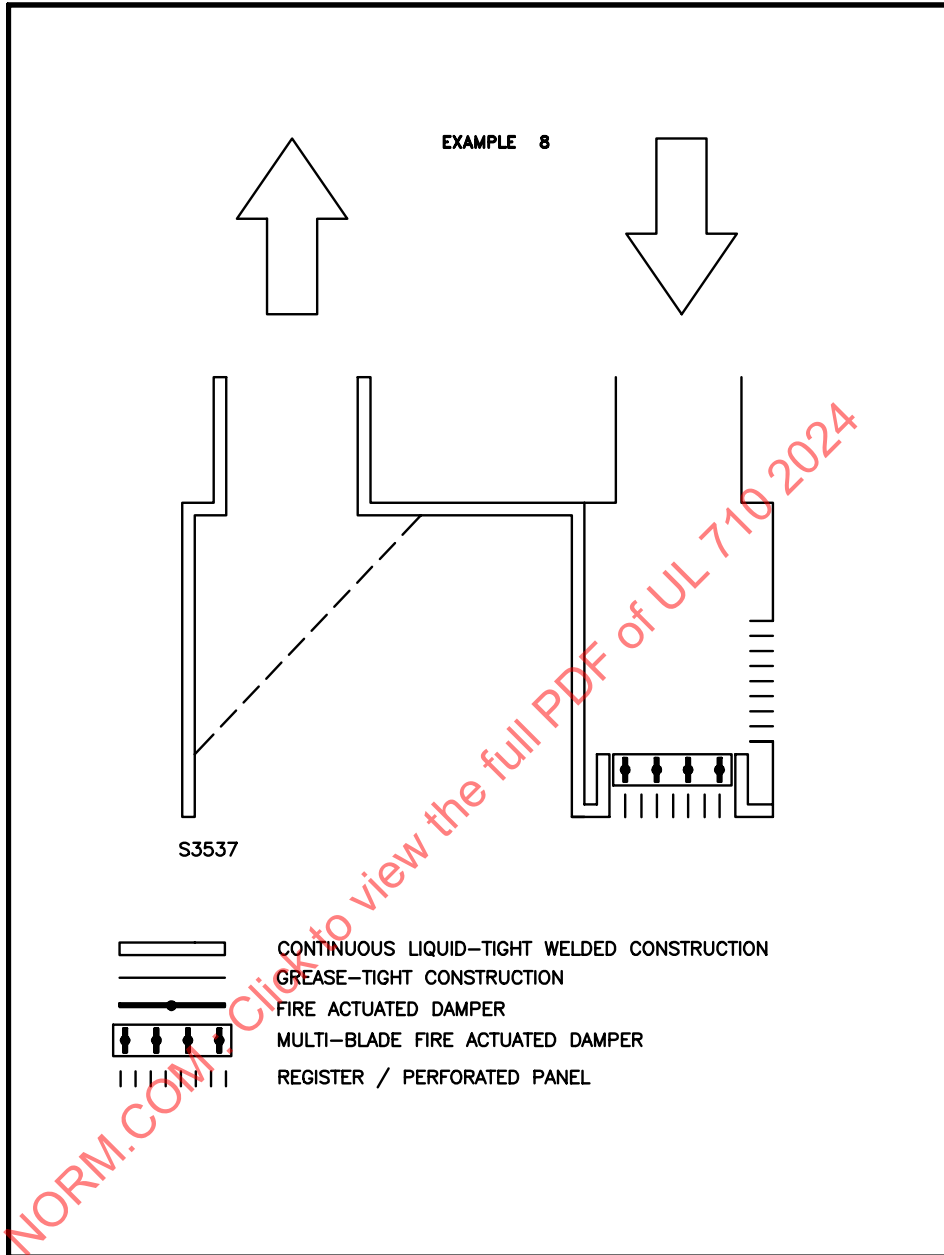


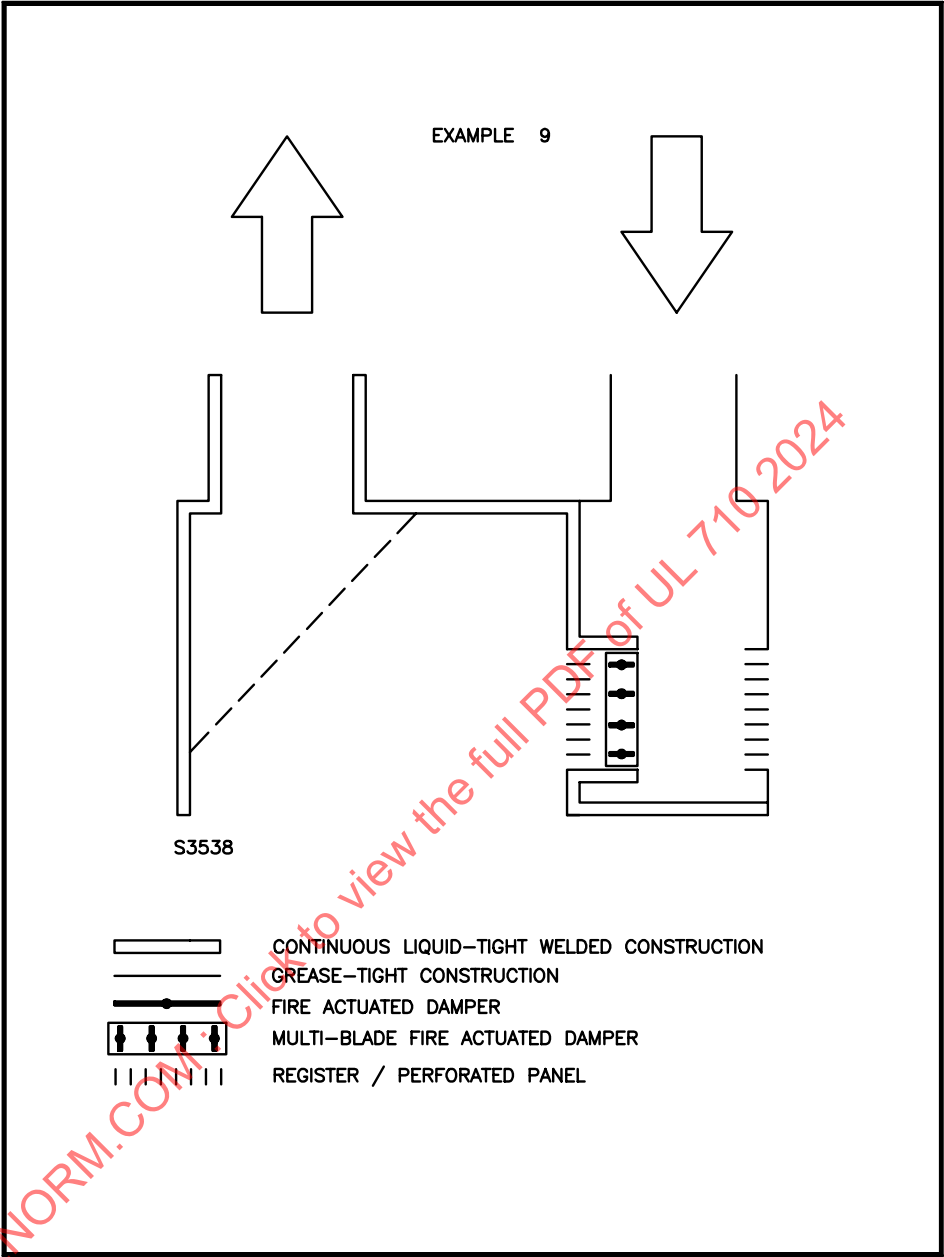


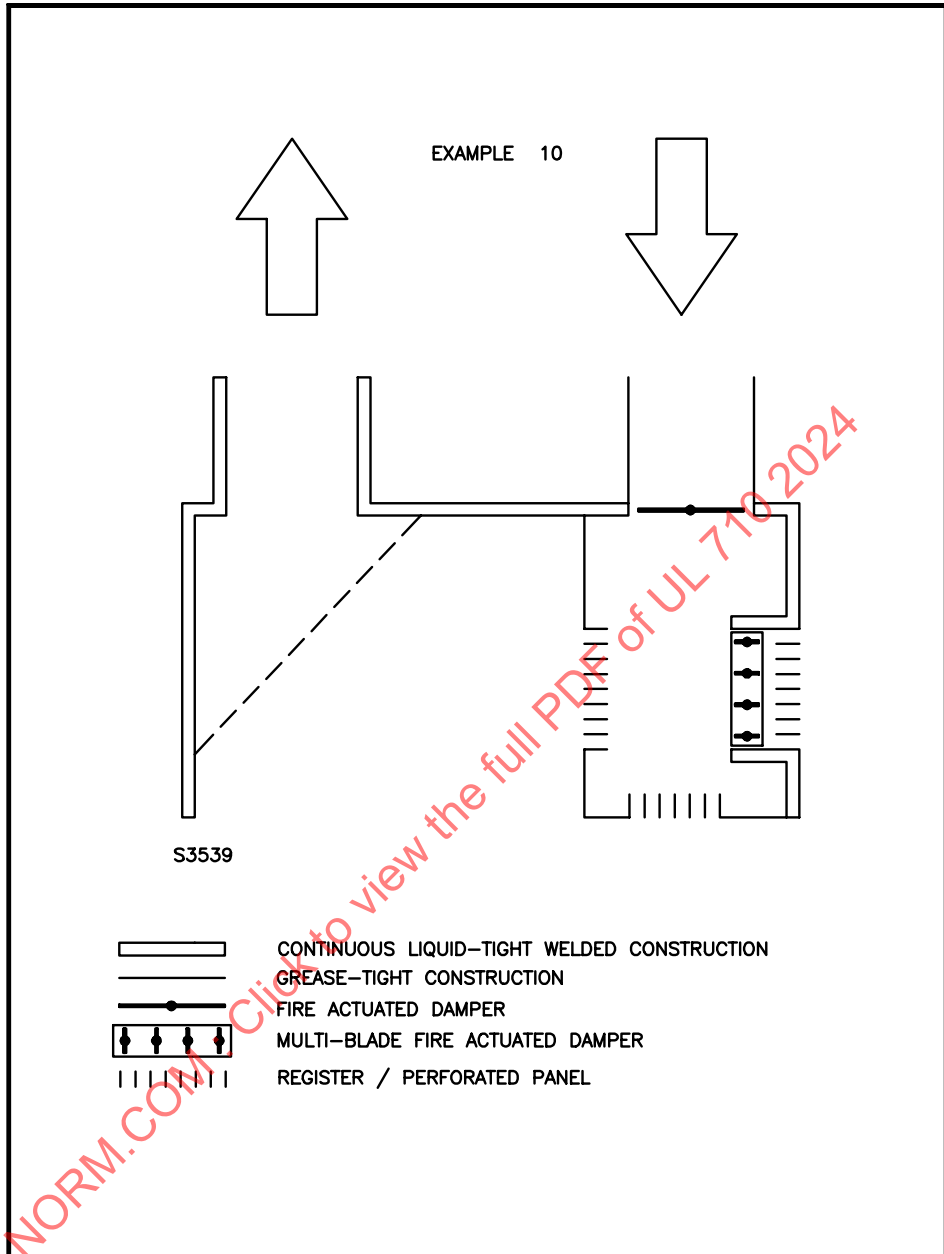












13.3 Fire actuated supply air dampers provided as part of an exhaust hood shall comply with UL 555, in the United States and ULC-S112, in Canada in addition to [13.1](#) (b), (d) and (e).

Exception: Fire actuated supply air dampers that comply with (b) – (g), and are installed in supply air plenums that have been subjected to the fire tests described in Sections [37](#) – [41](#).

14 Duct Collars

14.1 A collar for connection of duct work shall be provided attached as part of the exhaust hood if the hood is supplied with a fire actuated damper.

14.2 A hood not supplied with a duct collar shall be provided with a label on the exterior of the hood, in the vicinity where the grease duct is to be connected, specifying the location of the grease duct connection as tested (See [30.4](#)). The installation instructions shall also specify the grease duct connection locations as tested (See [30.4](#)).

14.3 A duct collar shall incorporate stops on the interior surfaces when field installed ductwork could interfere with the operation of a movable part of the exhaust hood or damage installed components if inserted too far.

14.4 The materials used for duct collars shall comply with [8.1](#) and [8.2](#).

14.5 An adjustable and/or telescoping duct collar shall be constructed as follows:

- a) There shall be a minimum of 152 mm (6 inch) of duct collar wall overlap when the hood is adjusted to any position allowed by the construction; and
- b) There shall be a mechanical stop that prevents the duct collar from separating to less than the 152 mm (6 inch) overlap requirement.

14.6 An adjustable duct collar that is not welded into a fixed position after installation shall be subjected to the applicable requirements of [29.4](#).

14.7 An adjustable duct collar that supports any portion of the weight of the exhaust hood shall comply with all the following:

- a) There shall be a mechanical stop that prevents the duct collar from separating during or after any of the required performance tests (Sections [33](#) – [40](#)) to less than the 6-inch overlap requirement;
- b) A duct collar that allows for continuous adjustment of the hood height and supports the weight of the hood shall be tested in accordance with Section [46](#), Tension Test for Adjustable/Telescoping Collar, and
- c) The duct collar shall be equipped with a mechanical stop, used to adjust the hood to the intended use heights (as used during performance tests), and as required to be permanently marked on the hood (See [54.2](#)).

15 Controls

15.1 Manual controls

15.1.1 When an electrically powered component, such as a damper or a water supply valve is required to operate in order for an exhaust hood to comply with the requirements in Sections [35](#) – [41](#), the exhaust hood shall include a manual means for actuating the electrical component.

15.1.2 The manual means specified in [15.1.1](#) shall:

- a) Not be located more than 2.1 m (7 feet) above floor level;
- b) Be accessible to the operator;
- c) Be operable using the unaided hand; and
- d) Be marked to identify the purpose and method of operation.

15.2 Limit controls

15.2.1 A temperature or other control device, that is provided so that the product complies with the performance requirement of this Standard, shall comply with the requirements in one of the following:

- a) UL 353.
- b) The following test parameters shall be among the items considered when judging the acceptability of an electronic protective control investigated using UL 60730-1 and CSA E60730-1:
 - 1) Failure-Mode and Effect Analysis (FMEA) or equivalent Risk Analysis method;
 - 2) Power Supply Voltage Dips, Variation and Interruptions within a temperature range of 10 °C (18 °F) and the maximum ambient temperature determined by conducting the Temperature Test;
 - 3) Surge immunity test – installation class 3 shall be used;
 - 4) Electrical fast transient/burst test, a test level 3 shall be used;
 - 5) Electrostatic Discharge Test;
 - 6) Radio-frequency electromagnetic field immunity:
 - i) Immunity to conducted disturbances – When applicable, test level 3 shall be used; and
 - ii) Immunity to radiated electromagnetic fields; field strength of 3 V/m shall be used;
 - 7) Thermal Cycling test shall be conducted at ambient temperatures of 10.0 +2 °C (50.0 +3 °F) and the maximum ambient temperature determined by conducting the Temperature Test; The test shall be conducted for 14 days;
 - 8) Overload shall be conducted based on the maximum declared ambient temperature (T_{max}) or as determined by conducting the Temperature Test;
 - 9) If software is relied upon as part of the protective electronic control, it shall be evaluated as software class B.

15.2.2 The primary input circuit of a limit control shall have a voltage rating of not more than 120 volts. A limit control, or other protective device, shall interrupt the ungrounded conductor.

15.2.3 A control circuit shall be provided with overcurrent protection rated at not more than the value appropriate for the rating of any control included in the circuit.

15.2.4 Each limit control shall be accessible.

15.2.5 A limit control shall be supported in such a manner that it and its sensing element remains in its intended position.

15.2.6 No means shall be provided to render ineffective any limit control or to allow operation of the product without the protection of each of the limit controls provided as specified in [15.2.1](#).

16 Electrical Enclosure

16.1 General

16.1.1 A control unit enclosure shall comply with UL 50 and CSA C22.2 No. 94.1, and UL 50E and CSA C22.2 No. 94.2, with the requirements in [16.1.2](#) – [16.4.11](#).

16.1.2 All electrical parts of a control unit shall be enclosed to provide protection against contact with uninsulated live parts.

16.1.3 The enclosure of a control unit installed in or attached to an exhaust hood shall be of a liquid-tight construction.

Exception No. 1: The door or cover of a control unit is not required to form a liquidtight seal between itself and the enclosure when attached to the exterior surface of an exhaust hood at a location not subject to exposure to any cooking smoke or vapors.

Exception No. 2: An enclosure or junction box installed on top of an exhaust hood that does not penetrate the continuously welded shell of the hood is not required to be of a liquid-tight construction.

16.1.4 The enclosure of a control unit which is recessed in an exhaust hood shall comply with [16.1.3](#) and shall be attached to the exhaust hood with a continuous liquidtight weld, when the enclosure penetrates that portion of the exhaust hood that serves as the liquidtight shell to capture grease laden vapors and exhaust gases.

Exception: The attachment of the control unit enclosure to the exhaust hood shall be other than a continuous liquidtight weld when subjected to the Fire and Leakage Test of Fittings, Seams, Joints, or Hood Penetrations, Section [45](#).

16.2 Transparent covers

16.2.1 Glass covering an observation opening in an electrical enclosure shall be secured in place so that it is not displaced in service and shall provide mechanical protection for the enclosed parts. The thickness of a glass cover shall be not less than that indicated in [Table 16.1](#).

Table 16.1
Thickness of Glass Covers

Maximum size of opening				Minimum thickness	
Length or width		Area			
mm	(inch)	cm ²	(inch ²)	mm	(inch)
102	(4)	103	(16)	1.6	(1/16)
305	(12)	929	(144)	3.2	(1/8)
305	(Over 12)	929	(Over 144)	a	
a 3.2 mm (1/8 inch) or more, based upon the size, shape, and mounting of the glass panel.					

16.2.2 A glass panel for an opening having an area of more than 929 cm² (144 inch²), or having any dimension greater than 305 mm (12 inch), shall be continuously supported at least 4.8 mm (3/16 inch) along all four edges of the panel, or an equivalent arrangement.

16.2.3 A transparent material other than glass shall be used for the cover of an observation opening when the material does not introduce a risk of fire, distort, nor become less transparent at the temperature to which it shall be subjected under either normal or abnormal service conditions.

16.3 Battery storage compartments

16.3.1 A storage compartment for batteries, shall have a total volume not less than twice the volume occupied by the batteries. Ventilating openings shall be provided so located as to permit circulation of air for dispersion of gas while the battery is being charged at the highest rate permitted by the means incorporated in the control unit.

16.3.2 The interior of a battery storage compartment shall be so protected that it resists detrimental action by the electrolyte.

16.4 Ventilation openings

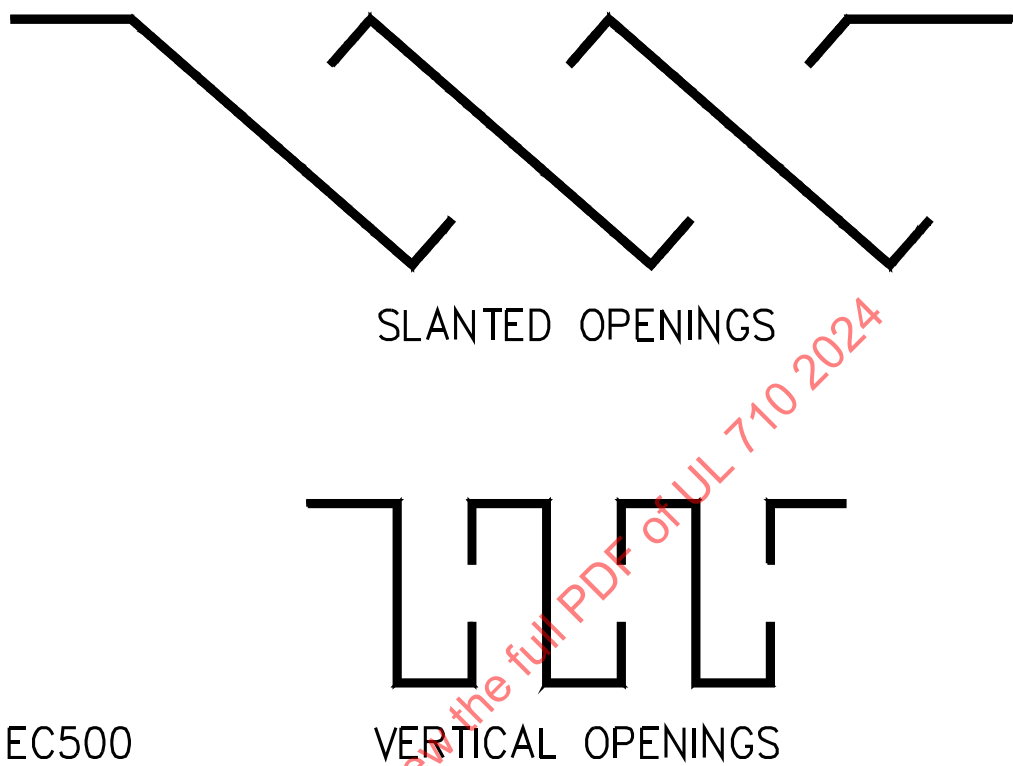
16.4.1 Ventilation openings are not permitted within electrical enclosures installed in or attached to an exhaust hood.

16.4.2 Ventilation openings shall be provided within the enclosure of a control unit not installed in or attached to an exhaust hood when they comply with [16.4.3](#) – [16.4.11](#).

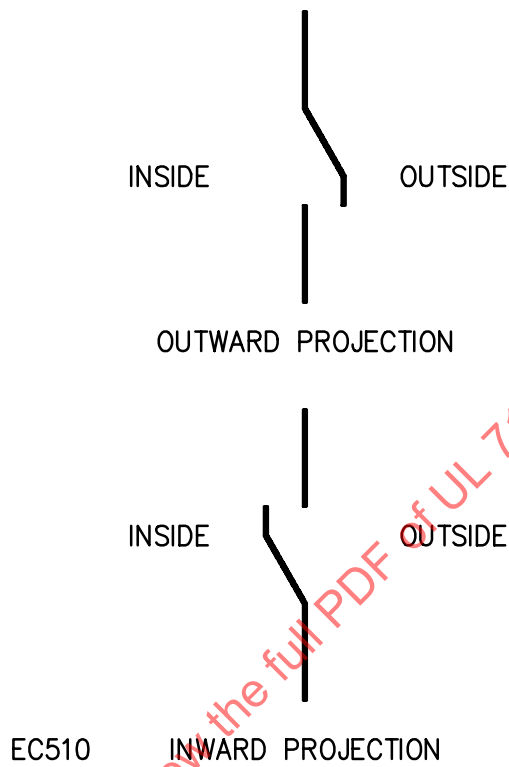
16.4.3 Openings in the top of the enclosure shall be constructed and sized to prevent entry of foreign objects.

16.4.4 To comply with the requirements in [16.4.3](#), openings directly over uninsulated live parts shall not exceed 475 mm (0.187 inch) in any dimension unless the configuration of the openings prevents direct access to uninsulated live parts. See [Figure 16.1](#) for examples of top cover designs.

Figure 16.1
Cross Sections of Top Cover Designs



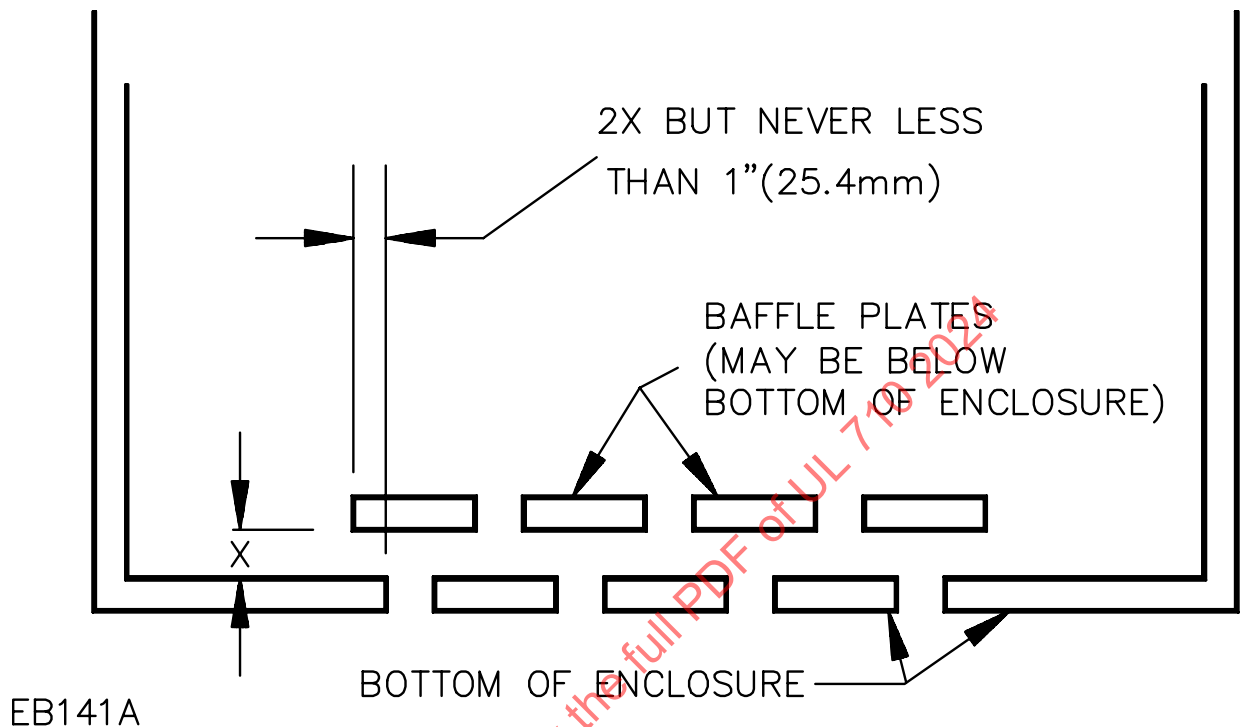
16.4.5 Openings in the sides of the enclosure shall be located and sized to prevent entry of a foreign object and to reduce the risk of personnel contacting internal parts. Louvers shall not be employed unless they are shaped to deflect external falling objects outward. See [Figure 16.2](#) for examples of louver designs.

Figure 16.2**Louvers**

16.4.6 The bottom of the enclosure under areas containing only materials classified as V-1 or better, as specified in UL 94, shall have openings not larger than 6.4 mm (1/4 inch) square. Openings that are not square shall not have an area greater than 2.56 mm² (1/16 inch²).

16.4.7 The bottom of the electrical enclosure ventilated as specified in [16.4.6](#) under areas containing materials not classified as V-1 or better shall be provided with a baffle as shown in [Figure 16.3](#).

Figure 16.3
Example of Baffle



16.4.8 All combustible plastic material used within an enclosure shall be classified as V-2, HF-2, or better, in accordance with UL 94.

Exception No. 1: Motors, relays, capacitors, semiconductors, transformers, switches, insulating tubing or tape, and other electrical elements that have been investigated for flammability.

Exception No. 2: Meter faces and cases (for mounting live parts) and indicator lamps or jewels, or both, are exempt from flammability requirements.

Exception No. 3: The following requirements apply to parts that are isolated either:

- a) By at least 12.5 mm (1/2 inch) of air; or
- b) By a solid barrier of V-1 or less flammable material from uninsulated electrical parts that involve a risk of electric shock.
 - 1) Gears, cams, belts, bearings, strain-relief bushings applied over PVC jacketed cords, and other small parts that contribute negligible fuel to a fire are not required to be investigated.
 - 2) Tubing for air or fluid systems, and foamed plastics, shall not be more flammable than HB. Foamed plastics classed HBF in accordance with UL 94, meet this requirement.

16.4.9 Openings in the enclosure shall not give access to any relays, terminals, controls, or related components that are subject to tampering.

16.4.10 An electrical enclosure intended for recessed mounting and whose front panel is to be flush with the surface of the wall shall have no openings that vent into concealed spaces of a building structure, such as into hollow spaces in the wall, when the product is mounted as intended.

16.4.11 The requirement in [16.4.10](#) does not apply to an opening for a mounting screw or nail or for a manufacturing operation (such as paint drainage) when:

- a) The opening does not have a dimension greater than 6.75 mm (17/64 inch) or an area greater than 35.5 mm² (0.055 inch²); and
- b) There is no more than one mounting screw hole for each 305 mm (12 inch) of length of mounting surface, or fraction thereof.

17 Field-Wiring Connections

17.1 General

17.1.1 Each product shall have provision for the connection of one of the applicable wiring systems in accordance with NFPA 70 in the United States and CSA C22.1, in Canada. A power supply cord shall not be provided.

17.1.2 The electrical enclosure of an exhaust hood shall be provided with wiring terminals or with leads not less than 152 mm (6 inch) long, for connection of field-wiring conductors. The terminals or leads shall be sized for connection as required by NFPA 70 in the United States and CSA C22.1 in Canada, corresponding to the marked rating of the product and the marked conductor type, such as AL and CU. See [54.9](#).

17.1.3 The location of an outlet box or compartment in which field wiring connections are to be made shall permit inspection of the connections after the product is installed as intended. The connections shall be accessible without removing parts other than service covers or panels and the cover of the outlet box or compartment in which the connections are to be made.

17.1.4 An outlet box or compartment in which field wiring connection is to be made shall comply with [16.1.3](#) and [16.1.4](#) with respect to its enclosure construction.

17.1.5 The outlet box or compartment to which field-wiring connections are made shall provide space for installation of the conductors of the number and size required by NFPA 70 in the United States and the CSA C22.1 in Canada when at least a 152 mm (6 inch) length of each conductor is brought into the wiring compartment.

17.1.6 A wire-binding screw shall not thread into material other than metal.

17.1.7 Field-wiring terminals shall be secured to their supporting surfaces by methods other than friction between surfaces so that they do not turn or shift in position when such motion results in reduction of spacings to less than the minimum required. This shall be accomplished by two screws or rivets; by square shoulders or mortices; by a dowel pin, lug, or offset; by a connecting strap or clip fitted into an adjacent part; or by some other equivalent method.

17.2 Grounding

17.2.1 An equipment-grounding terminal or lead shall be provided in a product intended for connection to the power supply by means other than a metal-enclosed wiring system, such as by nonmetallic-sheathed cable.

17.2.2 A field-wiring terminal intended solely for connection of an equipment grounding conductor shall be capable of securing a conductor of the size indicated in [Table 20.1](#) for the rating of the branch-circuit overcurrent protective device to which the product is connected. See [17.2.5](#).

17.2.3 The surface of an insulated lead intended solely for the connection of an equipment-grounding conductor shall be green with or without one or more yellow stripes and no other leads visible to the installer shall be so identified.

17.2.4 A wire-binding screw intended for the connection of an equipment-grounding conductor shall have a green colored head that is hexagonal-shaped, slotted, or both.

17.2.5 At a wire-binding screw, upturned lugs or the equivalent shall be provided to retain the conductor.

17.2.6 A pressure wire connector intended for connection of an equipment-grounding conductor shall be identified by being marked "G," "GR," "Ground," "Grounding," or the equivalent, or by a marking on a wiring diagram provided on the product. A pressure connector, when used adjacent to the connectors intended for the supply conductor, shall be additionally identified by a marking indicating "Equipment Ground," by a green color, or by both to avoid being mistaken for the neutral of a grounded supply.

17.2.7 The wire-binding screw or pressure wire connector described in [17.2.4](#) – [17.2.6](#) shall be located so that it is not removed during servicing of the product.

17.2.8 A field-wiring terminal intended for the connection of a grounded conductor shall be identified by means of a metallic plated coating that is substantially white in color and distinguishable from the other terminals, or by some other manner, such as on an attached wiring diagram.

17.2.9 A lead or terminal provided for connection of a grounded supply conductor shall be either:

- a) Finished in a white or gray color; or
- b) Have the word "WHITE" marked adjacent to the terminal. No other lead or terminal shall be so identified.

17.2.10 A field-wiring terminal or lead for connection to a grounded supply conductor shall not be electrically connected to a single-pole manual switching device that has an off position or to a single-pole overcurrent (not thermal) protective device.

18 Internal Wiring

18.1 General

18.1.1 The internal wiring of an exhaust hood shall be complete to the means provided for field-wiring connection.

18.1.2 Control equipment, including an auxiliary device supplied with the hood for field installation and is not part of the exhaust hood shall have provision for field-wiring connections in accordance with these requirements.

18.1.3 Wiring shall be enclosed in metal-clad cable, conduit, electrical metallic tubing, or metal raceways, control boxes, or the equivalent. Fittings shall comply with UL 514B and CSA C22.2 No. 18.3.

18.1.4 The internal wiring of an exhaust hood shall be installed within a liquid-tight metal raceway or conduit.

18.1.5 The internal wiring of an exhaust hood shall not be routed in or through the exhaust plenum (area of hood behind the filters or grease removal devices).

18.1.6 Wiring shall have insulation rated for the potential involved and the temperatures to which it is subjected. The temperature rating of the fixture wiring shall be at least that marked on the fixture.

18.1.7 Wiring shall be protected against mechanical damage, shall be supported and routed to reduce damage due to contact with a sharp edge, moving part, or hot part, and shall not be immersed in water.

18.1.8 Conductors used in hazardous voltage circuits and extra-low-voltage safety circuits shall be selected from [Table 18.1](#) in accordance with the circuit requirements for conductor size, voltage, and temperature rating.

Table 18.1
Typical Wiring Materials

Group	Type of wire, cord, or cable ^{a, b}	Wire size		Insulation thickness	
		mm ²	(AWG)	mm	(inch)
A	Thermoplastic or thermoset appliance wiring material, with insulation thicknesses shown at the right corresponding to wire sizes indicated; or Type TW; or Type ^d AC, ACT, FFH-2, TF, TFF, TFN, TFFN, SF-2, SFF-2, RH, RHH, RHW, THW, XHH, XHHW, MTW, THHN, THW-MTW, THWN, PF, PGF, PFF, PGFF; or Type ^c GTF, TW75, TEW, TR-32, R90, RW90, T90, SEW-1, SEW-2	5.3 to 0.41	(10 to 22)	0.8	(2/64)
		8.4	(8)	1.2	(3/64)
		13.3	(6)	1.6	(4/64)
		21.2	(4)	1.6	(4/64)
		26.7	(3)	1.6	(4/64)
		33.6	(2)	1.6	(4/64)
		42.4	(1)	2.0	(5/64)
		54.0	(1/0)	2.0	(5/64)
		67.0	(2/0)	2.0	(5/64)
		85.0	(3/0)	2/0	(5/64)
		107.2	(4/0)	2.0	(5/64)
B	Appliance wiring material having thermoplastic or thermoset insulation, with insulation thicknesses shown at right corresponding to the wire sizes indicated; or Type S, SJO, SJOO, SJT, SJTO, SJTOO, SO, SOO, SPT-3, ST, STO, STOO; or Type ^d SE, SJE, or Type ^c NMD90, NMWU	0.82	(18)	1.6	(4/64)
		1.3	(16)	1.6	(4/64)
		2.1	(14)	2.0	(5/64)
		3.3	(12)	2.0	(5/64)
		5.3	(10)	2.0	(5/64)
		8.4	(8)	2.4	(6/64)
		13.3	(6)	3.2	(8/64)
		21.2	(4)	3.6	(9/64)
		33.6	(2)	4.0	(10/64)
C	Appliance wiring material with cross-linked synthetic polymer insulation; or Type S, SJ; or Type ^d SP-3	Same as for Group B			

^a The designated cord or cable, or types of wire other than appliance wiring material, may be used without regard to the values specified in the Table.

^b Type CL wire may be used within a separate metal enclosure as leads of components.

^c Wire types included only in CSA C22.1.

^d Wire types included only in NFPA 70.

18.1.9 Wiring shall be enclosed in metal clad cable, conduit, electrical metallic tubing, or metal raceways, control boxes, or the equivalent. Appropriate fittings shall be used. Wiring of the types referenced in Groups B or C of [Table 18.1](#) may be employed in lieu of enclosed wiring, provided the requirements of [18.1.10](#) are met.

Exception: Wiring of the types in Group A of [Table 18.1](#) may be employed if secured and supported to prevent damage and the requirements of [18.1.10](#) are met.

18.1.10 Cords or appliance wiring material, used in the cabinet of equipment, shall be suitably enclosed so as to prevent damage to the wiring, ignition of combustible material, or emission of flame or molten metal through openings in the cabinet. Such wiring is suitably enclosed when the cabinet or compartment enclosing the wiring has:

a) No openings in the bottom, unless a U-shaped channel or trough is located beneath the wiring, and the wires do not project through the plane of the top of the channel or trough. A bottom closure is provided:

1) If the bottom opening is always intended to be connected to a supply or return indoor air duct; and the unit includes space heating means (electric heater, hot water, or steam heating coil); or

2) If the unit is intended only for nonresidential applications and is so marked, except those openings intended only for conduit or piping; or

3) If the bottom opening is provided with a finned coil construction at least two rows in depth and with at least 12 fins per 25.4 mm (1 in); or

4) If the bottom opening complies with Figure 23.1 and 23.4 of UL 1995; or

5) The bottom opening complies with the requirements of the tests specified in Appendix B of UL 1995;

b) No louvre or openings, other than duct openings, that will permit the probe (Figure 7.1), of UL 1995 when applied in a straight line, to contact wiring; and

c) No combustible material other than electrical insulation within the enclosure. Air filter may be employed within the enclosure.

Exception: The separation specified in (b) does not apply to wiring located above openings in the bottom enclosure of a unit for outdoor installation, provided that such openings comply with the requirements of Clause 20.10, of UL 1995.

18.2 Wiring methods

18.2.1 A splice or connection shall be mechanically secure and bonded electrically. A soldered connection shall be made mechanically secure before being soldered when breaking or loosening of the connection results in risk of fire or electric shock.

18.2.2 A splice shall be provided with insulation equivalent to that of the wires involved when the spacing between the splice and other metal parts is not permanent.

18.2.3 A splice shall be located, enclosed, and supported so that it is not subject to mechanical damage, flexing, motion, vibration due to air movement, or similar conditions.

19 Separation of Circuits

19.1 Unless provided with insulation rated for the highest voltage involved, insulated conductors of different internal wiring circuits, including wires in a junction box or compartment other than subdivided circuits or branch circuits of the same voltage and from the same feeder, shall be separated by barriers or shall be segregated; and shall also be separated or segregated from uninsulated live parts connected to a different circuit.

19.2 Segregation of insulated conductors shall be accomplished by clamping, routing, or an equivalent means that provides permanent separation.

19.3 The output of a transformer device supplying a low-voltage circuit as specified in [5.3](#) shall not be interconnected with the output of another such transformer device provided as a part of the product unless the voltage and current measurements at the output terminals of the interconnected devices are within the values for a single low-voltage transformer device.

19.4 Two or more transformer-supplied low-voltage circuits provided as a part of the product are to be treated as separate circuits. The circuits shall be segregated or separated by barriers in accordance with [19.1](#) and [19.2](#) and the output of each transformer shall be marked to indicate that the separation shall be maintained.

20 Bonding For Grounding

20.1 General

20.1.1 Each exposed noncurrent-carrying metal part that becomes energized shall be bonded to the point of connection of the field-equipment grounding terminal or lead, when required, and to the metal surrounding the knockout, hole or bushing provided for field power supply connections. See [20.1.2](#).

20.1.2 Uninsulated metal parts of cabinets, electrical enclosures, motor frames and mounting brackets, controller mounting brackets, capacitors, and other electrical components, interconnecting tubing and piping, valves, plumbing accessories, or similar materials, that come in contact with the user or by service personnel shall be bonded for grounding. See [7.5](#).

Exception: Metal parts as described below are not required to be bonded for grounding.

a) Adhesive-attached metal-foil labels, screws, handles, and similar materials, that are located on the outside of an enclosure or cabinet and isolated from electrical components or wiring by a grounded metal part.

b) Isolated metal parts, such as motor controller magnetic frames and armatures, small assembly screws, and similar materials, that are separated from wiring and uninsulated live parts.

c) A panel or cover that does not enclose an uninsulated live part when insulated parts and wiring are separated from the panel or cover.

d) A panel or a cover that is insulated from electrical components and wiring by an attached insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or similar material not less than 0.8 mm (1/32 inch) thick.

20.1.3 The bonding shall be by a positive means, such as by clamping, riveting, bolted or screwed connection, brazing, or welding.

20.1.4 The bonding connection shall penetrate nonconductive coatings, such as paint. A bolted or screwed connection that incorporates a star washer under the screwhead is capable of penetrating nonconductive coatings where required.

20.1.5 When a bonding means depends upon the threads of a screw, at least two full threads shall engage the metal.

20.1.6 Bonding around a resilient mount shall not depend on the clamping action of rubber or similar material.

Exception: A connection shall not depend upon the clamping action exerted by rubber or similar material unless it complies with the requirements in [20.1.9](#) under any degree of compression permitted by a variable clamping device and after exposure to the effects of oil, grease, moisture, and thermal degradation which occur in service.

20.1.7 A clamping device shall be arranged for reassembly in its intended position following disassembly or removal for maintenance purposes.

20.1.8 An equipment bonding jumper shall be used to connect the grounding terminal of a grounding-type receptacle to a grounded metal enclosure.

Exception: Where the metal enclosure is surface mounted, direct metal-to-metal contact between the device yoke and the metal enclosure shall be permitted to ground the receptacle to the metal enclosure. This exception shall not apply to cover-mounted receptacles unless the metal enclosure and cover combination provide satisfactory grounding continuity between the metal enclosure and the receptacle.

20.1.9 The adequacy of a bonding connection, such as a clamp, that is determined by examination, shall be established by subjecting a sample of the connection to:

- a) A short circuit test involving a fuse of the size required by the exhaust hood (see Short-Circuit Test, Section [50](#)); and
- b) An overcurrent test involving a current equal to twice the rating of the branch-circuit overcurrent device for a period of 2 minutes. None of the sample connection shall open as a result of the tests.

20.1.10 Metal-to-metal hinge bearing members for doors or covers are a means for bonding the door or cover for grounding when a multiple bearing pin type (piano-type) hinge is employed. This requirement does not allow the acceptance of hinges, bearings, and similar materials, for carrying current between interrelated fixed and moving parts.

20.2 Conductors

20.2.1 The size of a wire or strap conductor employed to bond an electrical enclosure or motor frame shall be based on the rating of the branch-circuit overcurrent protective device.

- a) The size of a wire conductor shall be in accordance with [Table 20.1](#).
- b) A conductor, such as a clamp or strap, used in place of a separate wire conductor as indicated in (a), shall not be used unless the minimum cross-sectional conducting area is equivalent to or greater than the applicable wire sizes indicated in [Table 20.1](#).

Exception No. 1: A smaller conductor shall not be used unless the bonding connection and conductor comply with [20.1.9](#).

Exception No. 2: A bonding conductor to an electrical component is not required to be larger than the size of the motor-circuit conductors or the size of the conductors supplying the component.

Table 20.1
Bonding Wire Conductor Size

Rating of overcurrent device Amperes	Size of bonding			
	Copper wire		Aluminum wire	
	mm ²	(AWG)	mm ²	(AWG)
15	2.1	(14)	3.3	(12)
20	3.3	(12)	5.3	(10)
30 – 60	5.3	(10)	8.4	(8)
100	8.4	(8)	13.3	(6)
200	13.3	(6)	21.2	(4)

NOTE – mm² or equivalent cross-sectional area.

20.2.2 When more than one size branch-circuit overcurrent protective device is involved, the size of the bonding conductor is to be based on the rating of the overcurrent protective device that is also intended to provide ground-fault protection for the component bonded by the conductor. For example, when a motor is individually protected by a branch-circuit overcurrent protective device smaller than other overcurrent protective devices used with the equipment, a bonding conductor for that motor is to be sized based on the overcurrent protective device that is also intended to provide ground-fault protection of the motor.

20.2.3 A bonding conductor shall be of material capable of being used as an electrical conductor. When of ferrous metal, it shall be protected against corrosion as specified in Protection Against Corrosion, Section [9](#).

20.2.4 A separate bonding conductor or strap shall be installed so that it is protected from mechanical damage. See [19.4](#).

20.2.5 A splice shall not be employed in a conductor used to bond an electrical enclosure, motor frame, or other electrical component.

21 Capacitors

21.1 Each motor starting and running capacitor shall be housed within an enclosure or container.

21.2 When the container of an electrolytic capacitor is constructed of metal, the container shall either be permanently insulated from dead metal parts by moisture resistant insulation not less than 0.8 mm (1/32 inch) thick or shall be separated from dead metal parts by spacings in accordance with [Table 26.1](#).

22 Overcurrent Protection

22.1 Each required overcurrent or overload protective device shall be wholly inaccessible from outside the exhaust hood without opening a door or cover, except that the operating handle of a circuit breaker, the reset button of a manually resettable motor protector, and similar parts shall project outside an enclosure.

22.2 Circuit breakers shall clearly indicate whether they are in the open "off" or closed "on" position. Where circuit breaker handles are operated vertically rather than rotationally or horizontally, the "up" position of the handle shall be the "on" position. Circuit breakers shall comply with UL 489, or CSA C22.2 No. 5.

22.3 A protective device integral with the motor that complies with UL 2111, or UL 1004-1 (and CSA C22.2 No. 77) and UL 1004-3 (and CSA C22.2 No. 77). An impedance-protected motor shall comply with UL 1004-1 and UL 1004-2. An electronically protected motor shall comply with UL 1004-1 and UL 1004-7 (and CSA C22.2 No. 77). When an impedance-protected motor is used, it shall not be installed in a compartment handling air for circulation through a duct unless smoke is not generated under any required test condition while the rotor of the motor is locked.

22.4 A fuse shall be used as a motor overload protective device when the motor is protected by the largest size fuse that is capable of being inserted in the fuseholder.

22.5 Fuseholders shall comply with UL 4248-5 or CSA C22.2 No. 4248-5.

22.6 Fuses shall comply with UL 248-1 and CSA C22.2 No. 248.1-00 and one of the following standards:

- a) UL 248-2 and CSA C22.2 No. 248.2 or;
- b) UL 248-3 and CSA C22.2 No. 248.3 or;
- c) UL 248-4 and CSA C22.2 No. 248.4 or;
- d) UL 248-5 and CSA C22.2 No. 248.5 or;
- e) UL 248-6 and CSA C22.2 No. 248.6 or;
- f) UL 248-7 and CSA C22.2 No. 248.7 or;
- g) UL 248-8 and CSA C22.2 No. 248.8 or;
- h) UL 248-9 and CSA C22.2 No. 248.9 or;
- i) UL 248-10 and CSA C22.2 No. 248.10 or;
- j) UL 248-11 and CSA C22.2 No. 248.11 or;
- k) UL 248-12 and CSA C22.2 No. 248.12 or;
- l) UL 248-13 and CSA C22.2 No. 248.13 or;
- m) UL 248-14 and CSA C22.2 No. 248.14 or;
- n) UL 248-15 and CSA C22.2 No. 248.15 or;
- o) UL 248-16 and CSA C22.2 No. 248.16.

23 Luminaires for Use Above Cooking Equipment

23.1 A luminaire incorporated in an exhaust hood shall comply with the requirements for luminaires for use above cooking equipment as specified in UL 1598 and CSA C22.2 No. 250.0.

23.2 The luminaire shall be mounted at a height above the cooking surface in accordance with the manufacturer's specifications and instructions.

23.3 The conductor used to connect the luminaire shall have insulation rated for temperature and voltage equal to or higher than that of the luminaire conductor or equal to or higher than the temperature attained in the temperature test, whichever is greater.

23.4 Multiple luminaire units shall be wired in parallel to a common field wiring junction box. The maximum ampacities or wattage of each light luminaire is to be added together and totaled to determine the correct wire gauge for the exhaust hood luminaires in accordance with [Table 23.1](#).

Table 23.1
Luminaire Wire Gauge

Wire gauge	Branch Circuit over-current device rating, amps	Amperes	Wattage at 120 vac
14	15	12	1440
12	20	16	2000
10	30	24	3000

24 Transformers

24.1 A power transformer shall have a secondary rating not less than the load controlled.

Exception: When the load controlled exceeds the marked rating, the transformer shall not exceed the maximum temperature during the performance tests.

24.2 A transformer that furnishes power to a low-voltage circuit shall be of the two-coil insulated type and comply with UL 5085-1 and CSA C22.2 No. 66.1, UL 5085-3 and CSA C22.2 No. 66.3.

24.3 A fuse provided in the secondary circuit of a Class 2 transformer shall be rated at not more than 5 amperes when the open circuit secondary potential of the transformer is 15 volts or less, nor more than 3.2 amperes when such potential is more than 15 volts.

25 Switches and Controllers

25.1 A switch or controller shall have a current, frequency, and voltage rating not less than that of the load that it controls when the blower is operated while connected to a supply circuit of rated voltage. The effects of the output waveform of motor speed controllers shall not impair the operation of the motor during all conditions of intended and unintended motor operation.

25.2 A switch subjected to a temperature higher than 65 °C (149 °F) is to be evaluated with respect to the temperature limitations of the materials employed.

25.3 A single pole switching device shall not be connected to the grounded conductor.

25.4 Switches and controllers shall clearly indicate whether they are in the open "off" or closed "on" position. Where these switch and controller handles are operated vertically rather than rotationally or horizontally, the up position of the handle shall be the "on" position.

Exception: Double pole switches.

25.5 A clock-operated switch, in which the switching contacts are actuated by a clock-work, by a gear-train, by electrically-wound spring motors, by electric clock-type motors, or by equivalent arrangements shall comply with:

- a) CSA C22.2 No. 177, and UL 917; or
- b) CSA E60730-1, CSA E730-2-7; and, UL 60730-1, UL 60730-2-7.

25.6 Enclosed and dead front switches shall comply with CSA C22.2 No. 4-04 and UL 98.

26 Electrical Spacings – High-Voltage Circuits

26.1 Except as noted in [26.3](#) – [26.6](#), the spacings between uninsulated live parts of opposite polarity and between an uninsulated live part and a dead metal part shall not be less than the values indicated in [Table 26.1](#).

Table 26.1
Minimum Spacings

Ratings		Minimum spacings					
Volt-amperes	Volts	Through air		Over surface		To enclosure ^b	
		mm	(inch)	mm	(inch)	mm	(inch)
0 – 2000	0 – 300 ^a	3.2	(1/8)	6.4	(1/4)	6.4	(1/4)
More than 2000	0 – 150	3.2	(1/8)	6.4	(1/4)	12.7	(1/2 ^c)
	151 – 300	6.4	(1/4)	9.5	(3/8)	12.7	(1/2 ^c)
	301 – 600	9.5	(3/8)	12.7	1/2 ^{b,c}	12.7	(1/2 ^c)

^a When over 300 volts, spacings in last line of table apply.

^b Includes fittings for conduit or metal-clad cable.

^c The spacings at wiring terminals of a motor shall be 6.4 mm (1/4 inch) for a motor rated 250 volts or less and 9.5 mm (3/8 inch) for a motor rated more than 250 volts.

26.2 The spacing resulting from the installation of an electrical component, including spacings to dead metal or enclosures, shall be those indicated in [Table 26.1](#).

26.3 The spacings between field wiring terminals of opposite polarity, or between a field wiring terminal and grounded metal, shall be not less than 6.4 mm (1/4 inch), except that when short-circuiting or grounding of such terminals does not result from projecting strands of wire, the spacing through air is not required to be greater than 3.2 mm (1/8 inch). Measurements are to be made for solid wire of adequate ampacity for the load connected to each terminal.

26.4 The through air and over surface spacings at an individual component part are to be judged based on the volt-amperes used and controlled by the individual component. However, the spacing from one component to another, and from any component to the enclosure or to other uninsulated dead metal parts excluding the component mounting surface, are to be evaluated based on the component with the highest maximum voltage rating; and the total volt-ampere rating of both components.

26.5 The spacing requirements in [Table 26.1](#) do not apply to the inherent spacings inside a motor, except at wiring terminals, or to the inherent spacings of a component provided as part of the exhaust hood. Such spacings are judged based on requirements for the component.

26.6 An insulating liner or barrier of vulcanized fiber, varnished cloth, mica, phenolic composition, or similar material employed in lieu of spacings, shall be not less than 0.71 mm (0.028 inch) in thickness, except that a liner or barrier not less than 0.33 mm (0.013 inch) in thickness shall be used in conjunction with an air spacing of not less than one-half of the through air spacing required. Material having a lesser thickness shall be used when it has equivalent insulating, mechanical, and flammability properties.

26.7 For an enclosure not provided with a conduit opening or knockout, spacings not less than the minimum specified in [26.1](#) – [26.6](#), and Electrical Spacing Low-Voltage Circuits, Section [27](#) shall be provided between uninsulated live parts and a conduit bushing installed at any location used during

installation. Permanent marking on the enclosure, a template, or a full-scale drawing furnished with the product shall be used to indicate such locations.

26.8 In measuring a spacing between an uninsulated live part and a bushing installed in the knockout referred to in [26.7](#), it is to be assumed that a bushing having the dimensions indicated in [Table 26.2](#) is in place, in conjunction with a single locknut installed on the outside of the enclosure.

Table 26.2
Dimensions of Bushings

Trade size of conduit		Bushing dimensions			
		Overall diameter		Height	
mm OD	(Inch)	mm	(Inch)	mm	(Inch)
21.3	(1/2)	25.4	(1)	9.5	(3/8)
26.7	(3/4)	31.4	(1-15/64)	10.7	(27/64)
33.4	(1)	40.5	(1-19/32)	13.1	(33/64)
42.2	(1-1/4)	49.2	(1-15/16)	14.3	(9/16)
48.3	(1-1/2)	56.0	(2-13/64)	15.1	(19/32)
60.3	(2)	68.7	(2-45/64)	15.9	(5/8)
73.0	(2-1/2)	81.8	(3-7/32)	19.1	(3/4)
88.9	(3)	98.4	(3-7/8)	20.6	(13/16)
101.6	(3-1/2)	112.7	(4-7/16)	23.8	(15/16)
114.3	(4)	126.2	(4-31/32)	25.4	(1)
141.3	(5)	158.0	(6-7/32)	30.2	(1-3/16)
168.3	(6)	183.4	(7-7/32)	31.8	(1-1/4)

27 Electrical Spacing – Low-Voltage Circuits

27.1 The spacing for electrical components that are installed in a low-voltage circuit (see [5.3](#)) that includes a temperature limiting device, motor overload protective device, or other protective device, and where a short or grounded circuit results in a risk of fire or electric shock, shall comply with the requirements in [Table 27.1](#).

Table 27.1
Minimum Spacings in Low-Voltage Circuits

Components	Minimum spacing
Between uninsulated live parts, regardless of polarity, and between an uninsulated live part and a dead metal part, other than the enclosure, which is to be grounded when the product is installed.	0.8 mm (1/32 inch), when the construction of the parts is such that the spacing is maintained
Between an uninsulated live part and the wall of a metal enclosure including fittings for the connection of conduit or metal-clad-cable.	3.2 mm (1/8 inch)
Between wiring terminals, regardless of polarity, and between the wiring terminal and a dead metal part, including the enclosure and fittings for the connection of conduit, that are to be grounded when the device is installed.	6.4 mm (1/4 inch)

28 Exhaust Hoods with Integral Power Ventilators

- 28.1 Power ventilators integral to the hood used to remove exhaust air shall comply with the requirements in UL 705, in the United States, and ULC-S645, in Canada, including the applicable requirements for restaurant exhaust applications.
- 28.2 Power ventilators integral to the hood are considered to comply with the requirements in [28.1](#) when complying with the following:
- a) Power ventilator complies with UL 705 and ULC-S645,
 - b) An open type motor shall not be exposed to grease-laden air, and
 - c) The entire unit complies with all the tests in Sections [35](#) – [41](#) of this Standard.

PERFORMANCE

29 General

29.1 Exhaust hoods shall be subjected to the tests described in Sections [35](#) – [41](#) (the Temperature, Cooking Smoke and Flare-Up, Abnormal Flare-Up, Fan-Failure, Fire, and Burnout Tests, respectively) and in accordance with the test matrix shown below in [Table 29.1](#).

Table 29.1
Test Matrix for Sections [35](#) to [41](#)

Hood/damper description	Temperature	Cooking smoke & flare up	Abnormal flare up	Fan-failure	Fire test	Burnout
Section	35	36	37	38	39	41
Hoods with Exhaust Dampers with or without Electrical Features						
Shortest	x	x	x	x	x	x
Longest		x	x		x	
Hoods without Exhaust Dampers with Electrical Features						
Shortest	x	x	x	x		
Longest		x				
Hoods without Exhaust Dampers without Electrical Features						
Shortest	x	x				
Longest		x				

- 29.2 If the vertical distance from the appliance surface to the grease removal device is less than the applicable installation specification in NFPA 96 in the chapter on "Grease Removal Devices in Hoods" the exhaust hood shall be subjected to the fire tests described in Sections [37](#) and [38](#).
- 29.3 Exhaust hoods with a minimum distance between the grease removal device and the cooking surface less than 0.46 m (18 inch) shall be subjected to the Burnout Test in Section [41](#) in addition to tests of [29.2](#). The hood used shall be marked denoting the grease removal device (s) allowed in accordance with [56.1](#).

29.4 Exhaust hoods without exhaust dampers incorporating continuous liquid-tight welded construction and no electrical components other than lighting fixtures that comply with the requirements in Luminaires for Use Above Cooking Equipment, Section 23 shall be subjected to the tests described in Sections 35 and 36. Exhaust hoods without exhaust dampers incorporating continuous liquid-tight welded construction and electrical components shall be subjected to the tests described in Sections 35 – 38. Exhaust hoods without exhaust dampers that have seams and joints constructed of other than a liquid-tight continuous weld shall be subjected to the tests described in Sections 35 – 41. See Exception No. 1 to 6.9.

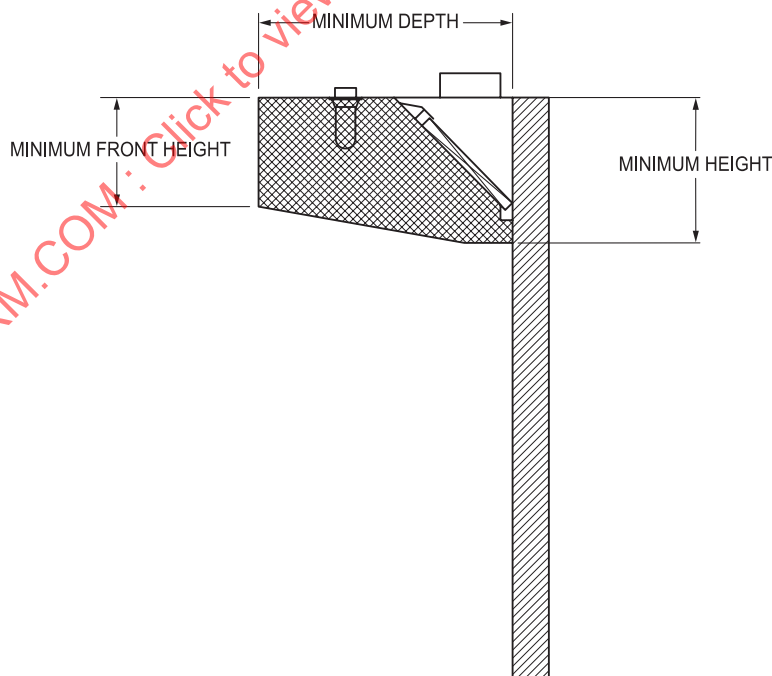
29.5 All exhaust hoods that utilize a water wash system shall be subjected to the applicable tests described in 29.1 or 29.4 with no water supply, as well as the Pressure Test, Section 42.

29.6 All exhaust hoods intended for installation adjacent to combustible building construction and labeled for installation clearances of less than 18 inches from combustible surfaces shall be installed as indicated in 31.11 and tested as described in Sections 35 – 41. Temperatures are to be measured on nearby surfaces, on the supporting surface, at points of support, and at other points as required.

30 Sample Selection

30.1 Exhaust hood lengths as specified in Table 29.1 for representative styles of exhaust hoods are to be tested. The samples shall be constructed in the minimum depth and height to represent the minimum internal canopy cross-section that the hood is manufactured. See Figure 30.1.

Figure 30.1
Minimum Cross Section



su0830

30.2 The shortest length exhaust hood investigated to Sections 35 and 36 may be used to evaluate electrical construction, non-continuously welded seams, access doors and through penetration devices.

30.3 Exhaust hoods having more than one exhaust collar shall be tested with the minimum and maximum hood lengths intended to be served by one exhaust collar.

30.4 The exhaust duct shall be located at the maximum offset distance from the center of the hood where the manufacturer intends to locate the exhaust duct in the field, opposite the test cooking equipment.

30.5 An exhaust hood supplied with a single supply duct shall have it located at maximum offset distance from the center of the hood where the manufacturer intends to locate the exhaust duct in the field, opposite the cooking equipment.

30.6 An exhaust hood supplied with two or more supply ducts shall have them located at the maximum equidistant locations manufactured along the entire hood length.

30.7 When the exhaust hoods are specified in the accompanying installation instructions for installation against combustible or limited combustible walls using standoffs, the test sample shall have the standoff in place during testing.

30.8 Exhaust hoods that are intended to use grease removal devices investigated to UL 1046 and ULC-S649 shall be tested using the tallest grease filters offered by the manufacturer for that hood and shall be tested using standard low pressure drop baffle filters that comply with UL 1046 and ULC-S649.

Exception: Exhaust hoods that require proprietary grease filters shall use the proprietary filter specified for use with the hood.

30.9 On hoods supplied with adjustable volume grease removal devices, the grease removal devices shall be adjusted as specified in accompanying installation instructions and/or markings for optimum performance. For hoods designed to have specified lengths of the hood operate at different air flow volumes, each specified length may use adjustable volume grease removal devices as specified in the accompanying installation instructions and/or markings.

30.10 Hoods intended to be supplied with filter blankoffs to adjust airflow rates along the length of the hood shall have the blankoffs installed during the testing.

31 Test Installation

31.1 The samples are to be installed in accordance with the manufacturer's instructions in a room that complies with the requirements described in [31.2](#) through [31.7](#).

31.2 The test room in which exhaust hoods are tested shall be free of drafts except for replacement (make-up) air directed into the room.

31.3 The room shall not develop a negative pressure in excess of 0.005 kPa water (0.02 inch). Replacement air shall be supplied to ensure that a negative pressure in excess of 0.005 kPa water (0.02 inch) water is not developed. The air is to be introduced into the room in a manner that does not significantly affect the exhaust hood's performance as determined by visual observation.

NOTE: It has been found that front face discharge plenums do not significantly affect the hood's performance.

31.4 For the tests described in the Cooking Smoke and Flare-Up Test in Section [36](#) the room temperature is to be maintained between 10 – 40 °C (50 – 104 °F).

31.5 For the tests described in Section 36 the temperature of replacement supply air brought in through integral or perimeter makeup air plenums shall be maintained within 8 °C (15 °F) of the initial room temperature during the test.

31.6 For the Temperature Test in Section 35 and the Abnormal Flare-Up, Fan-Failure, Fire, and Burnout Tests in Sections 37 – 41, the room temperature is to be maintained between 10 – 40 °C (50 – 104 °F).

31.7 The size of the room or building is to be at least 2.4 m (8 feet) high and have a floor space of at least three times the area of the exhaust hood being tested and meet the criteria for minimum clearances to back, front, and side walls as shown in Table 31.1.

Table 31.1
Minimum Clearances from the Test Hood

Hood style	Min. back clearance	Min. front clearance	Min. side clearance (left & right) ^a
Wall Canopy	0	1524 mm (60 inch)	610 mm (24 inch)
Single Island (V-bank or canopy)	610 mm (24 inch)	1524 mm (60 inch)	610 mm (24 inch)
Backshelf/Proximity/Passover	0	1524 mm (60 inch)	610 mm (24 inch)
^a If full side skirts are below the cooking surface, the hood will be exempt from the clearances in Table 31.1 for the side(s) with the skirt(s).			

31.8 Exhaust hoods with exhaust dampers shall be provided with an observation window located in the test sample's exhaust collar or the exhaust duct to permit the observation of flames within the collar. The bottom of the window is to be located no farther than 152 mm (6 inch) above the horizontal plane of the dampers.

31.9 The exhaust rates for the tests shall be provided by a power ventilator, either internal or connected by an exhaust duct.

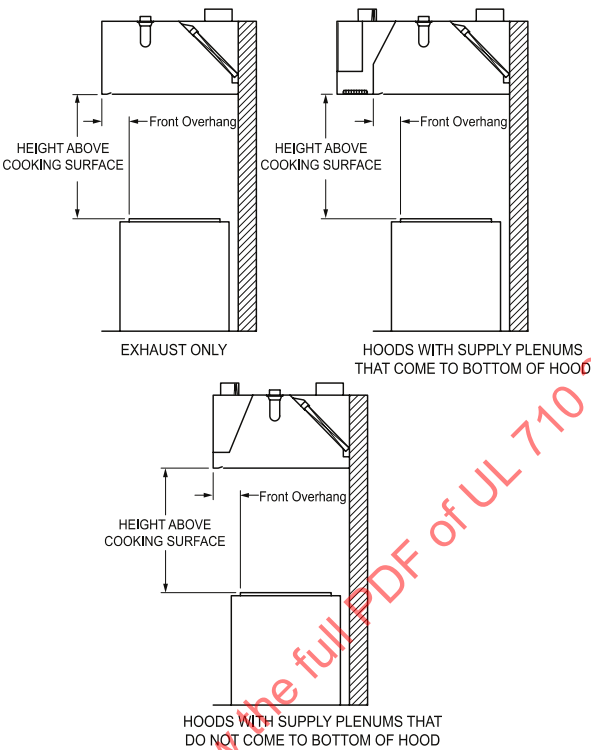
31.10 The exhaust and supply air flow values are to be adjusted to produce the rated air flow through the exhaust hood determined in Section 36. Air flow is to be measured in the exhaust and supply ducts not less than three equivalent duct diameters upstream or downstream from any elbows, bends, or fans. A minimum of nine measurements at one plane in the duct shall be averaged to determine the air flow rate. The measurements shall be made with a calibrated velometer, thermal anemometer, or other equivalently accurate device. The measurements are to be made at multiple locations within the duct, symmetrically located in the same locations as the thermocouples shown in Figure 32.2. The measurements are to be made with the cooking appliance removed from beneath the exhaust hood or in the unheated state.

31.11 Exhaust hoods intended for use adjacent to combustible construction and labeled for clearances of less than 0.46 m (18 inch) from combustible surfaces shall be mounted at the minimum specified clearances in an alcove consisting of a rear wall, side wall and/or ceiling extending a minimum of 0.61 m (24 inch) beyond the hood and constructed of minimum 9.5 mm (3/8-inch) (trade size) thick plywood. The surfaces facing the hood and other surfaces exposed to the appliance are to be painted flat black.

31.12 The cooking appliance used during the tests shall comply with the requirements specified in 33.1 – 33.11.

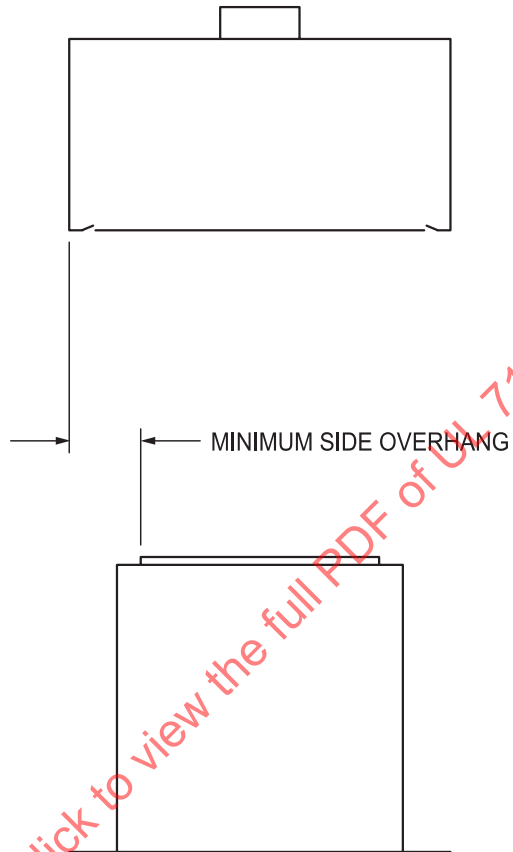
31.13 The exhaust hood shall be installed at the minimum specified horizontal overhang between the exhaust hood's sides and front panels, and the cooking surface for the tests described in Sections 35 – 41. (See Figure 31.1 and Figure 31.2)

Figure 31.1
Front Overhang Measurement



su0831a

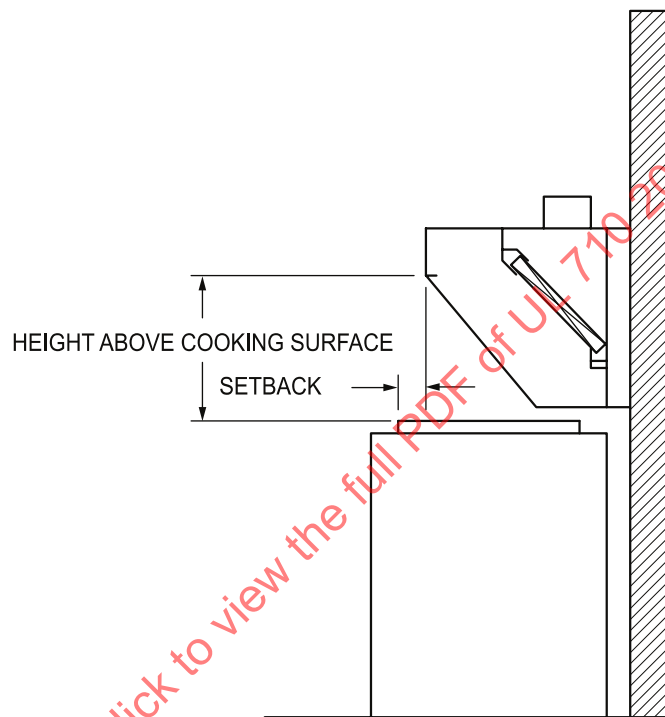
Figure 31.2
Side Overhang Measurement



su0832

31.14 Exhaust hoods intended for installations with the front edge of cooking appliance extending horizontally outside the front edge of the exhaust hood shall be tested with the cooking surface at the maximum specified distance from the front of the exhaust hood for the tests described in Sections [35](#) – [41](#). (See [Figure 31.3](#))

Figure 31.3
Backshelf Hood Setback



31.15 The exhaust hood shall be installed at the maximum specified vertical distance between the cooking surface and front lower edge of the exhaust hood for the Cooking Smoke and Flare-Up Test, Section [36](#).

31.16 The cooking appliance is to be installed at the minimum specified vertical clearance between the front lower edge of the exhaust hood and the cooking surface for the tests described in Sections [35](#) and [37](#) – [41](#).

31.17 The grease used in the tests described in Sections [36](#) – [41](#) is to be vegetable oil.

32 Instrumentation

32.1 Temperatures shall be measured by thermocouples except that the change-of-resistance method shall be used to measure the temperature of motor windings or of coils.

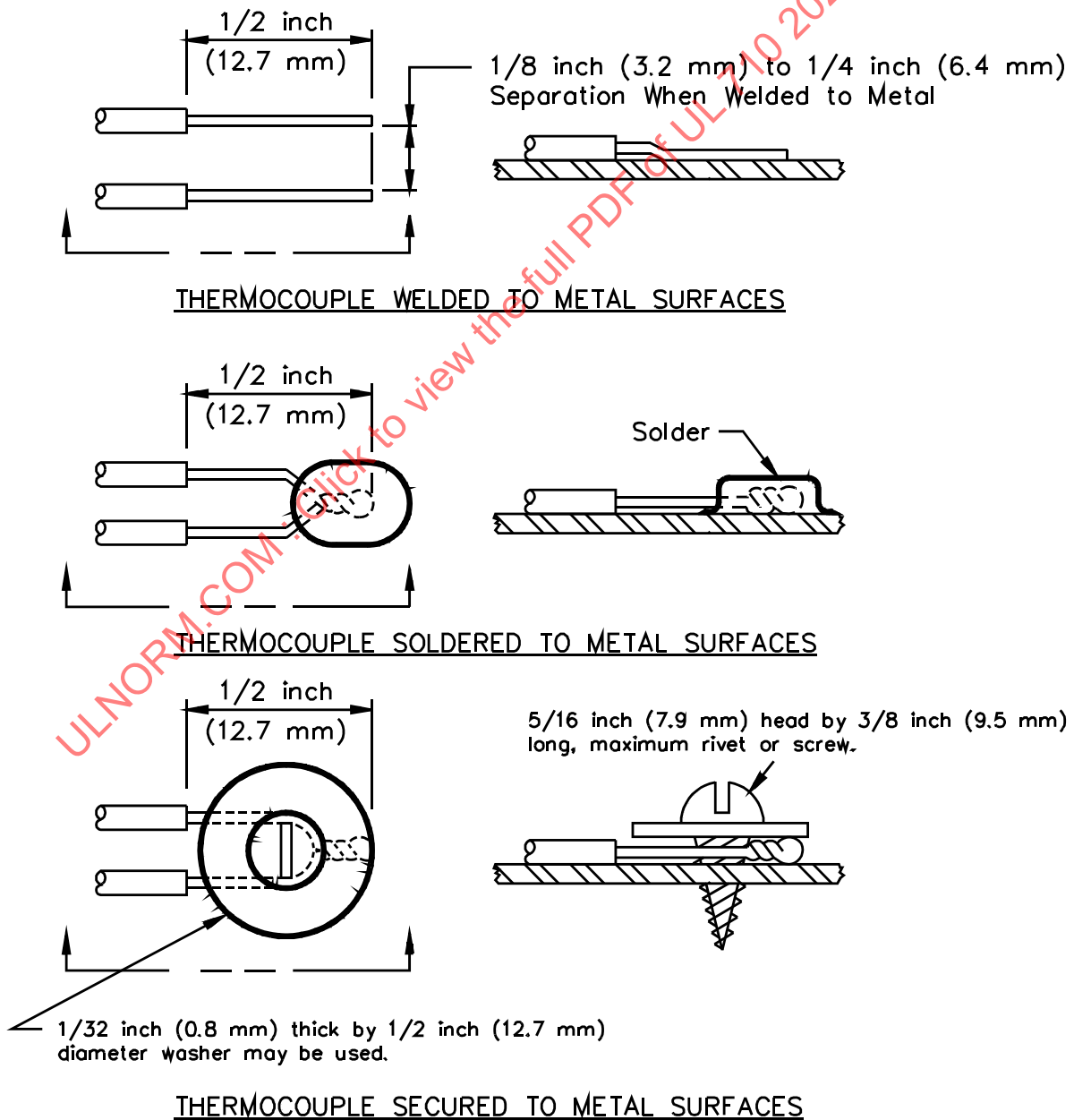
32.2 Thermocouples used in the determination of temperatures in connection with the heating of electrical equipment are to consist of wires not larger than 0.21 mm² (24 AWG) and not smaller than 0.05 mm² (30 AWG). When referee temperature measurements by means of thermocouples are required, thermocouples consisting of Type J (iron constantan wires) or Type K (chromel alumel wires) and a calibrated potentiometer type of indicating instrument are to be used. The thermocouple wire is to conform

to the requirements specified in the Tolerances on Initial Values of EMF versus Temperature tables in ASTM E230/E230M.

32.3 A 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. Taping or cementing the thermocouple to the surface provides thermal contact with the surface; and where a metal surface is involved, brazing, or soldering the thermocouple to the metal is required. See [Figure 31.1](#). Thermocouples are to be secured to wood surfaces by staples over insulated portions of the wire and the tip of the thermocouple is to be held in thermal contact with the surface by pressure-sensitive tape.

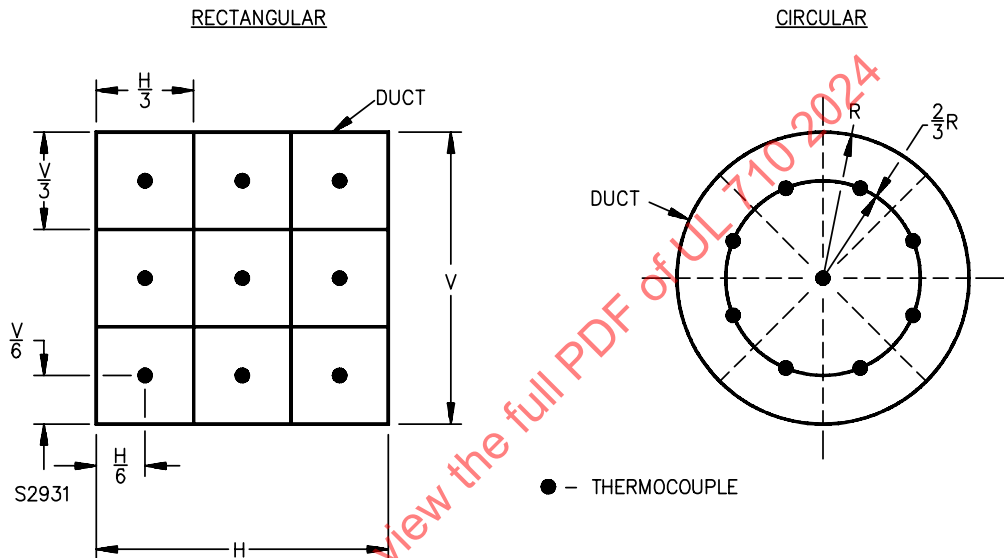
Figure 32.1

Thermocouple Installation Methods on Metal Surfaces



32.4 The exit gas temperature is to be measured in exhaust hoods with exhaust dampers using a grid of thermocouples of identical length wired in parallel. The thermocouple grid is to be in a plane perpendicular to the axis of air flow and within 152 mm (6 inch) downstream of the collar provided on the exhaust hood for attachment of duct work. The test collar in which the thermocouple grid is located is to be the same size as the collar of the exhaust hood and the cross section of the test collar is to be divided into equal areas with thermocouples located as illustrated in [Figure 32.2](#).

Figure 32.2
Thermocouple Location in Test Duct



Rectangular – Rectangular duct divided into nine equal areas as illustrated with a thermocouple located in the center of each of the resulting nine areas.

Circular – Circular duct divided radially into eight equal areas with thermocouples located as illustrated in each of the eight areas and at the center of the duct.

32.5 Room temperature is to be measured by a thermocouple centered 1.2 m (4 feet) in front of and at the same elevation as the top surface of the cooking appliance located centrally within a vertically oriented 152 mm (6 inch) length of 51 mm (2 inch) aluminum-foil-covered pipe that is open at both ends.

32.6 Thermocouples are to be secured to wood surfaces by staples placed over the insulated portion of the wires. The thermocouple tip is to be depressed into the wood to be flush with the wood surface at the point of measurement and held in thermal contact with the surface at that point by pressure-sensitive paper tape.

32.7 For test alcove elements in contact with hood parts or supports, junctions of thermocouples are to be placed on the hood part surfaces, except that at a point or line contact of a spacer not over 3.2 mm (1/8 inch) diameter, or width, thermocouples are to be placed on the test alcove at points 12.7 mm (1/2 inch) from the centerline of such point or line contact and secured to the wood surfaces according to [32.6](#).

33 Cooking Appliances

33.1 Cooking appliances used during the testing of exhaust hoods in the Temperature Test, Section 35 shall be of the commercial type and shall be representative of the highest duty rating being applied for as specified in Table 33.1.

Exception: Exhaust hoods shall be evaluated for use with a specific appliance only as described in 33.10.

NOTE: The exhaust rates from higher duty cooking equipment testing may be applied to lower duty cooking equipment ratings if the manufacturer chooses not to test all appliance duties.

**Table 33.1
Cooking Appliances**

Appliance duty	Test appliance	Minimum nominal cooking surface size square meter, m ² (square inch, inch ²)	Minimum rated input	Minimum average cooking surface temperature °C (°F)
Extra-heavy	Solid fuel charcoal broiler or gas char-broiler	0.348 (540)	25 lbs charcoal briquettes or 60,000 BTUH	357 (700)
Heavy	Gas char-broiler	0.348 (540)	60,000 BTUH	301 (600)
Medium	Electric griddle	0.348 (540)	8 kW, Ø	190 (400)
Light	Electric range boiling water	305 mm. (12 inch) dia by 203 mm (8 inch) high; Min. 76 mm (3 inch) water depth	2.0 kW	100 (212)

33.2 Cooking appliances used during the testing of exhaust hoods in the Cooking Smoke and Flare-Up Test, Section 36, shall be of the commercial type and shall be representative of the specific duty rating being applied for as specified in Table 33.1.

Exception: Exhaust hoods shall be evaluated for use with a specific appliance only as described in 33.10.

33.3 The cooking appliance used during the Abnormal Flare-Up, Fan-Failure, Fire, Abnormal Water Supply, and Burnout Tests described in Sections 37 – 41, respectively, shall be of commercial type and shall be the gas char broiler or the solid fuel char broiler specified in Table 33.1.

33.4 The light duty cooking appliance shall be an electric range boiling water on a single burner. The pot shall be a stainless-steel pot matching the cooking surface dimensions in Table 33.1. The edges of the pot shall be at the minimum specified horizontal overhang between the exhaust hood's sides and front panels.

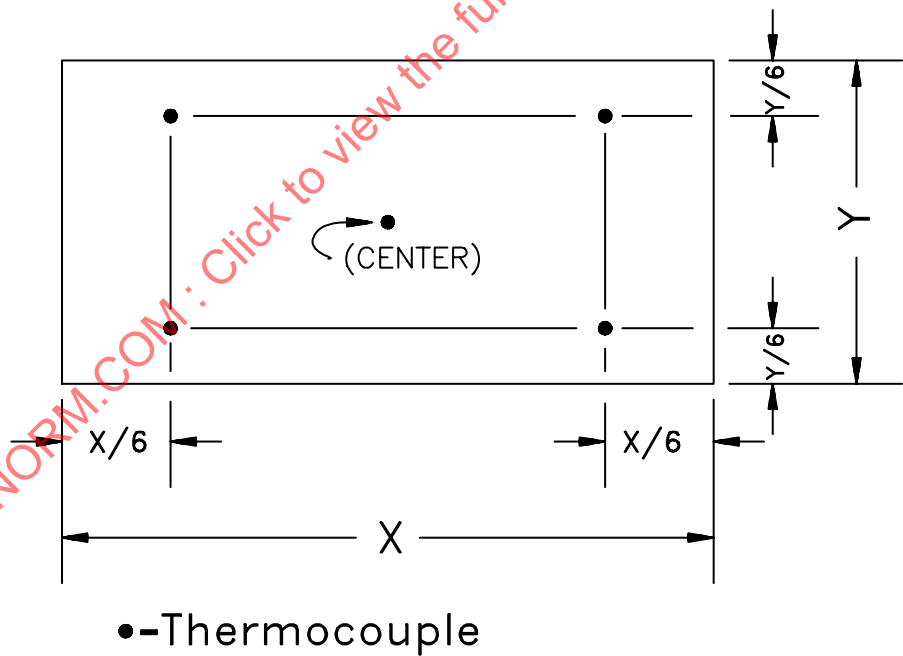
33.5 The medium-duty appliance shall be an electric griddle representative of the rating specified in Table 33.1.

33.6 The heavy-duty appliance shall be a gas underfired char broiler representative of the rating specified in Table 33.1.

33.7 The extra heavy-duty appliance shall be a solid-fuel or gas broiler representative of the rating specified in Table 33.1. The broiler shall be a commercially available broiler, or a charcoal broiler constructed to simulate a commercially available broiler. The solid-fuel charcoal broiler shall include a drip pan or equivalent solid bottom surface.

- 33.8 Regarding [33.7](#) for solid-fuel appliances, the fuel grate is then to be loaded with a minimum of 25 lbs of charcoal briquettes. The charcoal briquettes shall be evenly spread to a depth of not less than two layers.
- 33.9 Regarding [33.7](#) for solid-fuel appliances, the charcoal briquettes are to be heated until they are covered with ash prior to proceeding with testing. Lighter fuel, electric heaters, or self-lighting briquettes shall be permitted.
- 33.10 The performance testing for exhaust hoods shall be conducted using cooking appliances other than those specified in [Table 33.1](#) and products other than that specified in [36.7](#) – [36.8](#) when the exhaust hood is marked for use with that specific appliance(s) and product(s) only as specified in [54.1](#)(h). The cooking surface temperature used shall be the maximum temperature the appliance can produce, unless otherwise marked on the hood.
- 33.11 The temperature measurements of the cooking surfaces are to be made using thermocouples of the type specified in [32.2](#). The temperature at a minimum of five locations on the top of the cooking surface shall be measured to determine an average temperature. The thermocouples are to be securely held in thermal contact with the cooking surface as described in [32.3](#) and located as shown in [Figure 33.1](#).

Figure 33.1
Thermocouple Locations on Cooking Appliance Surface



S3540

34 Thermostat Calibration Test

34.1 Prior to conducting the other tests described in this Standard, each thermostat used in an exhaust hood to detect heat or fire is to be tested as specified in [34.2](#) – [34.5](#). Following all other tests described in this Standard, the thermostat is again to be tested in the oil bath to determine its operating temperature. Upon completion of the tests described in Sections [35](#) – [41](#), the operating temperature of a thermostat shall be within 2 % of the value determined prior to the tests conducted in Sections [35](#) – [41](#).

34.2 The thermostat is to be placed in an upright position and the temperature sensing element immersed in an oil bath. The vessel is to be provided with a source for heating the oil at the rate specified in [34.5](#) and with means to agitate the oil and measure the temperature of the oil bath.

34.3 Agitation is to be used as an aid in obtaining uniformity in temperature of the oil in the bath.

34.4 A mercury thermometer of laboratory quality or a 24 – 30 AWG Type J or K thermocouple is to be used to determine temperatures of the oil employed in the bath test. The point of measurement in the oil is to be level with the center of the temperature sensing element.

34.5 The temperature of the oil bath is to be raised at a convenient rate until the oil is within 11.1 °C (20 °F) of the temperature rating of the device. The rate of temperature rise is then to be controlled at a rate not exceeding 1/2 °C (1 °F) per minute until the thermostat operates. The temperature of the oil at the time of thermostat operation is to be recorded.

35 Temperature Test

35.1 When tested as specified in [35.3](#) – [35.5](#), the maximum temperature rise attained by an exhaust hood part during the temperature test shall not be more than the applicable values indicated in Column 1 of [Table 35.1](#). All values for temperature rise specified in [Table 35.1](#) apply to equipment intended for use at ambient temperatures normally prevailing in occupiable spaces, which usually are maintained between 25 °C (77 °F) and 40 °C (104 °F) for brief periods. Tests of equipment for service with such ambient temperatures is to be conducted, without correction, at any ambient temperature in the range of 10 – 40 °C (50 – 104 °F).

35.2 For exhaust hoods intended for use adjacent to combustible construction as described in [29.6](#), when tested as specified in [35.5](#), the surface temperature of the combustible construction shall not exceed 65 °C (117 °F) above ambient.

35.3 The exhaust air flow is to be adjusted to produce the minimum air flow through the exhaust hood specified by the manufacturer. The exhaust air flow is to be measured as described in [31.10](#) with the cooking appliance in the unheated state or removed from beneath the hood.

35.4 The supply air blower for the hood (when provided) shall be off.

35.5 The cooking appliance specified in [33.1](#) – [33.11](#) is to be energized to produce the intended surface temperature. The test is to be continued until equilibrium temperatures are attained on all components and parts of the assembly. A temperature is at equilibrium when three successive readings taken at 10-minute intervals indicate a fluctuation of not more than 3 °F or shows a decrease.

Table 35.1
Maximum Temperature Rises

Device or material	Column 1		Column 2	
	°C	(°F)	°C	(°F)
A. Motor ^{a,b} 1. Insulation systems on coil windings of alternating-current motors having a frame diameter of 7 inches (178 mm) or less (not including universal motors). a. Class A insulation systems				

Table 35.1 Continued on Next Page

Table 35.1 Continued

Device or material	Column 1		Column 2	
	°C	(°F)	°C	(°F)
1. In open motors – Thermocouple or resistance method	75	(135)	115	(207)
2. In totally enclosed motors – Thermocouple or resistance method	80	(144)	115	(207)
b. Class B insulation systems				
1. In open motors – Thermocouple or resistance method	95	(171)	140	(252)
2. In totally enclosed motors – Thermocouple or resistance method	100	(180)	140	(252)
2. Insulation systems on coil windings of alternating-current motors having a frame diameter of more than 7 inches (178 mm) and of direct-current motors and universal motors.				
a. Class A insulation				
1. In open motors –				
Thermocouple method	65	(117)	115	(207)
Resistance method	75	(135)	115	(207)
2. In totally enclosed motors –				
Thermocouple method	70	(126)	115	(207)
Resistance method	80	(144)	115	(207)
b. Class B insulation systems				
1. In open motors –				
Thermocouple method	85	(153)	140	(252)
Resistance method	95	(171)	140	(252)
2. In totally enclosed motors –				
Thermocouple method	90	(162)	140	(252)
Resistance method	100	(180)	140	(252)
B. Components				
1. Capacitors				
Electrolytic type ^c	40	(72)	(Not specified)	
Other types ^d	65	(117)		
2. Field Wiring	35	(63)	60	(108)
3. Relay, solenoid, and other coils (Thermocouple method): ^b				
a. Class 105 insulated winding	65	(117)	115	(207)
b. Class 130 insulated winding	85	(153)	140	(252)
4. Sealing compounds		40 °C (104 °F) less than melting point		
5. Transformer enclosures ^b				
a. Class 2 transformers	60	(108)	85	(153)
b. Power and ignition transformers	65	(117)	90	(162)
C. Insulated Conductors ^e				

Table 35.1 Continued

Device or material	Column 1		Column 2	
	°C	(°F)	°C	(°F)
1. Appliance wiring material				
75 °C (167 °F) rating	50	(90)	65	(117)
80 °C (176 °F) rating	55	(99)	70	(126)
90 °C (194 °F) rating	65	(117)	80	(144)
105 °C (221 °F) rating	80	(144)	95	(171)
200 °C (392 °F) rating	175	(315)	200	(360)
250 °C (482 °F) rating	225	(405)	250	(450)
2. Flexible cord— Types SJO, SJT, SO, ST	35	(63)	60	(108)
3. GTO cable	35	(63)	60	(108)
4. Wire, Code				
Types RF, FF, RUW	35	(63)	60	(108)
Types RH, RFH, FFH, RHW, THW, THWN	50	(90)	75	(135)
Types TF, TFF, TW	35	(63)	60	(108)
Types TA	65	(117)	90	(162)
5. Other types of insulated wires	See note f			
D. Electrical Insulation – General ^e				
1. Fiber used as a electrical insulation or cord bushings	65	(117)	90	(162)
2. Phenolic composition used as electrical insulation or as parts where failure results in a hazardous condition.	125	(225)	150	(270)
3. Varnished cloth insulation	60	(108)	85	(153)
4. Other material	25 °C (77 °F) less than its temperature rating			
E. Metals ^g				
1. Aluminum Alloys				
a. 1100	183	(330)	239	(430)
b. 3003	239	(430)	294	(530)
c. 2014, 2017, 2024, 5052	294	(530)	350	(630)
2. Aluminum-Coated Steel ^h	572	(1030)	708	(1275)
3. Carbon Sheet Steel and Cast Iron	461	(830)	517	(930)
4. Carbon Steel-Coated with Type A19 Ceramic	572	(1030)	628	(1130)
5. Galvanized Steel ⁱ	267	(480)	350	(630)
6. Stainless Steel				
Types 302, 303, 304, 321, 347	686	(1235)	767	(1380)
Types 309S	867	(1560)	950	(1710)
Types 310, 310B	894	(1610)	975	(1755)
Types 316	667	(1200)	748	(1345)
Types 405	683	(1230)	795	(1430)
Types 403, 409, 410, 416	572	(1030)	683	(1230)
Type 430	728	(1310)	808	(1455)
Type 442	877	(1580)	933	(1680)

Table 35.1 Continued on Next Page

Table 35.1 Continued

Device or material	Column 1		Column 2	
	°C	(°F)	°C	(°F)
Type 446	961	(1730)	1042	(1875)
7. Zinc Castings	89	(160)	145	(260)
F. Any handle, knob, grip, and similar item that the operator needs to touch to operate, regulate or shut off the exhaust hood.				
1. Metallic parts	33	(60)		
2. Nonmetallic parts	45	(80)		
^a The motor diameter is to be measured in the plane of the laminations of the circle circumscribing the stator frame, excluding lugs, boxes and similar item, used solely for motor cooling, mounting, assembly, or connection. ^b Coil or winding temperatures are to be measured by thermocouples unless the coil is inaccessible for mounting of these devices (for example, a coil immersed in sealing compound) or unless the coil wrap includes thermal insulation or more than two layers, 0.8 mm (1/32 inch) maximum, of cotton, paper, rayon, or similar material. For a thermocouple measured temperature of a coil or of an alternating-current motor, other than universal motor, having a diameter of 178 mm (7 inch) or less, the thermocouple is to be mounted on the integrally applied insulation on the conductor. At a point on the surface of a coil (not including universal motors) where the temperature is affected by an external source of heat, the temperature rise for Column 1 limits measured by a thermocouple is not capable of exceeding the indicated maximum by the following amounts, unless the temperature rise of the coil as measured by the resistance method is not more than specified in the table. 1. 5 °C (9 °F) for a Class A insulation on coil windings of alternating-current motors having a diameter of 178 mm (7 inch) or less, open type. 2. 10 °C (18 °F) for Class B insulation on coil windings of alternating-current motors having a diameter of 178 mm (7 inch) or less, open type. 3. 15 °C (27 °F) for Class A insulation on coil windings of alternating-current motors having a diameter of more than 178 mm (7 inch), open type. 4. 20 °C (36 °F) for Class B insulation on coil windings of alternating-current motors having a diameter of more than 178 mm (7 inch), open type. ^c For an electrolytic capacitor physically integral with or attached to a motor, the temperature rise on insulating material integral with the capacitor enclosure is not to be more than 65 °C (117 °F). ^d A capacitor which operates at a temperature higher than a 65 °C (117 °F) rise shall be judged on the basis of its marked temperature rating. ^e The limitations on phenolic composition and on rubber and thermoplastic insulation do not apply to compounds which have been investigated and found to have special heat resistant properties. ^f Reference shall be made to NFPA 70 for the temperature of a standard insulated conductor that is not specified. The Column 1 maximum temperature rise is 25 °C (77 °F) less than the temperature limit of the wire in question; and the maximum temperature rise where Column 2 rises are specified is to be based on the heat resistant properties of the insulation. ^g The specified maximum temperature rises apply to parts whose deterioration or malfunction results in the risk of fire, electric shock, or injury to persons. ^h When the reflectivity of aluminum-coated steel is utilized to reduce the risk of fire, the maximum allowable temperature rise is 461 °C (830 °F). ^j 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 the risk of fire.				

36 Cooking Smoke and Flare-Up Test

36.1 When the product is tested as specified in [36.2](#) – [36.11](#), there shall be no evidence of smoke or flame escaping outside the exhaust hood, there shall be no actuation of limit controls, and the maximum temperature rise attained by any exhaust hood part shall be not more than the temperature rise indicated for such part in Column 1 of [Table 35.1](#).

36.2 For exhaust hoods intended for use adjacent to combustible construction as described in [29.6](#), when tested as specified in [36.3](#) – [36.11](#) the surface temperature of the combustible construction shall not exceed 65 °C (117 °F) above ambient.

36.3 The exhaust air flow is to be adjusted to produce the minimum air flow through the exhaust hood specified by the manufacturer. The exhaust air flow is to be measured as described in [31.10](#) with the cooking appliance in the unheated state or removed from beneath the hood. When the hood is provided with an integral power ventilator, the outlet shall be uniformly restricted to simulate the maximum external static pressure.

36.4 The supply air flow (when provided) is to be adjusted to the maximum flow specified by the manufacturer. The supply airflow is to be measured as described in [31.11](#).

36.5 The cooking appliance, as specified in [Table 33.1](#), is to be installed beneath the exhaust hood at the farthest location from the exhaust collar, at the clearances and overhangs described in [Section 31](#).

36.6 Equilibrium temperatures are to be established as described in [35.5](#).

36.7 For testing light duty appliances, water shall be boiled as described in [33.4](#). Sufficient water shall be added to the pot to ensure that the level does not drop below the minimum level indicated in [Table 33.1](#) during the test being performed. The appliance shall be energized to bring the water to a steady boil.

36.8 For testing of medium, heavy, and extra heavy-duty appliances, thawed ground beef patties made of 73 ± 5 % lean ground beef 4 ± 0.25 inch in diameter and 0.25 ± 0.02 lb. beef patty placed uniformly on the cooking surface. For testing heavy, and extra heavy-duty appliances, frozen patties are also permitted to be used. The patties shall be placed on the cooking surface in rows and shall be the maximum permitted by the area of the cooking surface with a maximum of 1.0 inch between any row or the edge of the cooking surface. The testing procedure shall follow the steps specified for each appliance as described in [36.9](#) – [36.10](#).

36.9 The cooking procedure for Medium Duty appliances shall be:

1. Place the patties onto the griddle allowing 60 seconds to place
2. Cook the patties for 4.5 min after the last patty was placed
3. Turn all the patties over starting with first patty placed allow 60 seconds to turn all patties
4. Cook the patties an additional 4.5 min s after the last patty was flipped
5. Remove patties from griddle
6. Scrape griddle surface clean with steel spatula or equivalent
7. Provide griddle sufficient time to recover to temperature
8. Repeat steps 1 through 6 with a second set of uncooked patties.

36.10 The cooking procedure for Heavy and Extra heavy-duty appliances shall be:

1. Place the patties onto the grate allowing 90 seconds to place
2. Cook the patties for 3.5 min after the last patty was placed
3. Turn all the patties over starting with first patty placed allow 90 seconds to turn all patties
4. Cook the patties an additional 3.5 min after the last patty was flipped
5. Remove patties from grate
6. Brush grate surface clean with steel brush

7. Provide broiler grates sufficient time to recover to temperature
8. Repeat steps 1 through 6 with a second set of uncooked patties.

36.11 Exhaust hoods evaluated for use with a specific type of cooking appliance as described in [33.10](#) are to be tested using one of the following instead of the beef patties described in [36.8](#). The test shall be conducted by loading the maximum amount of the product on or in the cooking appliance and cooking the product until it is overcooked (very well done). This cooking cycle is to be repeated at least once.

- a) Deep fat fryers are to be tested with frozen, unbreaded fries intended for deep fat frying;
- b) Pressure deep fat fryers are to be tested with frozen, unbreaded chicken pieces;
- c) Ovens, roasters and similar appliances are to be tested using 2-1/2 to 3-1/2 lb skin-on and bone-in roasting chickens or quartered chicken pieces, loaded per the cooking appliance manufacturer's instructions;
- d) For testing ovens, or as an alternate when chicken does not produce visible cooking smoke and grease laden air, one sheet pan (nominal pan size 18 by 26 inch) filled with 1 lb. of pork bacon and coated with one cup of sugar distributed evenly is permitted to be used. The pan shall be placed at the lowest location (rack) of the oven, and the oven run at the maximum temperature for 10 minutes;
- e) Other appliances are to be tested using the food product(s) for which the appliances are designed.

37 Abnormal Flare-Up Test

37.1 During the test specified in [37.3](#) – [37.6](#), exit gas temperatures shall not exceed 190 °C (375 °F) and flame shall not enter the test collar connected to the exhaust hood. Parts of the exhaust hood, including bodies, shelving, framing, and dampers, shall not warp or otherwise be damaged to an extent that results in the product developing a risk of fire or electric shock in continued use. The temperature rise attained by any exhaust hood parts during the test shall be not more than the temperature rises indicated in Column 2 of [Table 35.1](#).

Exception: The 190 °C (375 °F) temperature limitation and the limitation on flames entering the test collar do not apply to exhaust hoods without exhaust dampers.

37.2 For exhaust hoods intended for use in combustible construction as described in [29.6](#), when tested as specified in [37.4](#) – [37.6](#) the surface temperature of the combustible construction shall not exceed 97 °C (175 °F) above ambient.

37.3 The exhaust air flow is to be adjusted to the minimum flow determined by the Cooking Smoke and Flare-Up Test in Section [36](#) and measured as described in [31.10](#). The supply air flow, when provided, is to be off.

37.4 Equilibrium temperatures are to be established as specified in [35.5](#).

37.5 One pint (0.5 L) of vegetable oil is to be placed in a shallow pan, 18 by 12 by 4 inches deep, and the pan placed on the surface of the cooking appliance. The pan is to be located where the flaming oil produces highest temperatures on the exhaust hood components. The test is to be repeated with the pan in other locations.

37.6 The oil is to be heated until ignition. When the cooking appliance is not capable of heating the oil to ignition, an external heat source is to be used. Following ignition, the fire is to be allowed to burn freely and no attempt is to be made to extinguish it.

38 Fan-Failure Test

38.1 During the test specified in [38.2](#), exit gas temperature shall not exceed 190 °C (375 °F) and flames shall not enter the test collar connected to the exhaust hood. The temperature rise attained by any exhaust hood part during each test shall be not more than the temperature rises indicated in Column 2 of [Table 35.1](#).

Exception: The 190 °C (375 °F) temperature limitation and the limitation on flames entering the test collar do not apply to exhaust hoods without exhaust dampers.

38.2 For exhaust hoods intended for use adjacent to combustible construction as referenced in [29.6](#), when tested as specified in [38.3](#) the surface temperature of the combustible construction shall not exceed 97 °C (175 °F) above ambient.

38.3 The test method and operating conditions are to be as specified in Abnormal Flare-Up Test, Section [37](#), with the exhaust and supply (when provided) blowers turned off.

39 Fire Test

39.1 When an exhaust hood is tested as specified in [39.2](#) – [39.8](#), exit gas temperatures shall not exceed 190 °C (375 °F) and flames shall not enter the test collar connected to the exhaust hood. Parts of the exhaust hood, including bodies, shelving, framing, and dampers, shall not warp or otherwise be damaged to the extent that the product increases the risk of fire, electric shock, or injury to persons during continued use.

Exception No. 1: The 190 °C (375 °F) temperature limitation and the limitation on flames entering the test collar do not apply to exhaust hoods without exhaust dampers.

Exception No. 2: Damage confined only to electrical wiring, components, and accessories, other than thermostats, subject to replacement and repair, is determined to comply with these requirements.

39.2 For exhaust hoods intended for use adjacent to combustible construction as described in [29.6](#), when tested as specified in [39.5](#) – [39.8](#) the surface temperature of the combustible construction shall not exceed 97 °C (175 °F) above ambient.

39.3 The initial test method and operating conditions are to be the same as those used for the Temperature Test, Section [35](#), except that a means is to be provided for burning oil in deep containers.

39.4 The exhaust air flow is to be adjusted to the minimum flow determined in Section [36](#) and measured as described in [31.10](#). The supply air flow, when provided, is to be off.

39.5 Equilibrium temperatures on the cooking appliance surface and in the exhaust collar are to be established as specified in [35.5](#).

39.6 A container, measuring 330 mm (13 inch) in diameter by 216 mm (8-1/2 inch) deep and having an evaporating surface at the liquid level of 0.084 m² (130 inch²) is to be placed on the cooking surface in a location where the flaming vegetable oil produces the highest exit gas temperature or flaming in the test collar. Three pints (1.7 L) of vegetable oil are to be placed in the container. The vegetable oil then is to be

heated in the container until ignition. If the vegetable oil fails to ignite after 20 minutes at self-ignition temperature, it may be ignited with the assistance of an external blow torch.

39.7 The test is to be continued until all of the vegetable oil has burned and the container is dry. Exit gas temperatures are to be recorded during this test for exhaust hoods with exhaust dampers.

39.8 When the exhaust hood is equipped to close a damper or to otherwise react to excessive temperature developed in the assembly and such a device is not actuated during the test, the test is to be repeated as follows until the damper closes. The size of the container or quantity of containers used, or both, is to be increased in any given increments to provide a burning surface not larger than an area equal to the length of the hood multiplied by the depth of the cooking surface. The quantity of vegetable oil used in such containers is to give a burning time equal to that produced during the initial test with 3 pints (1.4 L) of vegetable oil.

40 Abnormal Water Supply Test

40.1 An exhaust hood, employing water for flushing, cleaning, cooling, continuously wetting surfaces, etc., shall conform to the requirements of Section 35, Temperature Test, and Section 36, Cooking Smoke and Flare-Up Test, through to Section 39, Fire Test, under any condition of reduced water supply and also with no water supply.

41 Burnout Test

41.1 During the test specified in 41.3, exit gas temperatures shall not exceed 190 °C (375 °F), flame shall not enter the duct connected to the exhaust hood, and the grease in the duct shall not become ignited. The grease within the hood shall not penetrate any external seams or joints. The temperature rise attained by any exhaust hood part during the test shall be not more than the applicable value specified in Column 2 of Table 35.1.

Exception: The 190 °C (375 °F) temperature limitation and the limitation on flames entering the test collar do not apply to exhaust hoods without exhaust dampers.

41.2 For exhaust hoods intended for use adjacent to combustible construction as described in 29.6, when tested as specified in 41.3 the surface temperature of the combustible construction shall not exceed 97 °C (175 °F) above ambient.

41.3 Prior to this test, the cooking appliance is to be de-energized, and the grease containers removed. The interior surfaces of the exhaust hood and all interior surfaces of the test collar within 0.9 m (3 feet) of the collar of the exhaust hood are to be evenly coated with grease to obtain a loading of 1.5 kilogram per square meter (0.3 lb/ft²). Equilibrium temperatures are to be established under the conditions specified in 34.5.

41.4 The method for conducting the Abnormal Flare-Up Test, Section 37, is then to be followed placing the pan in the position found to produce the highest exit gas temperatures in the abnormal flare-up test.

Exception: The test collar and exhaust duct are not coated for exhaust hoods without exhaust dampers.

42 Pressure Test

42.1 Parts intended for the handling of fluids under pressure shall withstand, without rupture, a hydrostatic pressure equivalent to five times the maximum working pressure. Determination of the test pressure for fittings for hood penetrations shall be based on their intended use.

43 Damper Tests

43.1 General

43.1.1 The maximum size of each exhaust and supply damper assembly shall be subjected to the damper cycling and closure tests described in [43.2.1](#) – [43.3.2](#).

43.2 Cycling test

43.2.1 When tested as specified in [43.2.2](#), a damper operating mechanism shall be capable of closing the damper after 6000 cycles of operation. The damper shall not be damaged such that it does not perform acceptably when tested as specified in Sections [35](#) – [41](#).

43.2.2 The damper is to be mounted in the same orientation as intended in the exhaust hood. The damper is to be manually set (when manual-reset type) or automatically set (when of the automatic-reset type) in the open position. The dampers are to be triggered to close as intended. This process is to be repeated for the number of cycles specified in [43.2.1](#).

43.3 Closure test

43.3.1 When tested as specified in [43.3.2](#), exhaust and supply dampers shall remain completely closed.

43.3.2 Dampers are to be tested in an exhaust hood that is connected to exhaust and supply ducts of a size in accordance with the manufacturer's installation instructions. The dampers are to be set in the open position and the air flow is to be adjusted to the values specified by the manufacturer. The dampers are to be closed under these flow conditions and the static pressures developed within the exhaust and supply ducts are to be measured. The exhaust damper is to be subjected to the forces of a negative pressure of ten times the value measured in the exhaust duct. The supply damper is to be subjected to the forces of a positive pressure of ten times the value measured in the supply duct.

Exception No. 1: When the exhaust or supply damper is designed in such a manner that the damper cannot be opened by an increase in pressure in the duct. Examples include center pivoted blades or dampers incorporating a mechanism that locks the blade into position.

Exception No. 2: When the exhaust hood incorporates means to automatically shut down the exhaust or supply blowers, and when the exhaust or supply blower is a type requiring manual restart, then the exhaust or supply damper shall remain closed against a pressure of not less than two times the pressure value measured during intended operation.

44 Gasket and Sealant, Physical and Immersion Tests

44.1 Tensile strength and elongation

44.1.1 The tensile strength and elongation of gaskets and seals used in the construction of fittings and accessories for use with hoods and ducts shall not decrease by more than 50 % of their original tensile strength and elongation after being subjected to the exposures described in [44.2.2](#) and [44.2.3](#). The part shall show no apparent deterioration, such as cracking, hardening, softening, melting, or damage after these exposures.

44.1.2 The average volume change of gaskets and seals used in the construction of fittings and accessories for use with exhaust hoods and ducts shall be in the range of minus 1 to plus 50 % after being subjected to the exposures specified in [44.3.1](#).

44.1.3 For the tensile strength and ultimate elongation determinations, nine specimens are to be prepared. Dumbbell specimens are to be die cut from the gasket or seal, when possible. Specimens are to be die cut in accordance with ASTM D412, using Die C or D. Die D is to be used when the size or shape of the gasket or seal does not permit Die C specimens. The constricted portion of the specimen is to be buffed or skived to remove any surface irregularities. The buffing or skiving equipment is to be as specified in ASTM D3183. Three measurements for thickness are to be made in the constricted portion of the specimen. The minimum value obtained is to be used as the thickness of the specimen in calculating the tensile strength. A micrometer or equivalent is to be used for measuring dumbbell specimens as specified in Method A, ASTM D3767. For specimens requiring elongation, two benchmarks, 25 mm (1 inch) apart, are to be marked on the central portion of each specimen after the immersion. When an extensometer is used that does not require bench marks, the bench marks are to be omitted.

44.2 Aging and immersion

44.2.1 When the size or shape of the gasket or seal is such that tensile strength and elongation specimens are not obtained from the part, the complete part, or a section from the part, is to be subjected to the aging and immersion exposures specified in [44.2.2](#) and [44.2.3](#).

44.2.2 Three specimens are to be subjected to air oven aging at 136 ± 1 °C (277 ± 1.8 °F) for seven days. The test is to be conducted in accordance with the test procedures outlined in and using the air oven described in ASTM D573.

44.2.3 The specimens are to be immersed in such a manner that they do not touch each other or the sides of the container. Three specimens are to be immersed for 70 hours in lard and three specimens are to be immersed in corn oil. The lard and the corn oil are to be maintained at 136 ± 1 °C (277 ± 1.8 °F) throughout the immersion period. The specimens are then to be blotted with a soft cloth or filter paper, the 25 mm (1 inch) bench marks, when required, are to be applied, and the tensile strength and elongation tests are to be conducted. The average values obtained on the immersed specimens are to be compared with the average values for three specimens not immersed in lard or corn oil.

44.2.4 Tensile strength and elongation are to be determined in accordance with the test methods outlined in ASTM D412. The rate of travel of the power-actuated grip is to be 508.0 ± 25.4 mm (20 ± 1 inch) per minute.

Exception: The rate of travel of the power-actuated grip for gasket material that is a composite material is to be 127.0 ± 6.4 mm ($5 \pm 1/4$ inch) per minute.

44.2.5 The elongation, when required, is to be measured by means of a scale, extensometer, or other device indicating the elongation with an accuracy of 2.5 mm (0.1 inch).

44.3 Volume change

44.3.1 For the volume change test, smooth specimens from the gaskets or seals, or complete samples when the parts are small, are to be used. The volume of each specimen is to be determined by weighing it first in air and then in water. Three specimens are then to be dried and immersed for 70 h in lard and three specimens are to be dried and immersed in corn oil for 70 h. The lard and the corn oil are to be maintained at 136 ± 1 °C (277 ± 1.8 °F) throughout the immersion period. At the end of the immersion period, the specimens that have been immersed in lard are to be removed, gently wiped to remove excess lard, and allowed to cool 30 to 60 minutes at room conditions. The specimens that have been immersed in corn oil are to be cooled for 30 to 60 minutes in fresh corn oil maintained at room conditions then removed one at a time and gently wiped to remove excess corn oil immediately before weighing. The cooled specimens are to be rinsed briefly in ethyl alcohol, blotted dry with a soft cloth or filter paper, and again weighed, first in air and then in water. The percent change in volume is to be calculated for each specimen and the results for

three specimens in each of the test liquids are to be averaged. The percent change in volume by the displacement method is:

$$\Delta V\% = \frac{[(M3 - M4) - (M1 - M2)] \times 100}{M1 - M2}$$

in which:

M1 is the weight of the specimen in air on hook, and if used, the ballast, in water, before the immersion test,

M2 is the weight of the specimen, and, if used, the ballast, in water on hook before the immersion test,

M3 is the weight of the specimen in air on hook, and, if used, the ballast in water, after the immersion test, and

M4 is the weight of the specimen, and, if used, the ballast, in water on hook after the immersion test.

44.3.2 As an alternate to the liquid displacement method above, for flexible, open cellular, and other absorbing materials, the length, width, and thickness measurements are to be determined before and after immersion. The percent volume change is to be calculated for each of the three specimens and averaged. The percent change in volume by the measurement method for open flexible cellular material and other absorbing materials is:

$$\Delta V\% = \frac{(L \times W \times T) - (l \times w \times t)}{l \times w \times t} \times 100$$

in which:

L, *W*, and *T* are the length, width, and thickness after the immersion; and

l, *w*, and *t* are the length, width, and thickness before the immersion.

44.3.3 Apparatus for the volume change test shall consist of an analytical balance provided with a bridge for the support of a vessel of distilled water, a small diameter wire hook, alcohol, and a metal die or other equipment for cutting rectangular 1 by 2 inch specimens. When applying the alternate length and thickness measurement method for flexible, open cellular, and other absorbing materials, a scale in at least 2 1/2 mm (1/10 inch) divisions or a micrometer accurate to 0.025 mm (0.001 inch) are to be utilized for measurement.

45 Fire and Leakage Test of Fittings, Seams, Joints, or Hood Penetrations

45.1 When a fitting, seam, or joint is tested as specified in [45.2](#) – [45.5](#), there shall be no propagation of grease vapor or flame through or around the fitting, seam, or joint.

45.2 Two representative samples of the fitting shall be installed in a 508 by 508 mm (20 by 20 inch), 1.63 mm (0.064 inch) thick stainless-steel plate in accordance with the manufacturer's specifications. The plate and fittings shall then be evenly coated with grease on the fire exposed side (bottom) to obtain a loading of 1.5 kilogram per square meter (0.3 lb/feet²).

45.3 One representative sample of the seam or joint shall be installed in each of two, 508 by 508 mm (20 by 20 inch), steel plates manufactured with a representative material and material thickness. The plate

and seam or joint shall then be evenly coated with grease on the fire exposed side (bottom) to obtain a loading of 0.1 pound per square foot 0.5 kilogram per square meter (0.1 lb/ft²).

45.4 The plate containing the test samples is to be positioned horizontally (grease side down) 18 inch above a metal container holding three pints (1.4 L) of grease. The container is to measure 330 mm (13 inch) in diameter by 215 mm (8-1/2 inch) deep and having an evaporating surface at the liquid level of 839 cm² (130 inch²). This container is placed on a heat source capable of heating the grease to 600 °F (315 °C). The preheated grease is then ignited.

45.5 The test is continued until all of the grease has burned and the container is dry.

46 Tension Test for Adjustable/Telescoping Duct Collar

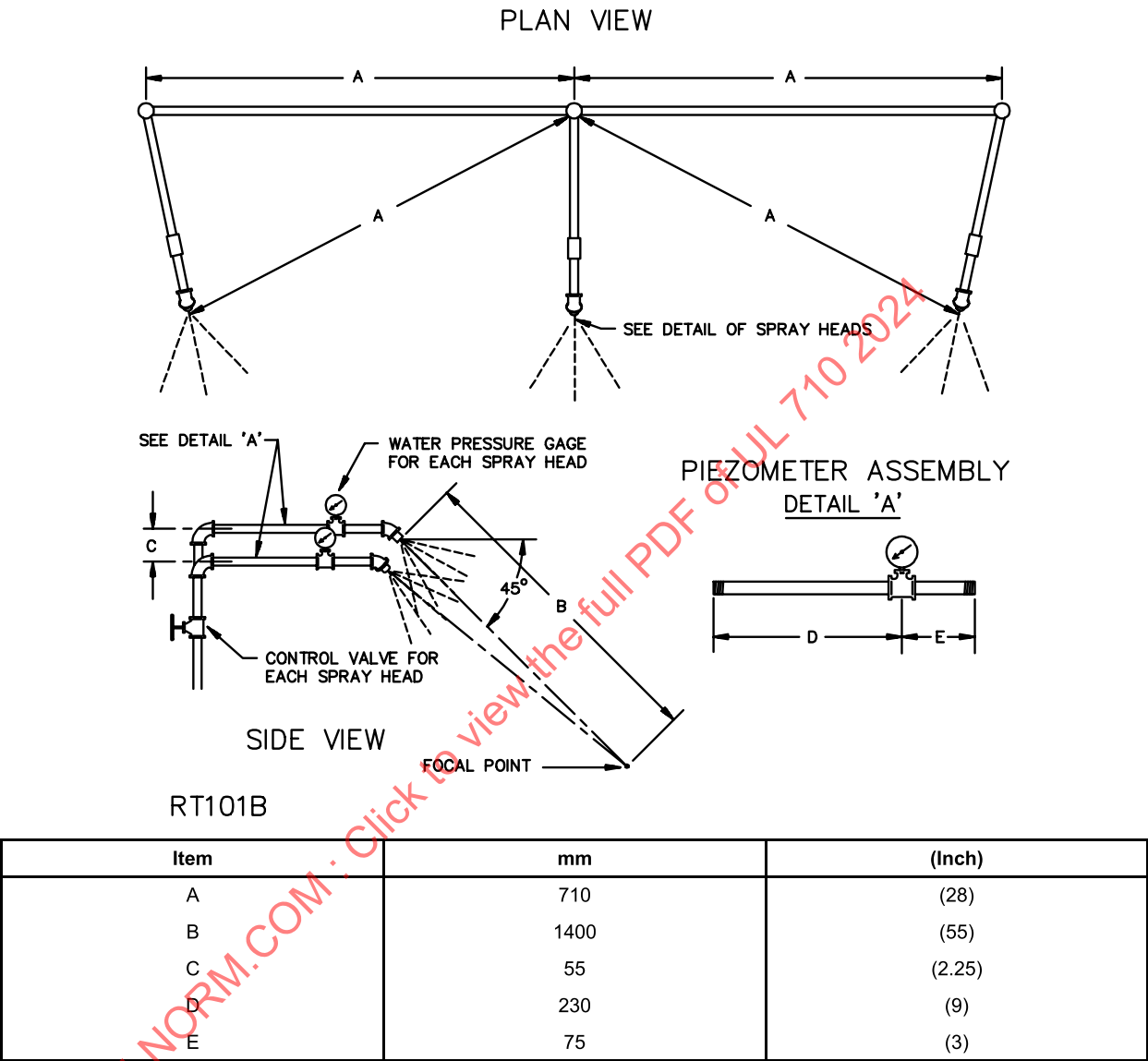
46.1 The duct collar and mechanical stop assembly shall support the hood and duct collar assembly without more than a 3.18 mm (1/8 inch) permanent deformation when tested in accordance with [46.2](#). Any counterbalance mechanism shall be disconnected or bypassed for the test.

46.2 Four times the total hood weight shall be mechanically attached to the hood assembly below the adjustable duct collar. The weight shall be applied such that the mechanical stop is subjected to the force applied by the total weight for a minimum of 1 hour.

47 Rain Test

47.1 The rain test apparatus shall consist of three spray heads mounted in a water supply rack as shown in [Figure 47.1](#). The spray heads shall be constructed in accordance with [Figure 47.2](#). The product shall be brought into the focal area of the three spray heads in such position, and under such conditions, that the greatest quantity of water will enter the product.

Figure 47.1
Rain Test Apparatus



47.2 The spray shall be directed at an angle of 45° to the vertical, towards the louvres or other openings closest to live parts. Water pressure shall be maintained at 5 psig (34.5 kPa) at each spray head.

47.3 The equipment shall be operated so that electrical components are energized, and the product shall be tested under the intended conditions of use judged most likely to cause the entrance of water into or onto electrical components. If the unit is equipped with an outdoor service receptacle, the test shall be conducted with a plug inserted in the receptacle. It could be necessary to operate the unit under various modes of operation or to deenergize the product, if more adverse conditions could result. In any case, each exposure shall be for 1 hour.

47.4 Openings intended for field conduit connection shall be provided with such connections, with the outer end sealed, but with pipe thread compound at the connection.

47.5 After the final exposure to the rain, the complete product shall be subjected to the Dielectric Voltage-Withstand Test, Section [49](#).

47.6 When multiple exposures to rain are necessary, the dielectric-withstand test shall be repeated in the wet condition if drying could occur between exposures.

47.7 Water shall not enter enclosures above the lowest electrical component other than insulated wire. Uninsulated hazardous voltage parts and extra-low-voltage safety circuits shall not be wetted. There shall be no accumulation of water within the enclosures of electrical parts.

Exception No. 1: Water may enter an enclosure above the lowest electrical component, if the point of entrance is not in proximity to live parts, and if live parts except insulated wire are not wetted.

Exception No. 2: A motor winding may be wetted if the motor complies with the Dielectric Voltage-Withstand Test of Section [49](#).

ELECTRICAL TESTS

48 Overvoltage and Undervoltage Operation Test

48.1 The operating parts and electronic circuits of a control unit shall be able to withstand 110 % of its rated voltage continuously without damage during the normal operating condition, and the control unit shall operate successfully during the normal operating condition at the increased voltage. It shall also operate successfully at 85 % of its rated voltage.

48.2 For operation at the higher voltage specified in [48.1](#), the control unit is to be subjected to the increased voltage during the normal operating condition until constant temperature is reached on the parts, and then tested for the normal operating conditions. For this test zero-line impedance is employed in the initiating device circuit.

48.3 For operation at the lower voltage specified in [48.1](#), the control unit is to be subjected to rated voltage during the normal operating condition until constant temperature is reached on the parts and then tested immediately for the normal operating condition at the reduced voltage. In making the reduced voltage test, the voltage is to be reduced by a means which maintains a stable potential of the required value under maximum severe conditions of normal loading. The reduced voltage value is to be computed on the basis of the rated nominal voltage when a storage battery is intended to be employed with the control unit.

48.4 When the maximum impedance of an initiating circuit extended from a control unit is required to be less than 100 ohms to obtain successful operation, the reduced voltage test is to be made with the maximum impedance connected to the circuit. When no impedance limitation is indicated in the marking,