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NATIONAL STANDARD

STANDARD FOR SAFETY

ANSI/CAN/UL/ULC 1201:2016, Sensor Operated Backwater Prevention Systems

Approved American National Standard
ANSI

ANSI/UL 1201-2016

Standards Council of Canada
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SCC FOREWORD

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UL Standard for Safety for Sensor Operated Backwater Prevention Systems, ANSI/CAN/UL/ULC 1201

First Edition, Dated December 14, 2016

Summary of Topics

The First Edition of the Standard for Sensor Operated Backwater Prevention Systems, ANSI/CAN/UL/ULC 1201.

The new requirements are substantially in accordance with Proposal(s) on this subject dated June 10, 2016.

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Standards Council of Canada
Conseil canadien des normes

December 14, 2016

UL/ULC 1201

Standard for Sensor Operated Backwater Prevention Systems

First Edition

December 14, 2016

This ANSI/CAN/UL/ULC Safety Standard consists of the First Edition.

The most recent designation of ANSI/UL 1201 as an American National Standard (ANSI) occurred on December 14, 2016. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, Preface or SCC Foreword.

This standard has been approved as a National Standard of Canada (NSC) by the Standards Council of Canada (SCC).

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Preface

This is the First Edition of the Standard for Sensor Operated Backwater Prevention Systems.

This Edition of the Standard has been formally approved by the UL/ULC Joint Committee on Prevention of Storm and Sanitary Backflow.

This Standard has been developed in compliance with the requirements of SCC and ANSI for accreditation of a Standards Development Organization.

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.

Appendix A, identified as Informative, is for information purposes only.

UL is accredited by the American National Standards Institute (ANSI) and the Standards Council of Canada (SCC) as a Standards Development Organization (SDO). ULC Standards is accredited by the Standards Council of Canada (SCC) as a Standards Development Organization (SDO).

This ANSI/CAN/UL/ULC 1201 Standard for Safety is under continuous maintenance, whereby each revision is ANSI/CAN approved upon publication. If no revisions occur, the initiation of the review of this Standard will commence within 5 years of the date of publication.

The review and action to revise or reaffirm this Standard will not exceed 5 years from the date of publication, unless the Standard is identified as fitting within a stabilized category, whereby the review will commence within the appropriate time frame set out by ULC Standards and Underwriters Laboratories Inc.

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.

This is a First Edition joint National Standard of Canada and American National Standard.

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

Attention is drawn to the possibility that some of the elements of this joint Canadian and American standard may be the subject of patent rights. ULC Standards shall not be held responsible for identifying any or all such patent rights.

Requests for interpretation of this Standard should be sent to ULC Standards. The requests should be worded in such a manner as to permit a "yes" or "no" answer based on the literal text of the requirement concerned.

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This list represents the STP 1201 membership when the final text in this standard was balloted. Since that time, changes in the membership may have occurred.

STP 1201 Membership

Name	Representing	Interest Category*	Region
Bob Bielawski	Mainline Backflow Products Inc.	Producer	USA
Robert Burnham	Zurn Industries	Producer	USA
Maribel Campos	ICC Evaluation Service LLC	Testing and Standards	USA
Mark Harrold	City of Lethbridge	Producer	Alberta
Edwin Ho	International Association of Plumbing and Mechanical Officials (IAPMO)	Testing and Standards	Canada
Paul Holland	City of Greater Sudbury	AHJ	Ontario
Christopher Johnson	Fluids Controls Institute (FCI)	General	USA
William LaRose	self	General	Canada
Christopher McLellan	Canadian Home Builders Association	General	Canada
Brian Murphy	ULC Standards	STP Co-Chair - Non-voting	Canada
Joe Musso	Underwriters Laboratories Inc.	STP Co- Chair - Non-voting	USA
Brian Patriquin	Inflotrolix	Producer	Canada
Mark Ramlochan	ULC Standards	STP Co- Project Manager - Non-voting	Canada
Shabbir Rawalpindiwala	Kohler Co	General	USA
Dan Sandink	Institute for Catastrophic Loss Reduction (ICLR)	AHJ	Canada
Claudio Spagnuolo	City of Brampton - Planning & Infrastructure Services	AHJ	Canada
Amy Walker	Underwriters Laboratories Inc.	STP Co- Project Manager - Non-voting	USA
Kevin Wong	Canadian Institute of Plumbing & Heating	General	Canada
* Testing and Standards interest category is non-voting for SCC.			

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This Standard is intended to be used for conformity assessment.

The intended primary application of this standard is stated in its scope. It is important to note that it remains the responsibility of the user of the standard to judge its suitability for this particular application.

CETTE NORME NATIONALE DU CANADA EST DISPONIBLE EN VERSIONS FRANÇAISE ET ANGLAISE

INTRODUCTION

1 Scope

1.1 This standard covers backwater prevention systems that use sensors, controls and mechanisms for the prevention of backflow for sanitary drainage and storm systems and specifies minimum requirements for materials, mechanical, electrical, performance tests and markings.

1.2 The purpose of this Standard is to enhance health and safety by:

a) Specifying acceptable criteria for sensor operated backwater prevention systems;

b) Serving as a guide for producers, distributors, architects, engineers, contractors, installers, inspectors and users; and

c) Promoting understanding regarding materials and manufacturing of sensor operated backwater prevention systems.

2 Units of Measurement

2.1 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.

3 Reference Publications

3.1 See Annex A for a list of publications referenced in this standard. 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. When the latest edition of a standard is not applicable, the appropriate edition is indicated accordingly in Annex A.

4 Glossary

4.1 SEALING ELEMENT – A pneumatic or mechanical component in a backwater prevention system that when deployed or activated, prevents the reverse flow of storm or sanitary drainage.

CONSTRUCTION

5 General

5.1 General

5.1.1 Sensor operated backwater prevention systems shall consist of

a) An electronic control panel;

b) A retractable sealing element;

c) Electrical cables and connectors to connect the control panel to the sealing element;

d) A service or cleanout cap;

e) Additional components such as gaskets; and

f) The installation hardware.

5.1.2 Caps shall firmly secure and seal the sealing element inside the fitting.

5.1.3 The sealing element shall comply with the performance tests specified.

5.1.4 If the sealing element is a pneumatic type device, the air tube shall be attached to the sealing element using a means to provide a secure tensile attachment. The air tube connection to the sealing element shall be capable of withstanding for 1 min a pull of 10 N applied to the tube without causing the tube to detach from the sealing element.

5.1.5 The sealing element shall be properly positioned and secured in its installed position using manufacturer provided installation hardware, in accordance with the manufacturer's installation instructions.

5.2 Grade

5.2.1 The sensor operated backwater prevention systems shall be designed and constructed such that when installed in its proper operating position in the drainage system, the upper face of the cap shall be parallel to the invert to the outlet so that the slope of the drain can be readily determined by placing a level on the top of the cap.

5.3 Access

5.3.1 The sensor operated backwater prevention systems shall be designed to provide access to working components for repair or replacement. The size of the access shall be based upon the requirements necessary to perform the repair or maintenance. The access cap shall be water and gas tight once installed.

6 Control Unit Frame and Enclosure

6.1 General

6.1.1 A control unit shall be so formed and assembled that it has the strength and rigidity necessary to resist the abuses to which it is likely to be subjected in service without adversely affecting its performance and without introducing fire, shock, or accident hazard due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts or other serious defects.

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

6.1.3 There shall be adequate space within a terminal or wiring compartment for completing all wire connections as specified by the installation wiring diagram.

6.1.4 An enclosure shall have suitable means for mounting, which shall be accessible without disassembling any operating part of the unit. Removal of a completely assembled panel or printed wiring board to mount the enclosure is not considered to be disassembly of an operating part.

6.1.5 A compartment enclosing electrical parts shall not be open to the floor or other support on which a unit rests.

6.2 Cast metal enclosures

6.2.1 The thickness of cast metal for an enclosure shall be as indicated in Table 1, except that cast metal having a thickness 0.8 mm less than that indicated in the Table may be employed if the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape and/or size of the surface is such that equivalent mechanical strength is provided.

6.2.2 If threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, or if an equivalent construction is employed there shall be not less than 3-1/2 nor more than 5 threads in the metal, and the construction shall be such that a standard conduit bushing can be properly attached.

6.2.3 If threads for the connection of conduit are tapped only part of the way through a hole in an enclosure wall, there shall be not less than five full threads in the metal, and there shall be a smooth, well-rounded inlet hole for the conductors which shall afford protection to the conductors equivalent to that provided by a standard conduit bushing.

6.3 Sheet metal enclosures

6.3.1 The thickness of sheet metal employed for the enclosure of a control unit shall be not less than that indicated in Table 2, except that sheet metal of two gauge sizes lesser thickness may be employed if the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape and/or size of the surface is such that equivalent mechanical strength is provided.

6.3.2 At any point where conduit or metal-clad cable is to be attached, sheet metal shall be of such thickness or shall be so formed or reinforced that it will have stiffness at least equivalent to that of uncoated flat sheet steel having a minimum thickness of 1.35 mm.

6.3.3 A plate or plug for an unused conduit opening or other hole in the enclosure shall have a thickness of not less than: 0.36 mm for steel or 0.48 mm for nonferrous metal for a hole having a 6.4 mm maximum dimension; and 0.69 mm steel or 0.8 mm nonferrous metal for a hole having a 35 mm maximum dimension.

6.3.4 A closure for a larger hole shall have a thickness equal to that required for the enclosure of the device or a standard knockout seal shall be used. Such plates or plugs shall be securely mounted.

6.3.5 A knockout in a sheet-metal enclosure shall be reliably secured but shall be capable of being removed without undue deformation of the enclosure.

6.3.6 A knockout shall be provided with a flat surrounding surface adequate for proper seating of a conduit bushing, and shall be so located that installation of a bushing at any knockout likely to be used during installation will not result in spacings between uninsulated live parts and the bushing of less than the requirements in this Standard.

6.4 Nonmetallic enclosures

6.4.1 A nonmetallic enclosure or enclosure part shall have mechanical strength and durability and be so formed that operating parts will be protected against damage, and shall resist the abuses likely to be encountered during installation and normal use and service, but in any case, the mechanical strength shall be at least equivalent to a sheet-metal enclosure of the minimum thickness specified in Table 2. The enclosure or enclosure part shall protect persons from shock hazard.

6.4.2 Among the factors taken into consideration when judging the acceptability of a nonmetallic enclosure with respect to aging are: the mechanical strength; resistance to impact; moisture-absorptive properties; combustibility and resistance to ignition from electrical sources; dielectric strength, insulation resistance, and resistance to arc tracking; and resistance to distortion and creeping at temperatures to which the material may be subjected under conditions of normal and abnormal usage.

6.4.3 The continuity of the grounding system shall not rely on the dimensional integrity of the nonmetallic material.

6.5 Electric shock

6.5.1 Any part that is exposed only during operator servicing shall not present the risk of electric shock. See Electric Shock Current Test, Subsection 33.14.

6.5.2 Each terminal provided for the connection of an external antenna shall be conductively connected to the supply circuit grounded conductor. The conductive connection shall have a maximum resistance of 5.2 MΩ, a minimum wattage rating of 1/2 W, and shall be effective with the power switch in either the on or off position.

6.5.3 The conductive connection need not be provided if such a connection is established in the event of electrical breakdown of the antenna isolating means, the breakdown does not result in a risk of electric shock, and in a construction employing an isolating power transformer, the resistance of the conductive connection between the supply circuit and chassis does not exceed 5.2 MΩ.

6.5.4 The maximum value of 5.2 MΩ specified in Clauses 6.5.2 and 6.5.3 is to include the maximum tolerance of the resistor value used; that is, a resistor rated 4.2 MΩ with 20% tolerance or a resistor rated 4.7 MΩ with a 10% tolerance is acceptable. A component comprised of a capacitor with a built-in shunt resistor that complies with the requirements for antenna isolating capacitors may be rated a minimum of 0.25 W.

6.5.5 The insertion in any socket of any component used in the product shall not result in a risk of electric shock.

6.6 Ventilating openings

6.6.1 Ventilating openings in an enclosure, including perforated holes, louvres, and openings protected by means of wire screening, expanded metal, or perforated covers, shall be of such size or shape that no opening will permit passage of a rod having a diameter of 3.6 mm. An enclosure for fuses or other overload-protective devices and provided with ventilating openings shall afford adequate protection against the emission of flame or molten metal.

6.6.2 Except as noted in Clause 6.6.3, perforated sheet metal and sheet metal employed for expanded-metal mesh shall be not less than 1.07 mm in average thickness, 1.17 mm if zinc coated.

6.6.3 If the indentation of a guard or enclosure will not alter the clearance between uninsulated, movable, live parts and grounded metal so as to affect performance adversely or reduce spacings below the minimum values given under Spacings, Subsection 21, 0.53 mm expanded-metal mesh (0.61 mm if zinc coated) may be employed, provided that the exposed mesh on any one side or surface of the device so protected has an area of not more than 465 cm^2 and has no dimension greater than 300 mm, or that the width of an opening so protected is not greater than 90 mm.

6.6.4 The wires of a screen shall be not smaller than 16 AWG and the screen openings shall be not greater than 3.2 mm by 3.2 mm.

7 Metal Covers and Doors

7.1 An enclosure cover shall be hinged, sliding, pivoted or similarly attached if it provides ready access to fuses or any other over current-protective device the normal functioning of which requires renewal, or if it is necessary to open the cover in connection with the normal operation and maintenance of the unit.

7.2 With reference to the requirement of the Clause 7.1, normal operation is considered to be operation of a switch for testing or for silencing an audible signal appliance or operation of any other component of a unit, which requires such action in connection with its intended performance.

7.3 A hinged cover is not required where the only fuse(s) enclosed is intended to provide protection to portions of internal circuits such as may be employed on a separate printed wiring board or circuit subassembly, to prevent excessive circuit damage resulting from a fault. The use of such a fuse(s) is acceptable if the following or equivalent marking is indicated on the cover:

"WARNING: CIRCUIT FUSE(S) INSIDE – Disconnect Power Prior To Servicing.″

and

« AVERTISSEMENT: CIRCUIT FUSIBLE À L'INTÉRIEUR – Couper le courant avant d'ouvrir ».

7.4 A hinged cover shall be provided with a latch, screw, or catch to hold it closed. An unhinged cover shall be securely held in place by screws or the equivalent.

8 Glass Panels

8.1 Glass covering an observation opening shall be held securely in place so that it cannot be readily displaced in service and shall provide adequate mechanical protection for the enclosed parts. The thickness of a glass cover shall be not less than that indicated in Table 3.

8.2 A glass panel for an opening having an area of more than 930 cm^2, or having any dimension greater than 300 mm, shall be supported by a continuous groove not less than 5 mm deep along all four edges of the panel.

8.3 A transparent material other than glass employed as a cover over an opening in an enclosure shall have equivalent mechanical strength to that of glass, not become a fire hazard, distort, nor become less transparent at the temperature to which it may be subjected under normal or abnormal service conditions.

9 Corrosion Protection

9.1 Except as indicated in Clause 9.2, iron and steel parts, except bearings, and the like, where such protection is impracticable, shall be suitably protected against corrosion by enamelling, galvanizing, sherardizing, plating, or other equivalent means.

9.2 The requirement of Clause 9.1 applies to all enclosing cases whether of sheet steel or cast iron, and to all springs and other parts upon which proper mechanical operation may depend. It does not apply to minor parts such as washers, screws, bolts, and the like, if the failure of such unprotected parts would not be liable to result in a hazardous condition or adversely affect the operation of the unit. Parts made of stainless steel, properly polished or treated if necessary, do not require additional protection against corrosion. Bearing surfaces should be of such materials and design as to ensure against binding due to corrosion.

10 Insulating Materials

10.1 Insulating materials for the support or separation of live parts shall be of a nonflammable, moisture-resistant insulating material, such as porcelain, phenolic or cold-moulded composition, or other material which is recognized for the support of live parts.

10.2 A base mounted on a metal surface shall be provided with an insulating barrier between the mounting surface and all live parts on the underside of the base which are not staked, upset, sealed, or equivalently prevented from loosening so as to prevent such parts and the ends of replaceable terminal screws from coming in contact with the supporting surface.

10.3 Vulcanized fibre may be used for insulating bushings, washers, separators, and barriers, but not for the sole support of live parts.

10.4 The thickness of a flat sheet of acceptable insulating material, such as phenolic composition employed for panel-mounting parts, shall be not less than that indicated in Table 4.

10.5 A terminal block mounted on a metal surface which may be grounded shall be provided with an insulating barrier between the mounting surface and all live parts on the underside of the base which are not staked, upset, sealed or equivalently prevented from loosening so as to prevent such parts and the ends of replaceable terminal screws from coming in contact with the supporting surface.

10.6 A countersunk, sealed part shall be covered with a waterproof insulating compound which will not melt at a temperature 15°C higher than the maximum normal operating temperature of the assembly, and at not less than 65°C in any case. The depth or thickness of sealing compound shall be not less than 3.2 mm.

11 Mounting of Electrical Components

11.1 All parts of a residential control unit shall be securely mounted in position and prevented from loosening or turning if such motion may affect adversely the normal performance of the control unit, or may affect the risk of fire and accident hazard incident to the operation of the control unit.

11.2 A switch, lampholder, attachment-plug receptacle, or plug connector shall be mounted securely and, except as noted in Clauses 11.3 and 11.4, shall be prevented from turning.

11.3 The requirement that a switch be prevented from turning may be waived if all the following conditions are met:

a) The switch is of a push button or other type that does not tend to rotate when operated (a toggle switch is considered to be subject to forces that tend to turn the switch during normal operation of the switch);

b) The means of mounting the switch makes it unlikely that operation of the switch will loosen the switch; or

c) The spacings are not reduced below the minimum acceptable values if the switch does rotate.

11.4 A lampholder of a type in which the lamp cannot be replaced, such as a neon pilot or indicator light in which the lamp is sealed in by a nonremovable jewel, need not be prevented from turning if rotation cannot reduce spacings below the minimum acceptable values.

11.5 The means for preventing turning of a device is to consist of more than friction between surfaces; for example, a suitable lockwasher, properly applied, is acceptable as the means for preventing a small stem-mounted switch or other device having a single-hole mounting means from turning.

11.6 Uninsulated live parts, including terminals, shall be secured to their supporting surfaces by methods other than friction between surfaces, so that they will be prevented from turning or shifting in position if such motion may result in reduction of spacings to less than those required. The security of contact assemblies shall be such as to ensure the continued alignment of contacts.

12 Operating Mechanisms

12.1 Operating parts, such as switches, relays, and similar devices, shall be adequately protected by individual protection on dust-tight cabinets, against fouling by dust or by other material which may affect adversely their normal operation.

12.2 A part shall be constructed of material that is acceptable for its intended application.

12.3 The assembly of an operating mechanism included as a part of a control unit shall be such that it will not be affected adversely by any condition of normal operation.

12.4 Moving parts shall have sufficient play at bearing surfaces to prevent binding.

12.5 Provision shall be made to prevent adjusting screws and similar adjustable parts from loosening under the conditions of actual use.

12.6 Manually operated parts shall have sufficient strength to withstand the stresses to which they will be subjected in operation.

12.7 An electromagnetic device shall provide reliable and positive electrical and mechanical performance in compliance with Section on Performance.

13 Current-Carrying Parts

13.1 A current-carrying part shall have adequate mechanical strength and current-carrying capacity for the service, and shall be of a metal such as silver, copper or copper alloy, or other material which will provide equivalent performance.

13.2 Bearings, hinges, and the like are not acceptable for carrying current between interrelated fixed and moving parts.

14 Servicing Protection

14.1 Uninsulated live parts or hazardous moving parts shall be located, guarded, or enclosed so as to prevent contact by persons during normal servicing conditions such as relamping, changing fuses, adjusting controls, battery replacement and maintenance, and operating switches. Protection by insulating tape, barriers, or equivalent, over exposed current-carrying parts operating in excess of 30 Vrms (42.4 V peak, or direct current) is acceptable.

15 Field-Wiring Connections

15.1 Primary power supply

15.1.1 A backwater valve control unit with provision for connection to a commercial power source normally available in a dwelling unit, shall provide permanent connection by means of wiring terminals or leads in a separate wiring compartment having provision for the connection of conduit, metal-clad cable, or non-metallic sheath cable.

15.1.2 Control units intended to be other than permanently connected shall be powered from an energy limited power supply having an open circuit voltage not in excess of 30 Vrms (42.4 V peak, or direct current) and its output capacity limited to a maximum of 100 VA, or powered from a commercial power source by means of a power-supply cord and attachment-plug cap. See Subsection 16, Installation Wiring Connections.

15.2 Secondary power supply

15.2.1 The use of a secondary power supply is optional if the primary power supply is intended for installation as described in Clause 15.1.1.

15.2.2 A secondary power supply such as that intended for installation as described in Clause 15.1.2 shall be provided, and shall be of sufficient capacity to supply the maximum normal power to the system for 24 h in the normal standby condition and thereafter be able to operate the control unit for the backwater valve signals for at least 5 min continuously.

15.3 Batteries

15.3.1 A battery employed as the secondary power supply shall be of a rechargeable type, and meet requirements of Standard for Safety for Household and Commercial Batteries, UL 2054. The maximum charging current, as well as the maximum trickle charging current available, shall not exceed the battery manufacturer’s recommendations.

15.3.2 The operation of a rechargeable standby battery shall be confirmed by either of the following means:

- a) A battery test switch which temporarily disconnects the primary ac power and sounds the audible signals on standby battery power; or
- b) Automatic battery monitoring for the following fault conditions:
  - 1) Battery disconnected;
  - 2) Loss of charging current; and
  - 3) Low battery voltage.

15.3.3 Batteries included as part of a control unit shall be so located and mounted that terminals of cells will be prevented from coming in contact with uninsulated live parts of the control unit, with terminals of adjacent cells, or with metal parts of the enclosure as a result of shifting.

15.3.4 A battery compartment intended for use with rechargeable batteries which emit gases during charging shall be provided with vent holes.

15.3.5 Ready access shall be available to the battery compartment to facilitate battery replacement without disassembly of any part of the control unit except for a cover or door.

15.3.6 Lead or terminal connections to batteries shall be identified with the proper polarity (plus or minus signs) and provided with strain relief.

15.3.7 Cells constructed of lithium metal, lithium alloy or lithium ion, that are used in batteries, shall meet the requirements in the Standard for Lithium Batteries, UL 1642.

16 Installation Wiring Connections

16.1 General

16.1.1 A control unit intended for permanent connection shall be provided with wiring terminals or leads for the connection of conductors corresponding to the rating of the unit, of at least the size required by:

a) The Canadian Electrical Code, Part I, CSA C22.1 in Canada; or

b) The National Electrical Code (NEC), ANSI/NFPA 70, in the United States.

16.1.2 Duplicate terminals or leads, or equivalent means to achieve electrical supervision, shall be provided for each incoming and outgoing alarm-initiating-circuit connection.

16.1.3 A common terminal may be used for connection of both incoming and outgoing wires, provided that the construction of the terminal does not permit an uninsulated section of a single conductor to be looped around the terminal and serve as two separate connections, thereby precluding supervision of the connection in the event that the wire becomes dislodged from under the terminal.

16.1.4 A notched clamping plate under a single securing screw is acceptable, provided that separate conductors of an initiating circuit are intended to be inserted in each notch, but this arrangement shall be supplemented by additional marking in the wiring area or on the installation wiring diagram specifying the intended connections to the terminals.

16.2 Field-wiring terminals

16.2.1 Terminal parts to which field connections are to be made shall consist of binding screws with terminal plates having upturned lugs, or the equivalent, to hold the wires in position. Other terminal connections may be provided if found to be equivalent.

16.2.2 A wire-binding screw employed at a field-wiring terminal shall be not smaller than No. 8, except that a No. 6 screw may be used for the connection of a 14 AWG or smaller conductor.

16.2.3 Except as noted in Clause 16.2.4, a terminal plate tapped for a wire-binding screw shall be of metal not less than 1.27 mm in thickness for a No. 8 or larger screw, and not less than 0.76 mm in thickness for a No. 6 screw, and shall have not less than two full threads in the metal.

16.2.4 A terminal plate may have the metal extruded at the tapped hole for the binding screw so as to provide two full threads in the metal. Other constructions may be employed if they provide equivalent security.

16.3 Field-wiring leads

16.3.1 Leads provided for field connections shall be not less than 150 mm long, provided with strain relief, shall be not smaller than 18 AWG, and the insulation, if of rubber or thermoplastic, shall be not less than 0.8 mm in thickness.

16.4 Power-supply cord

16.4.1 A cord-connected residential control unit shall be provided with no less than 2 m of flexible cord and a two or three prong attachment plug of proper type and rating for connection to the supply circuit.

16.4.2 The flexible cord shall be of Type SP-2, SPT-2, SV, SVT, SJ, SJT, or equivalent, minimum 18 AWG. It shall be rated for use at the voltage and ampacity rating of the appliance.

16.4.3 Means shall be provided to prevent the flexible cord from being pushed into the enclosure through the cord-entry hole if such displacement can subject the cord to mechanical injury or to exposure to a temperature higher than that for which the cord is rated, reduce spacings below the minimum acceptable values, or result in damage to internal components.

16.4.4 Where a flexible cord passes through any opening in a wall, barrier, or enclosing case, the edges of the hole shall be smooth and rounded, without burrs, fins, or sharp edges which may damage the cord jacket.

17 Strain Relief

17.1 General

17.1.1 A strain relief means shall be provided for a power-supply cord, supply leads, battery leads, and internally connected wires or cords which are subject to movement, in conjunction with operation or servicing of a residential control unit, to prevent any mechanical stress from being transmitted to terminals and internal connections. Inward movement of the cord or leads provided with a ring-type strain relief shall not damage internal connections or components.

17.2 Power-supply cord

17.2.1 The strain relief means provided on the flexible cord shall be capable of withstanding for 1 min, without displacement, a pull of 150 N applied to the cord with the connections within the control unit disconnected.

17.2.2 A 16 kg mass is to be suspended on the cord and so supported by the control unit that the strain relief means will be stressed from any angle, which the construction of the unit permits.

17.2.3 The strain relief is not acceptable if, at the point of disconnection of the conductors, there is such movement of the cord as to indicate that stress would have resulted on the connections.

17.3 Field-wiring leads

17.3.1 Each lead employed for field connections shall be capable of withstanding for 1 min a pull of 45 N, without any evidence of damage or of transmitting the stress to internal connections.

18 Internal Wiring

18.1 The internal wiring of a control unit shall consist of suitably insulated copper conductors or equivalent having adequate mechanical strength and current-carrying capacity for the service. The wiring shall be routed away from moving parts and sharp projections, and held in place with clamps, string ties, or equivalent, unless of sufficient rigidity to retain a shaped form.

18.2 Leads connected to parts mounted on a hinged cover shall be of sufficient length to permit the full opening of the cover without applying stress to the leads or their connections. The leads shall be secured or equivalently arranged to prevent abrasion of insulation and jamming between parts of the enclosure.

18.3 Where the use of a short length of suitably insulated conductor is not feasible, e.g., a short coil lead or the like, electrical insulating tubing may be employed.

18.4 The tubing is not to be subjected to sharp bends, tension, compression, or repeated flexing, and is not to contact sharp edges, projections, or corners. The wall thickness is to conform to the requirements for such tubing, except that the thickness at any point for the smaller sizes, 9.5 mm diameter or less, of polyvinyl chloride tubing is to be no less than 0.43 mm.

18.5 For insulating tubing of other types, the wall thickness is to be not less than that required to provide the mechanical strength, dielectric properties, heat- and moisture-resistant characteristics, etc. at least equal to 0.43 mm thick polyvinyl chloride tubing.

18.6 Wireways shall be smooth and free from sharp edges, burrs, fins, moving parts, etc., which may cause abrasion of the conductor insulation. Holes in sheet-metal partitions through which insulated wires pass shall be provided with a bushing if the wall is 1.07 mm or less in thickness. Holes in walls thicker than 1.07 mm shall have a bushing or smooth, rounded edges.

18.7 All splices and connections shall be mechanically secure and bonded electrically.

18.8 Stranded conductors clamped under wire-binding screws or similar parts shall have the individual strands soldered together or equivalently arranged to ensure reliable connections.

18.9 A splice shall be provided with insulation equivalent to that of the wires involved if permanence of adequate spacing between the splice and uninsulated metal parts is not assured.

18.10 Splices shall be located, enclosed, and supported so that they are not subject to damage from flexing, motion, or vibration.

18.11 Internal wiring of circuits, which operate at different potentials, shall be reliably separated by barriers or shall be segregated, unless the conductors of the circuits of lower voltage are provided with insulation, which is suitable for the highest voltage. Segregation of insulated conductors may be accomplished by clamping, routing, or equivalent means, which ensures permanent separation.

18.12 A metal barrier shall have a thickness at least as great as that required by Table 2, based on the size of the barrier. A barrier of insulating material shall be not less than 0.71 mm in thickness and shall be of greater thickness if its deformation may be readily accomplished so as to defeat its purpose. Any clearance between the edge of a barrier and a compartment wall shall be not more than 1.6 mm.

19 Grounding

19.1 Equipment grounding

19.1.1 A control unit intended for permanent connection shall be provided with means for grounding. This may consist of a knockout in a metal enclosure for the connection of a conduit or metal-clad cable, a grounding lead or terminal. The grounding means shall be reliably connected to all exposed dead-metal parts which are liable to become energized and all dead-metal parts within the enclosure which are exposed to contact during servicing.

19.1.2 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. No other lead shall be so identified. The lead shall be of a gauge size equivalent to that of the conductors supplying the unit.

19.1.3 A field-wiring terminal intended for connection of an equipment-grounding conductor shall be plainly identified, such as being marked ″G″, ″GR″, ″GROUND″, ″GROUNDING″ or the equivalent, or by a suitable marking on a wiring diagram provided on the appliance. The field-wiring terminal shall be so located that it is unlikely to be removed during normal servicing of the appliance.

19.1.4 The grounding conductor of a power-supply cord shall be green, with or without one or more yellow stripes. The grounding conductor shall be secured to the frame or enclosure by means of a screw that is not likely to be removed during any servicing operation not involving the power-supply cord, or by other equivalent means. Ordinary solder alone shall not be used for securing the grounding conductor. The grounding conductor shall be connected to the grounding blade or equivalent contacting member of a suitable attachment-plug cap.

19.2 Polarity identification

19.2.1 A lead intended for the connection of a grounded power-supply conductor shall be finished to show a white or gray colour, and shall be readily distinguishable from all other leads.

19.2.2 A terminal, such as a plate and screw, intended for the connection of a grounded power-supply conductor shall be identified by means of a metallic coating, substantially white in colour, distinguishable from the other terminals, or proper identification of the terminal shall be clearly shown in some other manner, such as on an attached or referenced wiring diagram or manual.

20 Components

20.1 Printed wiring boards

20.1.1 Printed wiring boards shall be acceptable for the application. The securing of components to the board shall be made in a reliable manner and the spacings between circuits shall comply with the requirements of Subsection 21, Spacings. The board shall be reliably mounted so that deflection of the board during servicing shall not result in damage to the board or in a fire or shock hazard.

20.2 Bushings

20.2.1 Where a lead or wire harness passes through an opening in a wall, barrier or enclosure, there shall be a metal or insulating-type bushing, or the equivalent, which shall have a smoothly rounded surface against which the wire may bear.

20.2.2 If the opening is in phenolic composition, or other suitable nonconducting material, a smoothly rounded surface is considered to be the equivalent of a bushing.

20.2.3 Ceramic materials and some moulded compositions are considered to be acceptable for insulating bushings; but separate bushings of wood and of hot-moulded shellac are not acceptable.

20.2.4 Fibre may be employed where it will not be subjected to a temperature higher than 90°C under normal operating conditions, if the bushing is not less than 1.2 mm in thickness, with a minus tolerance of 0.4 mm for manufacturing variations, and it is so formed and secured in place that it will not be affected adversely by conditions of ordinary moisture.

20.2.5 If a soft-rubber or neoprene bushing is employed in a hole in metal, the hole shall be free from sharp edges, burrs, projections, etc., which would be likely to cut into the rubber.

20.2.6 An insulating metal grommet would be considered acceptable in lieu of an insulating bushing, provided that the insulating material used is not less than 0.8 mm in thickness and completely fills the space between the grommet and the metal in which it is mounted.

20.3 Coil windings

20.3.1 The insulation of coil windings on relays, transformers, etc., shall be such as to resist the absorption of moisture.

20.3.2 Enamelled wire is not required to be given additional treatment to prevent moisture absorption.

20.4 Switches

20.4.1 A switch provided as part of a device shall have a current and voltage rating not less than that of the circuit which it controls when the device is operated under any condition of normal service.

20.4.2 A test switch shall be of the self-restoring type.

20.4.3 A reset switch shall be of the self-restoring type.

20.4.4 A switch to de-energize the power to the control unit, or to silence sounding devices shall not be provided unless its ″off-normal″ position is indicated by a visual or audible trouble signal. Where a remote switch is used, the trouble signal shall also be provided at the remote location.

20.4.5 In a combination system, a switch to de-energize circuits other than a backwater valve circuit may be used without a visual indication to signal its ″off-normal″ position.

20.5 Protective devices

20.5.1 Sensor operated backwater prevention system bodies manufactured from acrylonitrile-butadiene-styrene (ABS) shall conform to the physical property requirements contained in ASTM D3965 or CSA B181.1. The minimum cell classification shall be 3-2-2-2-2. The minimum thickness for the casting bodies shall be 3.96 mm (5/32 in). Inserts for fasteners in plastic shall be molded into the plastic material. Clean, rework plastic generated from the manufacturer’s own product and conforming to the cell requirements shall be permitted to be used provided that the valves comply with all requirements of this Standard.

21 Spacings

21.1 A control unit shall provide reliably maintained spacings between uninsulated live parts and dead-metal parts and between uninsulated current- carrying parts of opposite polarity. The spacings shall be not less than those indicated in Table 5.

21.2 The spacing between an insulated live part and: a wall or cover of a metal enclosure; a fitting for conduit or metal-clad cable; and a metal piece attached to a metal enclosure, where deformation of the enclosure is liable to reduce spacings, shall be not less than that indicated in Table 5.

21.3 The spacing between an uninsulated live part and: an uninsulated live part of opposite polarity; an uninsulated, grounded, dead-metal part other than the enclosure; and an exposed dead-metal part which is isolated (insulated), shall be not less than that indicated in Table 5.

21.4 The spacings within snap switches, lampholders, and similar wiring devices supplied as part of a unit are judged on the basis of the requirements for such devices.

21.5 A barrier or liner of insulating material which is used to provide spacings shall be of material such as impregnated fibre, phenolic composition, or the equivalent, and shall be not less than 0.71 mm in thickness.

21.6 A barrier or liner which is used in conjunction with not less than 50% the required spacing through air shall be not less than 0.33 mm in thickness, and so located that it will not be affected adversely by operation of the control unit.

21.7 Insulating material having a thickness less than that specified in Clause 21.5 or Clause 21.6 may be used if it has equivalent mechanical and electrical properties.

21.8 Film-coated wire is considered to be a bare current-carrying part in determining compliance of a device with the spacing requirements, but is acceptable as turn-to-turn insulation in coils.

22 Materials and Finishes

22.1 General

22.1.1 The items covered in this Standard shall be of the material specified, suitable for installation and service in the place specified, and shall meet all applicable requirements and standards given herein. Materials other than those specified in this Standard may be used provided such alternative materials, in all other respects, meet the applicable requirements of this Standard.

22.2 Internal working parts

22.2.1 The internal working parts shall be copper alloy in accordance with ASTM B16, stainless steel in accordance with ASTM A351, or equally corrosion resisting material. The castings or moldings shall be sound, free of blow holes, cold shuts, fins, flashings, and other imperfections affecting casting quality and shall be of uniform thickness.

22.2.2 If the pneumatic type sealing element is constructed of ethylene propylene dienemonomer (EPDM), it shall comply with ASTM D3568 and with the requirements specified in Table 6.

22.3 Cast iron

22.3.1 Castings shall conform to Class 25 in accordance with ASTM A48. The minimum thickness for the casting shall be 6 mm (7/32 in.).

22.4 Copper alloy

22.4.1 Castings shall conform to ASTM B584 and be either Copper Alloy No. 83600, 83800, or 84400. The minimum thickness for the casting shall be 3.96 mm (5/32 in.).

22.5 ABS

22.5.1 Sensor operated backwater prevention system bodies manufactured from acrylonitrile-butadiene-styrene (ABS) shall conform to the physical property requirements contained in ASTM D3965. The minimum cell classification shall be 3-2-2-2-2. The minimum thickness for the casting bodies shall be 3.96 mm (5/32 in.). Inserts for fasteners in plastic shall be molded into the plastic material. Clean, rework plastic generated from the manufacturer’s own product and conforming to the cell requirements shall be permitted to be used provided that the valves comply with all requirements of this Standard.

22.6 PVC

22.6.1 Sensor operated backwater prevention system bodies manufactured from polyvinyl chloride (PVC) shall conform to the physical property requirements contained in ASTM D1784 or CSA B181.2. The cell classification shall be 12454-B, 12454-C, or 14333-D. The minimum thickness shall be 3.96 mm (5/32 in). Inserts for fasteners in plastic drains shall be molded into the plastic material. Clean, rework plastic generated from the manufacturer’s own product and conforming to the cell requirements shall be permitted to be used provided that it comply with all requirements of this Standard.

22.7 Gaskets

22.71 Gaskets shall comply at least with classification M 1 BA 7 10 as specified in ASTM D2000. Alternatively, gaskets may comply with ASTM C564, ASTM C1440, CSA B602, SAE J200, or UL 157.

22.8 Bolting materials

22.8.1 Steel

22.8.1.1 Steel materials for studs, nuts, bolts, cap screws, and other steel fasteners shall, as a minimum, conform to the requirements of ASTM A 307, Grade A. Threads shall be Class 2A and Class 2B and shall be plated. Fasteners fabricated from stainless steel shall be 300 series alloy.

22.8.2 Copper Alloy

22.8.2.1 Copper Alloy materials for nuts, bolts, cap screws and other copper alloy fasteners shall, as a minimum, conform to the requirements of ASTM B16. Threads shall be Class 2A and Class 2B.

22.9 Finishes

22.9.1 In all cases where parts are to be coated or plated, they shall be pickled as required and cleaned to provide a suitable surface for proper bonding of the finish.

22.10 Coatings

22.10.1 Coatings applied to the backwater valve assembly shall comply with the requirements specified in ASME A112.18.1/CSA B125.1.

23 Connections

23.1 Hub and spigot

23.1.1 Hub and spigot connections shall conform to ASTM A74 or CSA B70 for soil pipe and fittings or shall conform to ASTM D2665 or CSA B181.1for ABS materials or ASTM D2661 or CSA B181.2 for PVC material for DWV pipe and fittings..

23.2 Flanged

23.2.1 Flanged connections shall conform to the Class 125 requirements in ASME B16.1.

23.3 Hubless

23.3.1 Hubless connections shall conform to ASTM A888 or CSA B70.

23.4 Threaded

23.4.1 Threaded outlet connections shall comply with ASME B1.20.1.

23.5 Solvent cement

23.5.1 Solvent cemented outlet connections shall be made using the appropriate solvent cement and methods of joining. ABS solvent cement joints shall be in accordance with ASTM D2661 and PVC solvent cement joints shall be in accordance with ASTM D2665.

23.6 O-ring joints

23.6.1 O-ring joints shall comply with ASTM C564, ASTM C1440, or CSA B 602.

23.7 Dimensions

23.7.1 The internal passageway of sensor operated backwater prevention systems shall comply with the internal dimensions and thread requirements specified in one of the following standards, as applicable:

a) For cast iron soil pipe: ASTM A74, ASTM A888, CISPI 301, or CSA B70;

b) For ABS pipe and fittings: ASTM D2122, ASTM D2661, ASTM D3212, CSA B181.1, or CSA B182.1; and

c) For PVC pipe and fittings: ASTM D2665, ASTM D3212, CSA B181.2, or CSA B182.2.

23.7.2 Table 7 specifies the ABS, PVC, and cast iron fitting types and sizes that can be used with sensor operated backwater prevention systems.

PERFORMANCE

24 General

24.1 The test specimen, a sensor operated backwater prevention systems, shall be installed in accordance with the manufacturer's instructions into the test apparatus. The test apparatus consists of a compliant ABS, PVC, or cast iron wye fitting of the size corresponding to the test specimen, assembled with two sections of pipe approximately 300 mm (1 ft) long and end caps.

25 Watertightness/Leakage and Backwater Pressure Test

25.1 The outlet of the test apparatus shall be connected to a water source capable of 34 kPa (5 psi). The water pressure shall be increased to 34 kPa (5 psi) in four steps as follows:

Water Pressure	
kPa	***(psi)***
1.7	(0.25)
3.4	(0.50)
6.8	(1.0)
34	(5.0)

25.2 The pressure shall be maintained at each step for 10 min ± 15 s. During each test period any water that is emitted from the entrance side of the inlet of the test apparatus shall be collected, measured, and recorded. The water leakage shall not exceed the values found in Table 8.

26 Cap Sealing and Thread Integrity Test

26.1 The cap shall be tightened to the manufacturers required installation torque. The assembly shall then be pressured to a 100 kPa (15 psi) with water. The assembly shall be inspected for any leakage at the cap seal. After 5 min the water shall be shut off and pressure shall be released by unscrewing the cap. The threads examined for damage.

26.2 These steps shall be repeated until five sets of data are obtained. For each test any signs of damage at the threads or leakage during testing shall be considered as failure.

27 Waterflow

27.1 The inlet through the test specimen shall permit the passage of a cylinder 300 mm (12 in.) long and a diameter as found in Table 9.

27.2 Where the test specimen body has an integral quarter bend on the outlet, or assembled in a floor drain, the test cylinder shall pass through the test specimen to the point of interference with the quarter bend or floor drain.

28 Rupture Test

28.1 If the sealing element is pneumatic type, it shall be inflated to 103 kPa (15 psi) and shall not rupture.

28.2 Rupture at a pressure of less than 103 kPa (15 psi) shall constitute a failure of this test.

29 Power Failure Mode Test

29.1 The test specimen shall be disconnected from AC power source. The test apparatus shall be completely filled with water at 23 ± 2 ºC (73 ± 5ºF). The sealing element shall begin to deploy within 10 s of water filling the pipe and completely seal the pipe and fitting within 60 s. The sealing element shall remain deployed for a period of 24 h.

29.2 Following the 24 h test period, test in accordance with 25.2.

30 Life Cycle Test

30.1 A complete test shall consist of a total of twice the number of cycles suggested by the manufacturer before replacement of the sealing element up to a maximum of 100 cycles. The test shall be conducted as follows:

a) The device shall be installed as per the manufacturer’s instructions

b) A minimum 300 mm (1 ft) length of clear pipe with an end plug shall be installed on the upstream side of the device. The pipe shall have vent to allow air to be released.

c) A minimum 300 mm (1 ft) length of clear pipe with a 90 degree elbow and a minimum 3650 mm (12 ft) vertical section installed on the downstream side of the device. The horizontal section of pipe shall have a valve as a means to completely drain the pipe.

d) Backwater condition shall be simulated by delivering water from the downstream side at a rate sufficient to trigger deployment of the sealing element.

e) The sealing element shall remain closed for a period of a minimum of 8 h.

f) The water shall be released and the sealing element shall reset to the open position.

g) Wait at least a period of 1 min after sealing element resets.

h) Repeat steps 30.1 C) – F) for the total number of cycles.

i) After completion of the final cycle, create a backwater condition to deploy the sealing element.

j) Remove the upstream pipe length.

k) A means to collect water that backflows through the device shall be located directly upstream from the device.

l) Test the device in accordance with Subsection 25.

31 Time Delay Requirement Test

31.1 System activation

31.1.1 To prevent the false detection of a backwater condition, there shall be a range of 5 to 20 s of continuous detection of backwater before the sealing element begins activating to the closed position when tested in accordance with Clause 31.2.

31.2 System activation test procedure

a) The device shall be installed as per the manufacturer's instructions.

b) A minimum 300 mm (1 ft) length of clear pipe with an end plug shall be installed on the upstream side of the device. The pipe shall have vent to allow air to be released.

c) A minimum 300 mm (1 ft) length of clear pipe with a 90 degree elbow and a minimum 3650 mm (12 ft) vertical section installed on the downstream side of the device. The horizontal section of pipe shall have a valve as a means to completely drain the pipe.

d) Fill downstream pipe until the horizontal section is full.

e) Start timing.

f) Leave pipe full for 3 to 4 s.

g) Drain the downstream pipe by opening valve.

h) Verify that the sealing element has not started to deploy.

i) Repeat steps (a) – (e).

j) Verify that sealing element has started to deploy after a period of no greater than 20 s.

31.3 System deactivation

31.3.1 To allow the stabilization of a backwater condition, there shall be a minimum 10 min time of continuous detection of no backwater condition before the sealing element begins to reset to the open position when tested in accordance with Clause 31.4.

31.4 System deactivation test procedure

a) The device shall be installed as per the manufacturer’s instructions;

b) minimum 300 mm (1 ft) length of clear pipe with an end plug shall be installed on the upstream side of the device. The pipe shall have vent to allow air to be released;

c) A minimum 300 mm (1 ft) length of clear pipe with a 90 degree elbow and a minimum 3650 mm (12 ft) vertical section installed on the downstream side of the device. The horizontal section of pipe shall have a valve as a means to completely drain the pipe;

d) Fill downstream pipe until the horizontal section is full;

e) Verify that the sealing element has been completely deployed;

f) Drain the downstream pipe by opening valve;

g) Start timing after water has completely drained from the downstream pipe;

h) Verify that the sealing element returns to its normally open position within manufacturers specification, but not less than 10 min;

i) Repeat steps (a) – (g); and

j) Verify that the sealing element is still deployed after 30 min.

32 Corrosion Test

32.1 Water sensors shall show no significant loss (i.e., less than 15%) of electrical impedance and no visible trace of corrosion after exposure to:

a) 5 ppm of hydrogen sulfide H_2S for 168 h; and

b) 50 ppm of hydrogen sulfide H_2S at 100% humidity for 1 h.

33 Control Unit Tests

33.1 General

33.1.1 Except as otherwise indicated, the performance of a residential control unit shall be investigated by subjecting a representative sample in commercial form to the tests described in the following Clauses and, as far as applicable, in the same order as presented.

33.1.2 Power supply terminals are to be connected to a supply circuit of rated voltage and frequency. Rated voltage is considered to be 120 V, if the marked rating is within the range of 110 to 125 V.

33.1.3 The type of battery, when used, with which the control unit is intended to be employed, shall be connected to the control unit.

33.1.4 In a combination control unit, circuits for backwater valve initiating devices shall be separate from circuits used for non-backwater valve devices.

33.1.5 If a control unit must be mounted in a definite position in order to function properly, it shall be tested in that position.

33.2 Normal operation test

33.2.1 A control unit shall be capable of operating reliably and uniformly for all conditions of its intended performance when employed in conjunction with initiating devices, and indicating devices to form a system combination of the type indicated by the installation diagram and any supplementary information provided.

33.2.2 A sensor operated backwater valve is to be connected to the control unit as specified by the installation diagram to form a typical combination, and the control unit is then operated for each condition of its intended performance.

33.2.3 A control unit shall be in the normal supervisory ″standby″ condition and prepared for normal signalling and actuation operation when it is connected to related devices and circuits as specified on the installation wiring diagram provided by the manufacturer. A ″power on″ visual indication shall be obtained.

33.2.4 The operation of any sensing device shall cause the control unit to operate related indicating devices so as to produce a clearly defined signal, different from a T3 and T4 alarm signal, of the type for which the combination is designed.

33.2.5 The normal operation of a backwater valve control unit shall not depend upon any ground connection.

33.3 Electrical supervision test

33.3.1 The initiating device (sensor) circuit and signalling circuit device of a residential control unit shall be electrically supervised to promptly indicate (by a distinctive audible trouble signal), the occurrence of a single break (open) or single ground fault which prevents the control unit from operating signalling devices when initiated. Prior to the application of a fault, the control unit shall be energized in the normal standby condition while connected to a rated source of voltage and frequency.

33.3.2 Supervision is not required for an initiating device circuit extending not more than 1000 mm from the control unit or not more than 1000 mm from a device (transmitter) that provides the required supervised transmission of an alarm at the control unit provided that a test feature or procedure is incorporated to test the operability of the circuit and the 1000 mm distance does not include an intervening barrier such as a wall or ceiling.

33.3.3 An open in the primary supply of a residential control unit shall be shown by de-energization of the ″power on″ indicator.

33.3.4 An open or ground fault in any circuit extending from a residential control unit, other than the initiating device circuit, shall not affect the normal operation of the control unit except for the loss of the function extending from that circuit.

33.3.5 A single break or single ground fault in any signaling device or indicating device circuit or any circuit extending from the control unit, or interruption and restoration of any source of electrical energy connected to a control unit, shall not cause an alarm signal.

33.3.6 A fault condition, open circuit ground, or short circuit of other than a backwater valve circuit or initiation circuit of a control unit shall not affect the backwater valve actuation.

33.3.7 A trouble signal shall be distinctive from all other signals.

33.3.8 If a silencing means, such as a switch, is provided to de-energize the audible trouble signal, its off-normal position shall be indicated by a trouble light.

33.4 Undervoltage operation test

33.4.1 A control unit shall operate successfully for its intended signalling performance while energized at 85% of its rated voltage.

33.4.2 The control unit is to be subjected to rated voltage during the normal supervisory condition for at least 3 h and then tested immediately for the normal signalling condition at the reduced voltage. The voltage is to be reduced by a means, which will maintain a stable potential of the required value under the most severe conditions of normal loading.

33.4.3 When a standby battery is employed with the control unit, the reduced voltage value is to be computed on the basis of the rated nominal battery voltage.

33.4.4 If the maximum impedance of an initiating circuit extended from a control unit is required to be less than 100 W in order to obtain successful operation, the Undervoltage Test is to be made with the maximum impedance connected to the circuit. If no impedance limitation is indicated in the Marking, 100 W shall be employed in the initiating device circuit.

33.5 Overvoltage operation test

33.5.1 A control unit shall be capable of withstanding 110% of its rated supply voltage continuously without injury during the normal standby condition and shall operate successfully for its intended normal signalling performance at the increased voltage.

33.5.2 The control unit is to be subjected to the increased voltage in the normal standby condition for approximately 16 h (overnight) and then tested for its intended normal signalling performance. For this test, zero line impedance shall be employed in the initiating device circuit.

33.6 Voltage and current measurements

33.6.1 Input Circuit

33.6.1.1 The input current of a control unit shall not exceed the marked rating of the control unit by more than 10% when the control unit is operated under conditions of intended use while connected to a rated source of supply.

33.6.2 Output Circuit

33.6.2.1 The measured voltage of a control unit output circuit shall be not more than 130% of rated voltage at no load conditions and not less than 100% of rated voltage at maximum rated load conditions. The same proportionate limits shall be maintained at the output circuit when the supply voltage is varied between 85 and 110% of rating. The rated loads shall be connected with the control unit connected to a rated source of supply.

33.6.2.2 The measured voltages at the output circuits, with the minimum and maximum (rated) loads applied in turn, shall be compatible with the rating of the device or appliance intended to be connected to the circuit.

33.7 Jarring test

33.7.1 A control unit and related accessories shall be capable of withstanding jarring resulting from impact and vibration such as might be experienced in use, without causing signalling operation of any part and without affecting adversely the subsequent normal operation. See Figure 1.

33.7.2 The control unit is to be mounted in a position of intended use to the centre of a 1800 by 1200 by 19 mm thick plywood board which is secured in place at four corners. A 100 mm^2 steel plate, 3.2 mm thick, shall be rigidly secured to the centre of the reverse side of the board. Three 1.5 J impacts are to be applied to the centre of the reverse side of the board by means of a 540 g, 50 mm diameter steel sphere swung through a pendulum arc from a height of 286 mm to apply 1.5 J of energy.

33.7.3 The effects of jarring are to be determined by supporting the unit in its intended position and conducting the Jarring Test with the unit in its normal standby condition and connected to a rated source of supply. Following the Jarring Test, the unit shall be tested for normal signalling performance.

33.8 Temperature test

33.8.1 The materials employed in the construction of a residential control unit shall not be adversely affected by the temperatures attained under any condition of normal operation.

33.8.2 A material will be considered as being adversely affected if it is subject to a temperature rise greater than that indicated in Table 10.

33.8.3 The classes of material used for electrical insulation referred to include materials as follows:

a) Class 105 – Impregnated cotton, paper and similar organic materials when impregnated, and enamel as applied to coil windings; and

b) Class 130 – Inorganic materials such as mica and impregnated asbestos.

33.8.4 All values for temperature rises apply to equipment intended for use with ambient temperatures normally prevailing which usually are not higher than 25°C. If equipment is intended specifically for use with a prevailing ambient temperature constantly more than 25°C, the test of the equipment is made at such higher ambient temperature, and the allowable temperature rises specified in Table 10 are to be reduced by the amount of the difference between that higher ambient temperature and 25°C.

33.8.5 Temperature measurements on equipment intended for recessed mounting shall be made with the unit installed in an enclosure of 19 mm wood having clearances of 50 mm on the top, sides and rear, and the front extended to be flush with the control unit cover.

33.8.6 A temperature is considered to be constant when three successive readings, taken at 5 min or greater intervals, indicate no change.

33.8.7 Temperatures are to be measured by means of thermocouples consisting of wires not larger than 24 AWG. The preferred method of measuring the temperature of a coil is the thermocouple method. Notwithstanding a temperature measurement by either the thermocouple or resistance method is acceptable, except that the thermocouple method is not to be employed for a temperature measurement at any point where supplementary thermal insulation is employed.

33.8.8 If thermocouples are used in the determination of temperatures in connection with the heating of electrical devices, it is standard practice to employ thermocouples consisting of 30 AWG iron and constantan wires and a potentiometer-type indicating instrument. Such equipment will be used whenever reference temperature measurements by thermocouples are necessary.

33.8.9 The temperature of a copper coil winding is determined by the resistance method by comparing the resistance of the winding at the temperature to be determined with the resistance at a known temperature by means of the formula:

$$T = \frac{R}{r}(234.5 + t) - 234.5$$

Where:

T is the temperature to be determined in degrees C;

R is the resistance in ohms at the temperature to be determined;

r is the resistance in ohms at the known temperature; and

t is the known temperature in degrees C.

33.8.10 As it is generally necessary to de-energize the winding before measuring R, the value of R at shutdown may be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after the instant of shutdown. A curve of the resistance values and the time may be plotted and extrapolated to give the value of R at shutdown.

33.8.11 To determine compliance with this test a control unit is to be connected to a supply circuit of rated voltage and frequency and operated under the following conditions:

a) Normal Standby – (16 h) – Constant temperatures;

b) Alarm – (1 h) – Audible signal operating; and

c) Alarm – (7 h) – Audible signal silenced.

33.9 Overload test

33.9.1 Control unit

33.9.1.1 A control unit shall be capable of operating in a normal manner after being subjected for 50 cycles of alarm signal operation at a rate of not more than 15 cycles/min with the supply circuit maintained at 115% of rated voltage and frequency. Each cycle shall consist of starting with the control unit energized in the normal stand-by condition, initiation for an alarm, and restoration to normal stand-by.

33.9.1.2 Rated test loads are to be connected to those output circuits of the control unit, which are energized from the control unit power supply, such as bells, buzzers, etc. The test loads shall be those devices or the equivalent, normally intended for connection. If an equivalent load is employed for a device consisting of an inductive load, a power factor of 60% is to be employed. The rated loads are established initially with the control unit connected to rated supply voltage and frequency, following which the voltage is raised to 115% of rating.

33.9.1.3 For direct-current signalling circuits an equivalent inductive test load is to have the required direct-current resistance for the test current and the inductance (calibrated) to obtain a power factor of 60% when connected to a 60 Hz, alternating current potential equal to the rated direct-current test voltage. When the inductive load has both the required direct-current resistance and the required inductance, the current measured with the load connected to an alternating-current circuit is to be equal to 0.6 times the current measured with the load connected to a direct-current circuit when the voltage of each circuit is the same.

33.9.2 Separately energized circuits

33.9.2.1 A residential control unit shall be capable of operating in a normal manner after being subjected to 50 cycles of alarm signal operation at a rate of not more than 15 cycles/min while connected to a source of rated voltage and frequency and 150% rated loads applied to output circuits which do not receive energy from the control unit. There shall be no electrical or mechanical failure of any of the components.

33.9.2.2 The test loads shall be set at 150% of rated current at rated voltage and frequency and 0.6 power factor.

33.10 Endurance test – control unit

33.10.1 A control unit shall be capable of operating in a normal manner after being subjected to 500 cycles of signal operation at a rate of not more than 15 cycles/min with the supply circuit at rated voltage and frequency and with rated devices or equivalent loads connected to the output circuits. There shall be no electrical or mechanical failure or evidence of failure of the control unit components. Each cycle shall consist of starting with the control unit in the normal standby condition, initiation for an alarm, and restoration to normal standby.

33.11 Variable ambient temperature test

33.11.1 A residential control unit and related accessories shall be capable of operating in a normal manner when the temperature of the ambient air is any temperature over the range 0°C to 49°C.

33.11.2 The unit is to be maintained at each temperature for a sufficient length of time to ensure that thermal equilibrium has been reached, at least 3 h, and then tested at that temperature for normal operation while connected to a source of rated voltage and frequency.

33.12 Humidity test

33.12.1 A residential control unit shall be capable of operating in normal manner while energized from a rated source of voltage and frequency after having been exposed for 24 h to moist air having a relative humidity of 85 ±5% at a temperature of 30 ±2°C. The performance shall be determined with the control unit in the humidity ambient.

33.13 Leakage current test

33.13.1 The leakage current from a control unit shall be not more than 0.5 mA as measured between an exposed section of the enclosure to the grounded leg of the alternating-current supply.

33.13.2 The leakage current measurement shall be made on the sample within 1 min after it has been removed from the ambient in the Humidity Test. The sample is to be connected to a source of rated voltage and frequency in the normal standby condition.

33.13.3 If a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using a metal foil with an area of 100 by 200 mm placed in contact with the surface. Where the surface is less than 100 by 200 mm, the metal foil is to be the same size as the surface. The metal foil is not to be pressed into openings and is not to remain in place long enough to affect the temperature of the sample.

33.13.4 The unit shall be mounted on an insulating table. For a cord-connected unit the grounding pin connection from the attachment-plug cap shall be disconnected prior to making the leakage current measurement.

33.13.5 The test meter employed to measure the leakage current is an average responding alternating-current milliammeter which indicates the root-mean-square value of a pure sine wave, has an error of not more than 5%, and an input impedance of not more than 1500 Ω.

33.14 Electric shock current test

33.14.1 A shock hazard from contact with a live part is considered to exist if the open circuit potential of the part to earth ground or any other exposed accessible part exceeds 42.4 V peak and the available current or stored energy exceeds the values specified in Clauses 33.14.2, 33.14.3 and 33.14.4.

33.14.2 To qualify as a nonhazardous part, the continuous current flow through a 500 Ω resistor connected between the part and earth ground or any other exposed accessible part shall not exceed the values specified in Table 11.

33.14.3 To qualify as a nonhazardous part, the duration of a transient current flowing through a 500 Ω resistor connected between the part and earth ground or other exposed accessible part shall not exceed the following:

a) The value determined by the following equation:

$$T \le \left(\frac{20\sqrt{2}}{I}\right)^{1.43}$$

Where:

I = the peak current in milliamperes; and

T = the interval, in seconds, between the time that the instantaneous value of the current first exceeds 7.1 mA and the time that the current falls below 7.1 mA for the last time (the interval between occurrences shall be equal to or greater than 60 s if the current is repetitive); or

b) 809 mA, regardless of duration.

33.14.4 Typical calculated values of maximum acceptable transient current duration are shown in Table 12.

33.14.5 The stored energy of a capacitor shall be considered nonhazardous if the maximum capacitance between the accessible terminals of the capacitor does not exceed the values given by the following equations:

$$C = \frac{88\,400}{E^{1.43}(\text{Ln } E - 1.26)} \quad \text{for} \quad 42.4 \le E \le 400$$

OR

$$C = 35\,288\ E^{-1.5364} \text{ for } 400 \le E \le 1000$$

Where:

C = The maximum capacitance of the capacitor in microfarads; and

E = The potential in volts across the capacitor prior to discharge. E is to be measured 5 s after the capacitor terminals are made accessible, such as by the removal or opening of an interlocked cover, or the like.

33.14.6 Typical calculated values of maximum capacitance are shown in Table 13.

33.14.7 With reference to the requirements of Clauses 33.14.2, 33.14.3 and 33.14.4, the current is to be measured while the resistor is connected between ground and each accessible part individually, and all accessible parts collectively if the parts are simultaneously accessible. The current also is to be measured while the resistor is connected between one part or group of parts and another part or group of parts, if the parts are simultaneously accessible.

33.14.8 With reference to the requirements of Clause 33.14.7, parts are considered to be simultaneously accessible if they can be contacted by one or both hands of a person at the same time. For the purpose of these requirements, one hand is considered to be able to contact parts simultaneously if the parts are within a 100 by 200 mm rectangle; and two hands of a person are considered to be able to contact parts simultaneously if the parts are not more than 1800 mm apart.

33.14.9 Electric shock current refers to all currents, including capacitively coupled currents.

33.14.10 If the product has a direct-current rating, measurements are to be made with the product connected in turn to each side of a 3 wire, direct current supply circuit.

33.14.11 Current measurements are to be made with any operating control, or adjustable control that is subject to user operation, in all operating positions, and either with or without a plug-in device, separable connector, or similar component in place. These measurements are to be made with controls placed in the position that causes maximum current flow.

33.15 Transient tests

33.15.1 General

33.15.1.1 A control unit and any equipment intended to be connected to it shall not cause a false alarm, operate for its intended signalling performance, not be affected adversely, and retain required stored memory (such as date, type, and location of a signal transmission) within the unit when subjected to 500 supply line (high-voltage circuit) transients, internally induced transients, and 60 supply line (low-voltage circuit) transients, while energized from a source of supply in accordance with Clause 33.1.2.

33.15.1.2 Supplemental information stored within the unit need not be retained.

33.15.1.3 At the conclusion of each test, the control unit and any equipment intended to be connected to the signalling circuits shall comply with the requirements in the Normal Operation Test, Subsection 33.2.

33.15.2 Supply line (high-voltage circuit) transients

33.15.2.1 A line voltage ac-operated control unit is to be subjected to supply line (high-voltage circuit) transients induced directly into the power supply circuit conductors.

33.15.2.2 For this test, the control unit is to be connected to a transient generator, consisting of a 2 kVA isolating power transformer and control equipment that produces the transients described in Clause 33.15.2.3. See Figure 2. The output impedance of the transient generator is to be 50 Ω.

33.15.2.3 The transients produced are to be oscillatory and are to have an initial peak voltage of 6000 V. The rise time is to be less than 0.5 ms. Successive peaks of the transient are to decay to a value of not more than 60% of the value of the preceding peak.

33.15.2.4 The control unit is to be subjected to 500 oscillatory transient pulses induced at a rate of 6 transients/min. Each transient pulse is to be induced 90° into the positive half of the 60 Hz cycle. A total of 250 pulses are to be applied so that the polarity of the transients is positive with reference to earth ground, and the remaining 250 pulses are to be negative with respect to earth ground.

33.15.3 Internally induced transients

33.15.3.1 The control unit is to be energized in the normal standby condition from a rated source of supply which is to be interrupted for approximately 1 s at a rate of not more than 6 cycles/min for a total of 500 cycles. Following the test the unit is operated for its intended normal signalling performance.

33.15.4 Input/output circuit (low-voltage circuit) transients

33.15.4.1 The control unit is to be energized in the normal standby condition while connected to a source of supply in accordance with Clause 33.1.2. The applicable transients described in Clauses 33.15.4.3 to 33.15.4.7 are to be induced in each low-voltage circuit and any equipment intended to be connected to the circuit.

33.15.4.2 A circuit or cable that interconnects equipment located within the same room need not be subjected to this test.

33.15.4.3 Circuits intended to be installed entirely within a building are to be tested as specified in Clause 33.15.4.3. The transient pulses are to be induced directly into each circuit of the control unit and any equipment intended to be connected to that circuit.

33.15.4.4 For this test each input/output circuit is to be subjected to a minimum of four different transient waveforms having peak voltage levels in the range of 100 to 2400 V, as delivered into a 200 Ω load.

33.15.4.5 A transient waveform at 2400 V shall have a pulse rise time of 100 V/ms, a pulse duration of approximately 80 µs, and an energy level of approximately 1.2 J.

33.15.4.6 Other applied transients shall have peak voltages representative of the entire range of 100 to 2400 V, with pulse durations from 80 to 1100 µs, and energy levels not less than 0.03 J or greater than 1.2 J.

33.15.4.7 The circuit and any connected signalling equipment is to be subjected to 60 transient pulses induced at the rate of 6 min as follows:

a) Twenty pulses (two at each transient voltage level specified in Clause 33.15.4.5) between each circuit lead or terminal and earth ground, consisting of ten pulses of one polarity, and ten of the opposite polarity (total of 40 pulses); and

b) Twenty pulses (two between each transient voltage level specified in Clause 33.15.4.5) between any two circuit leads or terminals consisting of ten pulses of one polarity and ten of the opposite polarity.

33.16 Dielectric voltage-withstand test

33.16.1 A residential control unit and related accessories shall withstand for 1 min, without breakdown, the application of an essentially sinusoidal ac potential of a frequency within the range of 40 to 70 Hz, or a dc potential, between: live parts and the enclosure; live parts and exposed dead metal parts; and live parts of circuits operating at different potentials or frequencies. The test potential shall be as follows (refer also to Clause 33.16.2).

a) For a unit rated 30 Vrms (42.4 Vdc or ac peak) or less – 500 V rms (707 V if a dc potential is used); and

b) For a unit rated more than 30 Vrms (42.4 V dc or ac peak) – 1000 V plus twice the rated voltage (1414 V dc plus 2.828 times the rated ac rms voltage, if a dc potential is used).

33.16.2 For the application of a dielectric potential between live parts of circuits operating at different voltages or frequencies, the voltage is to be the applicable value specified in item A, or B of Clause 33.16.1, based on the highest voltage of the circuits under test instead of the rated voltage of the unit. Electrical connections between the circuits are to be disconnected before the test potential is applied.

33.16.3 If an autotransformer is in the circuit, the primary of the transformer is to be disconnected and an ac test potential in accordance with Clause 33.16.1 (B) is to be applied directly to all wiring involving more than 150 V.

33.16.4 If the charging current through a capacitor or capacitor type filter connected across the line, or from line to earth ground, is sufficient to prevent maintenance of the ac test potential specified in Clause 33.16.1, the capacitor or filter is to be tested using an equivalent dc test potential. See Clause 33.16.1.

33.16.5 The test potential may be obtained from any convenient source having sufficient capacity to maintain the specified voltage. The output voltage of the test apparatus is to be monitored. Starting at zero volts, the potential is to be gradually increased at a rate of approximately 200 V/min until the required test value is reached and is to be held at that value for 1 min.

33.16.6 A printed wiring assembly or other electronic circuit component that would be damaged by the application of, or would short-circuit, the test potential, is to be removed, disconnected, or otherwise rendered inoperative before the test. A representative subassembly may be tested instead of an entire unit. Rectifier diodes in the power supply may be individually shunted before the test to avoid destroying them in the case of malfunction elsewhere in the secondary circuits.

33.17 Component failure test

33.17.1 Failure of electronic components, such as opening or shorting of capacitors, shall either have no adverse effect on normal operation or, if failure of a component affects operation, its failure shall be indicated by a trouble or an alarm signal.

33.17.2 If it is not practical to have a component failure indicated, a component may be employed if its reliability is attained by derating or is shown to be reliable as determined by a review of reliability data to be provided for the component.

33.18 Audibility test

33.18.1 An integral alarm sounding appliance shall be capable of providing a free field output of at least 85 dBA at 3000 mm.

33.18.2 The measurement of sound level is to be made with a sound level meter employing the A weighting network and fast response characteristics. The microphone and sounding appliance are to be mounted on a horizontal plane not less than 3000 mm apart. The sounding appliance is to be located so that its plane of maximum audibility is to be directed toward the microphone. The device under test is to be mounted on a support as intended in service. The ambient noise level is to be at least 10 dB below the measured level produced by the signal device.

33.18.3 The device shall be mounted in its intended position, not less than 1500 mm from the ground on a support, with the microphone located 3000 mm from the appliance. There shall be no obstructions in the direction of sound projection within 1500 mm of the signal appliance or the microphone.

33.18.4 Alternately, an anechoic chamber of not less than 30 m^3, with no dimension less than 2000 mm, and with an absorption factor of 0.99 or greater from 100 Hz to 10 kHz for all surfaces may be used for this measurement.

33.19 Abnormal operation test

33.19.1 A residential control unit shall be capable of operating continuously under abnormal conditions without resulting in a fire or shock hazard. Leakage current measurements shall not exceed 0.5 mA.

33.19.2 A unit is to be operated under the most severe abnormal conditions liable to be encountered in service while connected to a source of rated supply. There shall be no emission of flame or molten metal or any other manifestation of a fire hazard. Leakage current following the test shall be measured in accordance with the Leakage Current Test, Subsection 33.13.

33.19.3 In determining if a residential control unit complies with the requirements with respect to circuit fault conditions, the fault condition is to be maintained continuously until constant temperatures are attained or until burnout occurs, if the fault does not result in the operation of an overload protective device.

34 Marking

34.1 All components of sensor operated backwater prevention systems shall be marked with the:

a) Manufacturer’s name or trademark; and

b) Nominal size for the sealing element and pipe sealing diameter; and

c) Direction of flow.

34.2 Markings shall be permanent and legible.

34.3 Each sensor operated backwater prevention system shall have detailed installation and operation instructions specifying at least the following:

a) Any special materials, methods, and equipment necessary for proper installation;

b) Requirements for connection to the supply circuit;

c) Acceptable lubricants;

d) Minimum maintenance requirements; and

e) Safety considerations

35 Maintenance And Operating Instructions

35.1 Each backwater valve shall be supplied with operation and maintenance instructions by the manufacturer.

35.2 The manufacturer shall provide the number of deployment cycles before replacement of the sealing element.

TABLES

Table 1
Cast metal enclosures

(Reference: Clause 6.2.1)

USE, OR DIMENSIONS OF AREA INVOLVED [a]	MINIMUM THICKNESS	
	DIE-CAST METAL	CAST METAL OTHER THAN DIE-CAST TYPE
(m^2)	(mm)	(mm)
Area of 155 cm^2 or less and having no dimension greater than 150 mm	1.6	3.2
Area greater than 155 cm^2 or having any dimension greater than 150 mm	2.4	3.2
At a threaded conduit hole	6.4	6.4
At an unthreaded conduit hole	3.2	3.2

[a] The area limitation for metal 1.6 mm in thickness may be obtained by the provision of reinforcing ribs subdividing a larger area.

Table 2
Sheet metal enclosures

(Reference: Clauses 6.3.1, 6.4.1, 18.12)

MAXIMUM ENCLOSURE DIMENSIONS		MINIMUM THICKNESS OF SHEET METAL			
Length or Width	Area of Any Surface	Steel		Aluminum	Brass
		Zinc-Coated	Uncoated		
(mm)	(cm^2)	(mm)	(mm)	(mm)	(mm)
305	580	1.0	1.0	1.2	1.2
610	2320	1.2	1.2	1.6	1.6
1220	7740	1.6	1.6	2.0	2.0
1524	9670	2.0	2.0	2.5	2.5
Over 1524	Over 9670	2.8	2.8	3.5	3.5

Table 3
Thickness of glass covers

(Reference: Clause 8.1)

MAXIMUM SIZE OF OPENING		MINIMUM THICKNESS OF GLASS
Length or Width (mm)	Area (cm^2)	(mm)
100	100	1.6
300	930	3.2
Over 300	Over 930	See Note 1

Note 1: 3.2 mm or more, depending upon the size, shape and mounting of the glass panel. A glass panel for an opening having an area of more than 930 cm^2, or having any dimension greater than 300 mm, shall be supported by a continuous groove not less than 5 mm deep along all four edges of the panel.

Table 4
Thickness of insulating material

(Reference: Clause 10.4)

MAXIMUM DIMENSION (mm)	MAXIMUM AREA (cm^2)	MINIMUM THICKNESS[a] (mm)
150	230	2
300	930	3
600	2,320	10
1,200	7,430	13
1,200	11,150	16
Over 1,200	Over 11,150	19

[a] Material less than the minimum thickness shown may be employed for a panel if the panel is adequately supported or reinforced to provide equivalent rigidity.

Table 5
Minimum spacings

(Reference: Clauses 21.1, 21.2, 21.3)

POINT OF APPLICATION	VOLTAGE RANGE (V)[d]	MINIMUM SPACINGS[a]	
		Through Air (mm)	Over Surface (mm)
To Wall of Enclosure			
Cast Metal Enclosures	0 – 300	6.3	6.3
Sheet Metal Enclosures	0 – 300	12.5	
Installation Wiring Terminals	0 – 30	3.2	
(General Application)[a]	31 – 150	3.2	
With Barriers	151 – 300	6.3	
Without Barriers	0 – 30	4.7	
	31 – 150	6.3	
	151 – 300	9.5	
Rigidly Clamped Assemblies[b]			
100 Volt-Amperes Maximum[c]	0 – 30	0.8[c]	
Over 100 Volt-Amperes	0 – 30	1.2	
	31 – 150	1.6	
	151 – 300	2.4	
Other Parts	0 – 30	1.6	
	31 – 150	3.2	
	151 – 300	6.3	

[a] Measurements are to be made with solid wire of adequate ampacity for the applied load connected to each terminal. In no case is the wire to be smaller than 18 AWG.

[b] Rigidly clamped assemblies include such parts as contact springs on relays or cam switches, printed wiring boards, and the like.

[c] Spacings less than those indicated, but not less than 0.4 mm are acceptable for the connection of integrated circuits and similar components where the spacing between adjacent connecting wires on the component is less than 0.8 mm.

[d] RMS volts for sinusoidal waveform. The equivalent peak voltage should be used for nonsinusoidal waveforms.

Table 6
Physical property requirement for EPDM pneumatic type sealing element material

(Reference: Clause 22.2.2)

Property	ASTM Test Method	Conditions	Requirements
Tensile strength	D412	Unaged	Minimum 400% elongation at 10 MPa (1,450 psi)
	D573	After aging in an oven for 96 h at 70°C (158°F)	Maximum decrease of 50%
Elongation	D412	Unaged	400%, 30 to 50 Shore A durometer
	D573	After aging in an oven for 96 h at 70°C (158°F)	Maximum decrease of 50%
Hardness	D2240	Unaged	30 to 50 Shore A durometer
		After aging in an oven for 96 h at 70°C (158°F)	Maximum increase of 10 units of the initial hardness value
Compression set	D395 Method B	After 22 h at 70°C (158°F)	Maximum 25%
Low-temperature Flexibility	D2137	3 min at -40°C (-40°F)	No brittleness
Water absorption	D471	After 48 h in water at 70°C (158°F)	Maximum of 5% change in volume

Table 7
Applicable fitting types and sizes

(Reference: Clauses 23.7.2)

Access Fitting Type and Dimension	Nominal Pipe Size, in						
	Same Size	3	4	5	6	8	10
Wye							
3	x	x	x				
4	x		x	x	x		
5	x			x	x		
6	x				x		
8	x					x	x
10	x						
12	x						
15	x						
Tee-Wye							
3	x	x	x				
4	x		x	x	x		
5	x			x	x		
6	x				x	x	
8	x					x	
10	x						x
Tee							
3	x	x	x				
4	x		x	x			
5	x			x	x		
6	x				x	x	
8	x					x	
10	x						x

Table 8
Water leakage values

(Reference: Clause 25.2)

Nominal Size		Volume of Collected Water	
mm	(in.)	ml	(fl oz)
38	(1.5)	162	(5.5)
50	(2)	281	(9.5)
75	(3)	636	(21.5)
100	(4)	1 139	(38.5)
150	(6)	2 473	(87.0)
200	(8)	4 525	(153.0)

Table 9
Cylinder diameter

(Reference: Clause 27.1)

Nominal Size		Diameter of Cylinder	
mm	(in.)	mm	(in.)
38	(1.5)	19	(0.75)
50	(2)	25	(1.00)
75	(3)	38	(1.50)
100	(4)	50	(2.00)
150	(6)	76	(3.00)
200	(8)	101	(4 00)

Table 10
Maximum temperature rises

(Reference: Clauses 33.8.2, 33.8.4)

MATERIAL AND COMPONENTS	
Components	°C
Capacitors[a]	75% of manufacturer's rating and not more than 40 °C
Relay, Solenoid, Transformer, and other Coils with:	
a. Class 105 insulation system:	
Thermocouple method	65
Resistance method	75
b. Class 130 insulation system:	
Thermocouple method	85
Resistance method	95
Resistors[b]	
a. Carbon	25
b. Wirewound	50
c. Other	25
Solid State Devices	See Note c
Other Components and Materials	
a. Fibre used as electrical material or bushings	65
b. Varnished cloth insulation	25
c. Thermoplastic material[d]	Rise based on temperature of the material
d. Phenolic composition used as electrical insulation or as parts where failure will result in a hazardous condition[d]	125
e. Wood or other combustible	65
f. Sealing Compound 15	15°C less than its melting point and not more than 65°C
g. Fuses	25
Conductors	
Equipment wiring	25°C less than temperature limit of wire
Field-wired circuits	25

Table 10 Continued on Next Page

Table 10 (Continued)

MATERIAL AND COMPONENTS	
Components	**°C**
Printed wiring boards	Based on maximum rise temperature rating of printed wiring board material
General	
All surfaces of the product and surfaces adjacent to or upon which the product may be mounted.	65
Surfaces normally contacted by the user in operating the unit (control knobs, push buttons, levers, or the like)	40
Surfaces subjected to casual contact by the user (enclosure, grille, or the like)	40

[a] Temperature rise limit may be exceeded if the failure rate at the temperature attained is not more than 0.5 failures/million hours of operation.

[b] The temperature rise of a resistor may exceed the values shown if the power dissipation is 50% or less of the resistor manufacturer's rating and the temperature rating of the resistor is not exceeded.

[c] The temperature of a solid state device shall not exceed 75% of its rating during the Standby Condition. The temperature of a solid state device shall not exceed 75% of its rated temperature derated according to the power-temperature derating curve for power devices. For reference purposes, 0°C shall be considered as 0%.

[d] The limitations on phenolic composition and on rubber, thermoplastic insulation and rubber, do not apply to compounds that have been investigated and found to have special heat-resistant properties.

Table 11
Maximum acceptable continuous current

(Reference: Clause 33.14.2)

FREQUENCY (Hz)[a]	MAXIMUM ACCEPTABLE CURRENT THROUGH A 500 Ω RESISTOR (ma) Peak
0 – 100	7.1
500	9.4
1,000	11.0
2,000	14.1
3,000	17.3
4,000	19.6
5,000	22.0
6,000	25.1
7,000 or more	27.5

[a] Linear interpolation between adjacent values may be used to determine the maximum acceptable current corresponding to frequencies not shown. The Table applies to repetitive nonsinusoidal or sinusoidal waveforms.

Table 12
Maximum acceptable transient current duration

(Reference: Clause 33.14.4)

MAXIMUM PEAK CURRENT (I) THROUGH 500 Ω RESISTOR (mA)	MAXIMUM ACCEPTABLE DURATION (T) OF WAVEFORM CONTAINING EXCURSIONS MORE THAN 7.1 mA PEAK (s)	MAXIMUM PEAK CURRENT (I) THROUGH 500 Ω RESISTOR (mA)	MAXIMUM ACCEPTABLE DURATION (T) OF WAVEFORM CONTAINING EXCURSIONS MORE THAN 7.1 mA PEAK (ms)
7.1	7.26	100.0	164
8.5	5.58	150.0	92
10.0	4.42	200.0	61
12.5	3.21	250.0	44
15.0	2.48	300.0	34
17.5	1.99	250.0	27
20.0	1.64	400.0	23
22.5	1.39	450.0	19
25.0	1.19	500.0	16
30.0	0.92	600.0	12
40.0	0.61	700.0	10
50.0	1.44	809.0	8.3
60.0	0.34		
70.0	0.27		
80.0	0.23		
90.0	0.19		

Table 13
Electric shock – stored energy

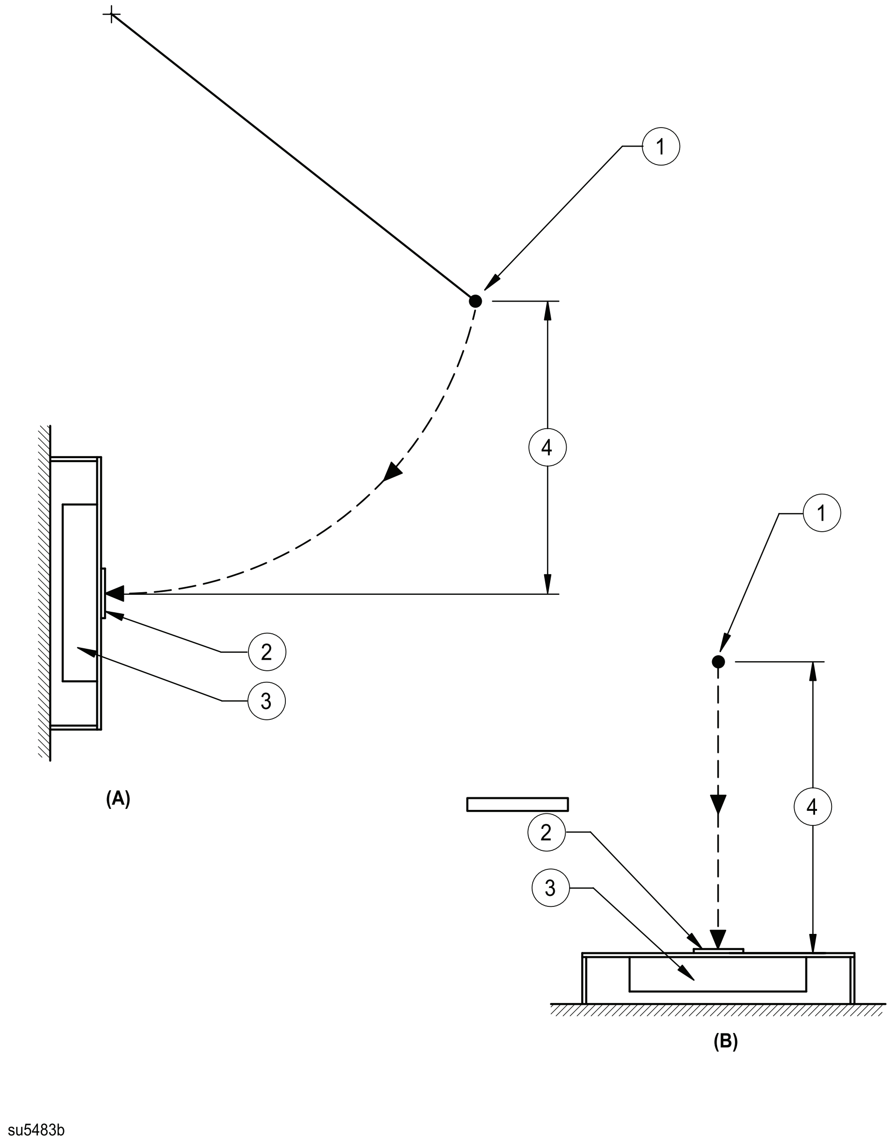
(Reference: Clause 33.14.6)

POTENTIAL ACROSS CAPACITANCE PRIOR TO DISCHARGE (V)	MAXIMUM ACCEPTABLE CAPACITANCE (μF)	POTENTIAL ACROSS CAPACITANCE PRIOR TO DISCHARGE (V)	MAXIMUM ACCEPTABLE CAPACITANCE (μF)
1000	0.868	200	11.2
900	1.02	180	13.4
800	1.22	160	16.3
700	1.50	140	20.5
600	1.90	120	26.6
500	2.52	100	36.5
400	3.55	90	43.8
380	3.86	80	53.8
360	4.22	70	68.0
340	4.64	60	89.4
320	5.13	50	124.0
300	5.71	45	150.0
280	6.40	42.4	169.0
260	7.24		
240	8.27		
220	9.56		

FIGURES

Figure 1
Jarring test

(reference: clause 33.7.1)



(A) TEST METHOD FOR UNIT INTENDED TO BE MOUNTED VERTICALLY

1 – 50 mm DIAMETER, 540 g STEEL SPHERE

2 – STEEL PLATE

3 – DEVICE UNDER TEST

4 – 286 mm

(B) TEST METHOD FOR UNIT INTENDED TO BE MOUNTED HORIZONTALLY

1 – 50 mm DIAMETER, 540 g STEEL SPHERE

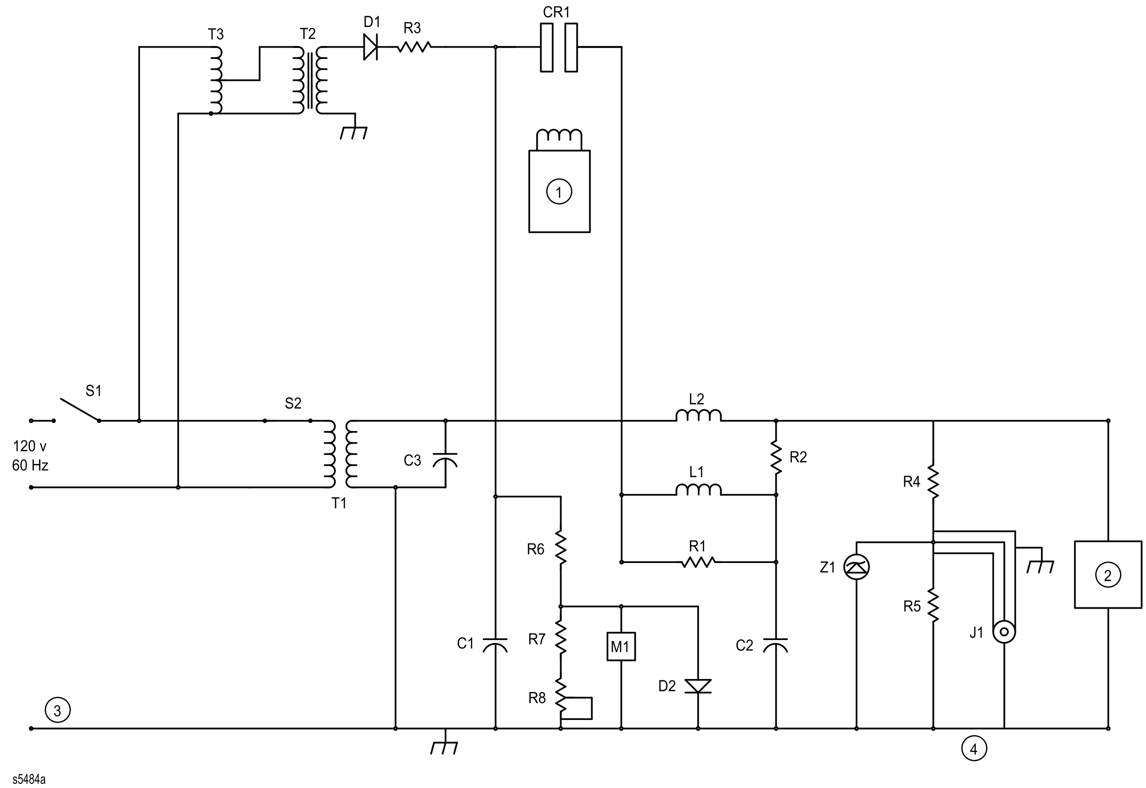
2 – STEEL PLATE

3 – DEVICE UNDER TEST

4 – 286 mm

Figure 2
Transient generator

(Reference Clauses: 33.15.2)



1 – RELAY CONT CCT

2 – DEVICE UNDER TEST

3 – GROUND

4 – ‘NEUTRAL’/GROUND

Parts list

C1 –	0.025 µf, 15kV	R2 –	12 Ω, 1 W composition
C2 –	0.006 µf, 15kV	R3 –	1.5 MΩ, 15 kV, (10 in series, 150 kΩ, 1/2 W each)
C3 –	13 µf, 460 Vac, oil-filled	R4 –	1.25 MΩ, 15 kV, 1/2 W
CR1 –	6 form ’A’ in series, 25 A, Each contact rated 600 V ac	R5 –	1 KΩ, 1/2 W
D1 –	Varco VF 25 – 40	R6 –	60 MΩ, 15 kV, 1/2 W
D2 –	1N4004	R7 –	300 Ω, 1/2 W
J1 –	BNC Scope Monitor	R8 –	500 Ω, 1/2 W, variable
L1 –	15 µH (23 turns, 23 AWG Wire, 18 mm diameter air core	S1 –	20 A, 120 V
		S2 –	20 A, 120 V
L2 –	70 µH (28 turns, 23 AWG Wire, 66 mm diameter air core)	T1 –	2 kVA, 120 V
		T2 –	90 VA, 120/15000 V
M1 –	0 – 20 kV, 4 1/2 Digit, 100 µV	T3 –	2.5 A, 120 V, variable
R1 –	22 Ω, 1 W, composition	Z1 –	1N965, 15 V

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ANNEX A

Reference Standards

(Informative)

Underwriters Laboratories (UL)

UL 157, Gaskets and Seals

American Society of Mechanical Engineers (ASME)

ASME A112.14.1, Backwater Valves

ASME A112.18.1, Plumbing Supply Fittings

ASME B1.20.1, Standard on Pipe Threads, General Purpose, Inch

ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings

American Society of Testing and Materials (ASTM)

ASTM A48, Standard Specification for Gray Iron Castings

ASTM A74, Standard Specification for Cast Iron Soil Pipe and Fittings

ASTM A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength

ASTM A351, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts

ASTM A888, Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

ASTM B16, Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines

ASTM B584, Standard Specification for Copper Alloy Sand Castings for General Applications

ASTM C440, Standard Specification for Thermoplastic Elastomeric (TPE) Gasket Materials for Drain, Waste, and Vent (DWV), Sewer, Sanitary and Storm Plumbing Systems

ASTM C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings

ASTM D395, Standard Test Methods for Rubber Property—Compression Set

ASTM D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension

ASTM D471, Standard Test Method for Rubber Property – Effect of Liquids

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

ASTM D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

ASTM D2000, Standard Classification System for Rubber Products in Automotive Applications

ASTM D2122, Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

ASTM D2137, Standard Test Methods for Rubber Property – Brittleness Point of Flexible Polymers and Coated Fabrics

ASTM D2240, Standard Test Method for Rubber Property – Durometer Hardness

ASTM D2661, Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings

ASTM D2665, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

ASTM D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

ASTM D3568, Standard Test Methods for Rubber – Evaluation of EPDM (Ethylene Propylene Diene Terpolymers) Including Mixtures with Oil

Canadian Standards Association (CSA)

CSA B125.1

CSA B181.1, Acrylonitrile-butadiene-styrene (ABS) drain, waste, and vent pipe and pipe fittings

CSA B181.2, Polyvinylchloride (PVC) and chlorinated polyvinylchloride (CPVC) drain, waste, and vent pipe and pipe fittings

CSA B182.1, Plastic drain and sewer pipe and pipe fittings

CSA B182.2, Polyvinylchloride (PVC) sewer pipe and fittings (PSM type)

CSA B602, Mechanical couplings for drain, waste, and vent pipe and sewer pipe

CSA B70, Cast iron soil pipe, fittings, and means of joining

CSA C22.1, Canadian Electrical Code, Part I

Cast Iron Soil Pipe Institute (CISPI)

CISPI 301, Standard specification for hubless cast iron soil pipe and fittings for sanitary and storm drain, waste, and vent piping applications

International Association of Plumbing and Mechanical Officials (IAPMO)

IAPMO IGC 283-2011ae1, Electro-Pneumatic Backwater Prevention Systems

National Fire Protection Association (NFPA)

ANSI/NFPA 70, National Electrical Code (NEC)

SAE International

SAE J200, Classification System for Rubber Materials

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