# UL 346

## STANDARD FOR SAFETY

# Waterflow Indicators for Fire Protective Signaling Systems

UL Standard for Safety for Waterflow Indicators for Fire Protective Signaling Systems, UL 346

Fifth Edition, Dated June 30, 2005

***Summary of Topics***

***This revision to ANSI/UL 346 dated September 20, 2019 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.***

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated July 19, 2019.

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# UL 346

## Standard for Waterflow Indicators for Fire Protective Signaling Systems

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**Fifth Edition**

**June 30, 2005**

This ANSI/UL Standard for Safety consists of the Fifth Edition including revisions through September 20, 2019.

The most recent designation of ANSI/UL 346 as a Reaffirmed American National Standard (ANS) occurred on September 20, 2019. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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# INTRODUCTION

## 1 Scope

1.1 These requirements cover vane type waterflow indicators intended for use in fire protective signaling systems to be employed in ordinary indoor locations, in accordance with the National Fire Alarm Code, NFPA 72.

1.2 Waterflow indicators covered by these requirements include sizes 3/4 inch and larger. The indicator sizes refer to the nominal inside diameter of the main sprinkler pipe or tubing on which they are installed.

1.3 A vane type waterflow indicator is an assembly of a mechanism having electrical contacts arranged to transmit a coded or noncoded signal when the vane, located in the supply pipe (riser) of a sprinkler system, is moved by the flow of water in the pipe. This flow is normally caused by the opening of one or more sprinkler heads resulting from a fire condition. The signaling contacts are intended to be connected to circuits of private fire protective signaling systems.

1.4 These requirements do not cover pressure-operated waterflow indicators.

## 2 General

### 2.1 Units of measurement

2.1.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

### 2.2 Components

2.2.1 Except as indicated in 2.2.2, a component of a product covered by this standard shall comply with the requirements for that component.

2.2.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

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

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

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## 2.3 Undated references

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

## 3 Glossary

3.1 For the purpose of this standard, the following definitions apply.

3.2 The following abbreviations are used throughout this standard:

ASTM – American Society for Testing and Materials

AWG – American Wire Gauge

NFPA– National Fire Protection Association

psig – pounds per square inch gauge

3.3 ELECTRICAL CIRCUITS:

a) LOW-VOLTAGE CIRCUIT – A circuit classified as low-voltage is one involving a potential of not more than 30 volts alternating current (42.4 volts ac peak or direct current), and supplied from a circuit whose power is limited to a maximum of 100 volt-amperes (VA).

b) HIGH-VOLTAGE CIRCUIT – A circuit classified as high-voltage is one having circuit characteristics in excess of those of a low-voltage circuit.

3.4 RETARD TIME – The elapsed time in seconds between the initial movement of the vane resulting from the flow of a discrete amount of water and the actual transmission of an alarm signal.

3.5 SENSITIVITY – The minimum rate-of-flow from a system outlet, expressed in gallons per minute (gpm), which will cause the device to send an alarm signal.

3.6 SLIGHT WEEPING – Leakage not exceeding 1 fluid ounce (29.6 $cm^3$) per hour per linear inch of pipe diameter.

# CONSTRUCTION

## 4 General

### 4.1 Installation

4.1.1 A vane type waterflow indicator shall be so constructed that it will be suitable for connection to control units, electrically actuated transmitters, or similar units which will permit its application in conformity with applicable standards of the National Fire Protection Association (NFPA).

4.1.2 Waterflow indicators are required to be easily installed using tools ordinarily used by pipe fitters in the installation of sprinkler system devices.

### 4.2 Retard feature

4.2.1 If a retard feature is provided on a waterflow indicator, it shall be readily adjustable in accordance with the manufacturer's instructions and shall be marked with an appropriate scale or equivalent and an indication of the direction of time delay on the device or adjacent to it. If the retard can be adjusted for a greater than 90 second delay, a mechanical stop shall be provided to limit the delay to 90 seconds.

### 4.3 Working pressures

4.3.1 A waterflow indicator shall be constructed for a maximum working pressure of 175 psig (1.21 MPa) unless specifically indicated otherwise on the device.

### 4.4 Mounting positions

4.4.1 A waterflow indicator may be constructed to operate as intended when installed in the horizontal position only, or the vertical position only, or it may be constructed to operate in both of these positions. An indicator intended for mounting only in one position, shall be marked to indicate that position.

## 5 Enclosure

### 5.1 General

5.1.1 The enclosure of a waterflow indicator shall be formed and assembled so that it has the strength and rigidity necessary to resist the abuses to which it is likely to be subjected in service without impairing its operation due to total or partial collapse with resulting reduction of spacings, or loosening, or displacement of parts.

5.1.2 All electrical parts of a waterflow indicator shall be enclosed to provide protection against contact with uninsulated live parts.

5.1.3 The enclosure of a waterflow indicator shall be provided with means for mounting in the intended manner. Any fittings, such as brackets, hangers, or the like, necessary for the intended mounting shall be furnished with the unit. The mounting means shall be accessible without disassembling any operating part of the indicator.

5.1.4 An enclosure shall have provision for the connection of metal-clad cable, conduit, or nonmetallic sheathed cable.

*Exception: An enclosure without such provision may be acceptable if definite instructions are furnished with it indicating the sections of the waterflow indicator which are intended to be drilled in the field for the connection of raceways, or if the unit is intended for mounting on an outlet box.*

## 5.2 Cast metal enclosures

5.2.1 The thickness of cast metal for an enclosure shall be as indicated in Table 5.1.

**Table 5.1**
**Cast-metal enclosures**

| Use, or dimensions of area involved | Minimum thickness, inch (mm)[a] | | | |
|---|---|---|---|---|
| | Die-cast metal | | Cast metal of other than the die-cast type | |
| Area of 24 square inches (155 $cm^2$) or less and having no dimension greater than 6 inches (152 mm) | 1/16 | (1.6) | 1/8 | (3.2) |
| Area greater than 24 square inches or having any dimension greater than 6 inches | 3/32 | (2.4) | 1/8 | (3.2) |
| At a threaded conduit hole | 1/4 | (6.4) | 1/4 | (6.4) |
| At an unthreaded conduit hole | 1/8 | (3.2) | 1/8 | (3.2) |

[a] Cast metal having a thickness 1/32 inch (0.8 mm) less than that indicated may be employed if the surface under consideration is curved, ribbed or otherwise reinforced, or if the shape or size or both of the surface is such that equivalent mechanical strength is provided.

5.2.2 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 five threads in the metal, and the construction shall be such that a standard conduit bushing can be properly attached.

5.2.3 If threads for the connection of conduit are tapped part 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, rounded conduit stop of inside diameter equal to that specified for the standard conduit bushing of the appropriate size for the protection of the conductors.

## 5.3 Sheet metal enclosures

5.3.1 The thickness of sheet metal employed for the enclosure of a waterflow indicator shall be not less than that indicated in Table 5.2, except that sheet metal of two gauge sizes less in 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 adequate mechanical strength is provided.

**Table 5.2**
**Sheet metal enclosures**

| Maximum dimensions of enclosure | | | | Minimum thickness of sheet metal | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Steel | | | | | | Brass or aluminum | | |
| Length or width, | | Area, | | Zinc-coated, | | | Uncoated, | | | | | |
| inches | (mm) | inches$^2$ | (cm$^2$) | inch | (mm) | GSG | inch | (mm) | MSG | inch | (mm) | AWG |
| 12 | (305) | 90 | (581) | 0.034 | (0.86) | 20 | 0.032 | (0.81) | 20 | 0.045 | (1.14) | 16 |
| 24 | (610) | 360 | (2322) | 0.045 | (1.14) | 18 | 0.042 | (1.07) | 18 | 0.058 | (1.47) | 14 |

5.3.2 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 an uncoated flat sheet of steel having a minimum thickness of 0.053 inch (1.35 mm) and the construction shall be such that a standard conduit bushing can be attached.

5.3.3 A plate or plug for an unused conduit opening or other hole in the enclosure shall be not less than 0.027 inch (0.66 mm) thick steel or 0.032 inch (0.81 mm) nonferrous metal.

5.3.4 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.

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

5.3.6 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. See Spacings, Section 13.

### 5.4 Nonmetallic enclosures

5.4.1 An enclosure or parts of an enclosure of nonmetallic material shall have the mechanical strength and durability and be so formed that operating parts will be protected against damage. The enclosure parts 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 5.2.

5.4.2 Nonmetallic material shall not be employed for parts of an enclosure of waterflow indicators which are intended to be connected directly to rigid conduit or metal-clad cable or which are subject to abnormal mechanical stresses or pressures. It may be employed as an enclosure cover or an internal dust cover.

5.4.3 Among the factors taken into consideration when judging the acceptability of a nonmetallic enclosure are mechanical strength, resistance to impact, moisture absorptive properties, flammability 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 or abnormal usage. All these factors are considered with respect to aging.

## 6 Electric Shock

6.1 Any part that is exposed only during operator servicing shall not present the risk of electric shock. See Electric Shock Current Test, Section 23.

6.2 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 megohms, a minimum wattage rating of 1/2 watt, and shall be effective with the power switch in either the on or off position.

*Exception No. 1: The conductive connection need not be provided if:*

*a) Such a connection is established in the event of electrical breakdown of the antenna isolating means,*

*b) The breakdown does not result in a risk of electric shock, and*

*c) 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 megohms.*

*Exception No. 2: A component comprised of a capacitor with a built-in shunt resistor that complies with the requirements for antenna isolating capacitors may be rated 1/4 watt or more.*

6.3 The maximum value of 5.2 megohms mentioned in 6.2 is to include the maximum tolerance of the resistor value used; that is, a resistor rated 4.2 megohms with 20 percent tolerance or a resistor rated 4.7 megohms with a 10 percent tolerance is acceptable.

6.4 The insertion of any socket of any vacuum tube or its glass or metal equivalent of like designation used in the product shall not result in a risk of electric shock.

## 7 Drain Holes

7.1 A drain hole at least 1/16 inch (1.6 mm) in diameter shall be provided for each position at the lowest point in the enclosure to drain off any water that may enter the compartment. If the device can be mounted in more than one position, a drain hole shall be provided for each position.

## 8 Protection Against Corrosion

8.1 An iron or steel part shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means.

8.2 The requirement of 8.1 applies to an enclosure, whether of sheet steel or cast iron, and to a spring or other part upon which mechanical operation may depend. It does not apply to a minor part, such as a washer, screw, bolt, and the like, if the failure of the unprotected part would not be likely to result in a risk of fire, electric shock, or unintentional contact with moving parts that involve a risk of injury to persons, or impair the operation of the indicator. A part made of stainless steel having corrosion resistance at least equivalent to AISI Type 416 stainless steel does not require additional protection. Bearing surfaces shall be of such materials so as to reduce the likelihood of binding due to corrosion.

8.3 Metals used in a cabinet or enclosure shall be galvanically compatible.

8.4 A hinge or other attachment shall be resistant to corrosion.

8.5 A nonferrous part need not be protected against corrosion.

## 9 Field Wiring Connections

### 9.1 Field wiring terminals and leads

9.1.1 A waterflow indicator shall be provided with wiring terminals or leads for the connection of conductors of at least the size required by the National Electrical Code, NFPA 70, corresponding to the electrical rating of the indicator.

9.1.2 Duplicate terminals or leads, or equivalent means to achieve electrical supervision, shall be provided for each incoming and each outgoing conductor. A common terminal may be used for connection of both incoming and outgoing wires, provided that the design and 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. A notched clamping plate under a single securing screw, where separate conductors are intended to be inserted in each notch, is acceptable, 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.

9.1.3 A part to which field wiring connections are to be made may consist of a binding screw with a terminal plate having upturned lugs or the equivalent to hold the wires in position. Connections may also be made between two parallel metal plates in conjunction with a securing screw. A wire binding screw shall thread into metal. The terminal assemblies may be integral with any switches employed in the unit.

9.1.4 If a wire binding screw is employed at a field wiring terminal, the screw shall be not smaller than a No. 8 (4.2 mm diameter) except that a No. 6 (3.5 mm diameter) screw may be used for the connection of a No. 14 AWG (2.1 $mm^2$) or smaller conductor. The screws may be plated steel.

9.1.5 A terminal plate tapped for a wire binding screw shall be of metal at least 0.050 inch (1.27 mm) thick for a No. 8 (4.2 mm diameter) or larger screw, and not less than 0.030 inch (0.76 mm) thick for a No. 6 screw (3.5 mm diameter) and shall have not less than two full threads in the metal. The metal may be extruded at the tapped hole to provide two full threads for the binding screw.

9.1.6 If more than one conductor is to be connected to the same terminal, a nonferrous intervening washer shall be provided for each additional conductor.

*Exception: A washer is not required if the conductors are separated and secured under a common clamping plate.*

9.1.7 Terminal connections other than those described in 9.1.3 – 9.1.6 may be employed if found to be equivalent.

9.1.8 Leads provided for field connections shall be not less than 6 inches (152 mm) long, provided with strain relief, and not smaller than No. 18 AWG (0.82 $mm^2$). The insulation, if of rubber or thermoplastic, shall be not less than 1/64 inch (0.4 mm) in thickness.

### 9.2 Field wiring compartment

9.2.1 The field wiring compartment shall be of sufficient size for completing all field wiring connections as specified in the National Electrical Code, NFPA 70, and by the installation wiring diagram. There shall be sufficient space within the compartment to permit the use of a standard conduit bushing on conduit connected to the compartment if a bushing is required for installation.

9.2.2 Internal components and wire insulation shall be protected from sharp edges by insulating barriers or metal barriers having smooth, rounded edges.

9.2.3 An outlet box or compartment in which field wiring connections are to be made shall be located such that the connections may be inspected after the indicator is installed as intended. The removal of not more than two mounting screws, or an equivalent arrangement, to view the field wiring connections is considered to comply with this requirement.

### 9.3 Grounded supply terminal and leads

9.3.1 A field wiring terminal for the connection of a grounded supply conductor shall be identified by means of a metallic plated coating substantially white in color and shall be readily distinguishable from the other terminals, or proper identification of the terminal for the connection of the grounded conductor shall be clearly shown in some other manner, such as on an attached wiring diagram.

9.3.2 A field wiring lead provided for connection of a grounded supply conductor shall be finished to show a white or gray color and shall be readily distinguishable from other leads and no other leads, other than grounded conductors, shall be so identified.

9.3.3 A terminal or lead identified for the connection of the grounded supply conductor shall not be electrically connected to a single-pole manual switching device which has an OFF position or to a single-pole overcurrent (not thermal) protective device.

### 9.4 Strain relief

9.4.1 To prevent the transmission of stress to terminals, internal connections, or components, a strain relief means shall be provided for field wiring leads and internally connected wires or wire harnesses and cables which are subject to movement in conjunction with the operation or servicing of waterflow indicators.

9.4.2 Each lead employed for field connections shall be capable of withstanding for 1 minute a pull of 10 pounds (44.5 N) without any evidence of damage or of transmitting the stress to internal connections.

## 10 Grounding and Bonding for Grounding

10.1 Each waterflow indicator shall have provisions for grounding all dead-metal parts which are exposed or which are likely to be touched by a person during normal adjustment or servicing of the device and which are likely to become energized.

10.2 The provision of a knockout or other opening in a metal enclosure for the connection of metal-clad cable, conduit, metal raceway, or the like, is considered to be acceptable as a means for grounding of an overall enclosure.

10.3 Uninsulated metal parts of electrical enclosures, motor frames and mounting brackets, capacitors, and other electrical components shall be bonded for grounding if they may be contacted by the user or by a service person in servicing the equipment.

10.4 Metal parts as described below need not comply with the requirements of 10.3.

a) Adhesive attached metal foil markings, screws, handles, or the like, which are located on the outside of the indicator enclosure and isolated from electrical components or wiring by grounded metal parts so that they are not likely to become energized.

b) Isolated metal parts, such as small assembly screws, and the like, which are positively separated from wiring and uninsulated live parts.

c) Panels and covers which do not enclose uninsulated live parts if wiring is positively separated from the panel or cover so that it is not likely to become energized.

d) Panels and covers which are insulated from electrical components and wiring by an insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or similar material not less than 1/32 inch (0.8 mm) thick and secured in place.

10.5 A bonding conductor shall be of material acceptable for use as an electrical conductor. If of ferrous metal, it shall be protected against corrosion by painting, plating, or the equivalent. The conductor shall be not smaller than the maximum size wire employed in the circuit wiring of the component or part. A separate bonding conductor or strap shall be installed in such a manner that it is protected from mechanical damage.

10.6 The bonding shall be by a positive means, such as by clamping, riveting, bolted or screwed connection, brazing, or welding. The bonding connection shall penetrate nonconductive coatings, such as paint. Bonding around a resilient mount shall not depend on the clamping action of rubber or similar material.

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

## 11 Internal Wiring

### 11.1 General

11.1.1 The internal wiring in waterflow indicators shall consist of insulated conductors having the 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 the equivalent, unless of sufficient rigidity to retain a shaped form.

11.1.2 Each lead or a cable assembly 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 reduce the likelihood of abrasion of insulation and jamming between parts of the enclosure.

11.1.3 If the use of a short length of insulated conductor is not feasible, that is, a short coil lead or the like, electrical insulating tubing may be employed. The tubing shall not be subjected to sharp bends, tension, compression, or repeated flexing, and shall not contact sharp edges, projections, or corners. The wall thickness shall conform to the requirements for such tubing, except that the wall thickness at any point for polyvinyl chloride tubing of sizes 3/8 inch (9.5 mm) diameter or less shall be at least 0.017 inch (0.43 mm). For insulating tubing or other types, the thickness shall be not less than that required to provide the required mechanical strength, dielectric properties, heat and moisture resistant characteristics, and the like, at least equal to 0.017 inch thick polyvinyl chloride tubing.

11.1.4 Stranded conductor clamped under wire binding screws or similar parts shall have the individual strands soldered together or be equivalently arranged to provide reliable connections.

### 11.2 Wireways

11.2.1 Wireways shall be smooth and free from sharp edges, burrs, fins, moving parts, and the like, which may cause abrasion of the conductor insulation. See 11.3.1 – 11.3.6.

### 11.3 Bushings

11.3.1 Where a lead or wire harness passes through an opening in a wall, barrier, or enclosing case, there shall be a metal or insulating type bushings or the equivalent, which shall be substantial, secured in place, and shall have a smooth, rounded surface against which the wire may bear.

11.3.2 If the opening is in phenolic composition or other nonconducting material or in metal of thickness greater than 0.042 inch (1.07 mm), a smooth, rounded surface having rounded edges, is considered to be the equivalent of a bushing.

11.3.3 Ceramic materials and some molded compositions are considered to be acceptable for insulating bushings, but separate bushings of wood and of hot-molded shellac are not acceptable.

11.3.4 Fiber may be employed where it will not be subjected to a temperature higher than 90°C (194°F) under normal operating conditions, if the bushing is not less than 1/16 inch (1.6 mm), with a minus tolerance of 1/64 inch (0.4 mm) for manufacturing variations, and if it is so formed and secured in place that it will not be impaired by conditions of ordinary moisture.

11.3.5 If a soft rubber bushing is employed in a hole in metal, the hole shall be free from sharp edges, burrs, projections, and the like, which would be likely to cut into the rubber.

11.3.6 An insulating metal grommet may be considered acceptable in lieu of an insulating bushing, provided that the insulating material used is not less than 1/32 inch (0.8 mm) thick and completely fills the space between the grommet and the metal in which it is mounted.

### 11.4 Splices

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

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

11.4.3 Each splice shall be located, enclosed, and supported so that it is not subject to damage, flexing, motion, or vibration.

## 12 Components

### 12.1 Adjustments and stops

12.1.1 If a control is nonadjustable following factory calibration, it may be marked with a single set point.

12.1.2 If a control is adjustable in the field, the set points over the range of allowable field adjustment shall be indicated thereon.

12.1.3 An adjustable stop employed for limiting a set point shall not be used for other adjustments. It shall be firmly secured by a means provided solely for that purpose and in a manner such that the maximum or ″safe″ setting cannot be increased except by the use of tools or by deliberate bending or removal of some part. Nuts, screws, or the like, used for this purpose shall be provided with integral lock washers, or the equivalent. Parts used for support of the adjustment means shall have strength sufficient to resist accidental bending.

12.1.4 If it is evident that a set point may be altered by resetting or removing the stop, or if a control includes on it directions for altering the set point, a statement shall appear on the dial, scale, or stop, or directly adjacent thereto or on the outside (not inside) of the cover. This statement shall be to the effect that the setting is a ″safety″ stop and is not to be altered to permit a higher or less ″safe″ operating point; for example, ″SAFETY STOP – DO NOT ALTER.″

### 12.2 Barriers

12.2.1 A metal barrier shall have a thickness at least equal to that required by Table 5.2, based on the size of the barrier. A barrier of insulating material shall be not less than 0.028 inch (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 less than 1/16 inch (1.6 mm).

### 12.3 Coil windings

12.3.1 The insulation of coil windings of relays, transformers, and the like, shall be such as to resist the absorption of moisture.

12.3.2 Enameled wire is not required to be given additional treatment to prevent moisture absorption.

### 12.4 Current-carrying parts

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

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

### 12.5 Insulating materials

12.5.1 Insulating materials for the support or separation of live parts shall withstand the most severe conditions likely to be met in service.

12.5.2 Among the factors to be considered in judging electrical insulation are mechanical and electrical strength, resistance to burning, moisture, arcing, and creep, that is, flow due to stress, and resistance to the temperatures anticipated in use. Examples of some acceptable materials include slate, porcelain, phenolic, or cold-molded composition. Other insulating materials may be employed if they have equivalent mechanical and electrical properties.

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

12.5.4 The thickness of a flat sheet of insulating material, such as impregnated asbestos-cement composition or phenolic composition, employed for panel-mounting parts, shall be at least 1/8 inch (3.2 mm) thick.

*Exception: Material less than 1/8 inch thick but not less than 1/16 inch (1.6 mm) thick may be employed for a panel if the panel is supported or reinforced to provide rigidity not less than that of a 1/8 inch sheet.*

12.5.5 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.

12.5.6 A countersunk, sealed part shall be covered with a waterproof insulating compound which will not melt at a temperature 15°C (27°F) higher than the maximum normal operating temperature of the assembly, and at not less than 65°C (149°F) in any case. The depth or thickness of sealing compound shall be not less than 1/8 inch (3.2 mm).

### 12.6 Metallic components

12.6.1 Metallic components of waterflow indicators, other than the saddle, which may be exposed to water, shall be fabricated from brass, bronze, monel, stainless steel, or the equivalent, and constructed so as to minimize galvanic corrosion and stress corrosion cracking.

12.6.2 Stressed copper alloy, stainless steel, or other functional metal parts shall be resistive to stress cracking.

### 12.7 Nonmetallic components

12.7.1 Plastic materials employed in a waterflow indicator shall comply with the tests for Polymeric Materials, Section 27.

12.7.2 Elastomeric materials, such as gaskets, ″O″ rings, seals diaphragms, and the like, which are employed in a waterflow indicator shall comply with the tests for Elastomeric Materials, Section 30.

### 12.8 Mounting of parts

12.8.1 Each part of a waterflow indicator shall be securely mounted in position and prevented from turning or loosening if such motion may impair the performance of the unit, or may increase the risk of fire, electric shock, or injury to persons incident to its operation.

12.8.2 A switch, plug connector, or similar electrical component shall be mounted securely and, shall be prevented from turning.

*Exception: The requirement that a switch be prevented from turning may be waived if all of 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 operation of the switch.*

*b) The means of mounting the switch makes it unlikely that operation of the switch will loosen the switch.*

*c) The spacings are not reduced below the minimum acceptable values if the switch rotates.*

12.8.3 Friction between surfaces shall not be the sole means of preventing a device from turning in its mounting. However, a lock washer may be employed to prevent the turning of a small stem-mounted switch or other device having a single hole mounting.

12.8.4 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 provide continued alignment of contacts.

12.8.5 Bolts, nuts, and studs employed for securing of pressure holding parts shall be acceptable for the pressures to which they may be subjected using the maximum tightening torque as recommended by the manufacturer.

### 12.9 Tamper protection

12.9.1 The cover of the device shall be provided with a tamper switch unless the construction is such that it cannot be readily removed using a commonly available tool, such as an Allen wrench, slotted or Phillips screwdriver, or pliers.

### 12.10 Operating mechanisms

12.10.1 Operating parts, such as switches, relays, gears, contact assemblies, and similar devices shall be protected by individual protection or dust-tight cabinets against fouling by dust or by other material which may impair operation. The use of individual dust covers over operating mechanisms or a gasket between the enclosure and cover shall be considered as meeting this requirement.

12.10.2 An operating mechanism shall be so assembled that it is not impaired by any condition of intended operation.

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

12.10.4 Gears and coded signaling wheels shall have smooth engaging surfaces. Cams, wheels, and similar parts shall be secured in a positive manner, other than by friction between surfaces or the use of a lock washer, to prevent independent turning or loosening.

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

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

12.10.7 An electromagnetic device shall be so constructed as to provide positive electrical and mechanical performance under all conditions of intended operation.

12.10.8 A gear-train driving spring shall be securely anchored at each end. The spring-winding means shall be provided with a positive stop to limit the winding or shall withstand the maximum force likely to be applied without impairing the operation of the mechanism.

### 12.11 Printed wiring boards

12.11.1 Each component on the board shall be secured in a reliable manner and the spacings between circuits shall comply with the spacing requirements of this standard, see Spacings, Section 13. The board shall be mounted so that deflection of the board during servicing shall not result in damage to the board.

12.11.2 The board shall be of a fire resistant material classified as Type V-2 or equivalent, when tested in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

### 12.12 Switches

12.12.1 A switch provided as part of a waterflow indicator shall be acceptable for the current and voltage of the circuit which it controls when the indicator is operated under any condition of intended service.

12.12.2 Mercury tube switches shall be acceptable as determined by tests described in the Performance section of this standard. Wire leads shall be as short as possible and shall terminate at eyelets or the equivalent, at terminal plates on the supporting base.

## 13 Spacings

13.1 For a waterflow indicator the spacings between uninsulated live parts and dead-metal parts and between uninsulated live parts of opposite polarity shall be not less than those indicated in Table 13.1.



**Table 13.1**
**Minimum spacings**

| Point of application | Voltage range – volts | Minimum spacings – inch[a] (mm) | | | |
|---|---|---|---|---|---|
| | | Through air | | Over surface | |
| To walls of enclosure[b] | | | | | |
| Cast metal enclosures | 0 – 300 | 1/4 | (6.4) | 1/4 | (6.4) |
| Sheet metal enclosures | 0 – 300 | 1/2 | (12.7) | 1/2 | (12.7) |
| Installation wiring terminals | | | | | |
| With barriers | 0 – 30 | 1/8 | (3.2) | 3/16 | (4.8) |
| | 31 – 150 | 1/8 | (3.2) | 1/4 | (6.4) |
| | 151 – 300 | 1/4 | (6.4) | 3/8 | (9.5) |
| Without barriers | 0 – 30 | 3/16 | (4.8) | 3/16 | (4.8) |
| | 31 – 150 | 1/4 | (6.4) | 1/4 | (6.4) |
| | 151 – 300 | 1/4 | (6.4) | 3/8 | (9.5) |
| Rigidly clamped assemblies[c] | | | | | |
| 100 volt-amperes or less | 0 – 30 | 1/32[d] | (0.8) | 1/32[d] | (0.8) |
| Over 100 volt-amperes | 0 – 30 | 3/64 | (1.2) | 3/64 | (1.2) |
| | 31 – 150 | 1/16 | (1.6) | 1/16 | (1.6) |
| | 151 – 300 | 3/32 | (2.4) | 3/32 | (2.4) |
| Other parts | 0 – 30 | 1/16 | (1.6) | 1/8 | (3.2) |
| | 31 – 150 | 1/8 | (3.2) | 1/4 | (6.4) |
| | 151 – 300 | 1/4 | (6.4) | 3/8 | (9.5) |

[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 No. 18 AWG (0.82 $mm^2$).

Table 13.1 Continued on Next Page

**Table 13.1 Continued**

| Point of application | Voltage range – volts | Minimum spacings – inch[a] (mm) | |
|---|---|---|---|
| | | Through air | Over surface |

[b] The spacings for ″To walls of enclosure″ apply between an uninsulated live part and (1) a wall or cover of a metal enclosure, (2) a fitting for conduit or metal-clad cable, and (3) a metal piece attached to a metal enclosure, where deformation of the enclosure is likely to reduce spacings. They are not to be applied to an individual enclosure of a component part within an outer enclosure.

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

[d] Spacings less than those indicated, but in no case less than 1/64 inch (0.4 mm) are acceptable for the connection of integrated circuits and similar components where the spacing between the adjacent connecting wires on the component is less than 1/32 inch (0.8 mm).



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

13.3 A barrier or liner of insulating material employed where spacings would be otherwise insufficient, shall be of material, such as impregnated fiber, phenolic composition, or the equivalent, and shall be not less than 1/32 inch (0.8 mm) thick, minimum 0.028 inch (0.71 mm). A barrier or liner which is used in conjunction with not less than one-half the required spacing ″through air″ may be less than 1/32 inch (0.8 mm), but shall be not less than 0.013 inch (0.33 mm) thick and so located that it will not be adversely affected by operation of the unit.

13.4 Insulating material having a thickness less than that specified in 13.3 may be used if it has equivalent mechanical and electrical properties.

13.5 Enamel insulated wire is considered to be an exposed uninsulated live part in determining compliance of a device with the spacing requirements, but enamel is acceptable as turn-to-turn insulation in coils.

## 14 Servicing and Maintenance

14.1 An uninsulated live part within the enclosure shall be located, guarded, or enclosed so as to minimize the likelihood of unintentional contact by persons performing service functions which may be performed with the equipment energized.

14.2 In determining compliance with 14.1, only uninsulated live parts in high-voltage circuits are to be considered.

14.3 An electrical component which may require examination, adjustment, servicing, or maintenance while energized shall be located and mounted with respect to other components and with respect to grounded metal so that it is accessible for such service without subjecting the user to a risk of electric shock from adjacent uninsulated live parts.

14.4 The following are not considered to be uninsulated live parts:

a) Coils of controllers, relays, and solenoids, and transformer windings, if the coils and windings are provided with acceptable insulating overwraps,

b) Enclosed motor windings,

c) Terminals and splices with acceptable insulation, and

d) Insulated wire.

# PERFORMANCE

## 15 General

### 15.1 Test units

15.1.1 Waterflow indicators that are fully representative of production units are to be used for each of the following tests unless otherwise specified.

15.1.2 The devices employed for testing are to be those specified by the wiring diagram of the indicator, except that substitute devices may be used if they produce functions and load conditions equivalent to those obtained with the devices intended to be used with the waterflow indicator in service.

15.1.3 A waterflow indicator that must be mounted in a specific position to function as intended is to be tested in that position; otherwise it is to be tested in the position that would be most likely to result in unacceptable performance.

### 15.2 Test voltages

15.2.1 Unless specifically noted otherwise, the test voltage for each test of a waterflow indicator is to be as specified in Table 15.1 and at the rated frequency.

**Table 15.1**
**Test voltages**

| Rated voltage, nameplate | Test voltage |
|---|---|
| 110 to 120 | 120 |
| 220 to 240 | 240 |
| Other | Marked rating |



### 15.3 Test samples and data

15.3.1 The following samples and data are to be provided for testing:

a) Waterflow Indicators – The specific pipe sizes for a multiple range of sizes are to be determined by a review of the paddle areas of each waterflow indicator size with respect to the internal area of the pipe size in which it is intended to be installed. Samples of waterflow indicators are to be submitted as follows, where an individual set of samples as required in item (1) of each group is to be submitted for each schedule of pipe under consideration (for example, if one size is being investigated for Schedules 80, 40, and 10 pipe, 18 samples are required).

Six or More Consecutive Sizes –

1) Four samples for each of the smallest, medium, and largest pipe size.

2) Three additional samples of any size, if a retard feature is employed.

Three to Five Consecutive Sizes –

1) Four samples of each of the smallest and largest pipe size.

2) Three additional samples of any size, if a retard feature is employed.

Two Consecutive Sizes –

1) Four samples of each size.

2) Three additional samples of either size, if a retard feature is employed.

One Size –

1) Six samples.

2) Three additional samples, if a retard feature is employed.

b) One pipe spool piece, approximately 2 feet (0.61 m) in length, with flanged ends acceptable for the device working pressure involved, in an appropriate pipe schedule for each size indicator provided in accordance with (a).

c) Vane Drawings – One drawing of each vane size to be investigated together with the surface area of the vane and internal cross-sectional area (in square inches) of the respective pipe or tubing size in which it is to be installed.

d) Saddle Gaskets – Six samples for the smallest size and six samples for the largest size indicator provided in accordance with (a).

e) Vanes – Six samples of smallest size and six samples of largest size. The securing member is to be included, attached to vanes.

f) Retard Feature – One sample that can be disassembled for examination.

g) Thermoplastic Parts – Twelve samples of each compound used.

h) Diaphragms – Twelve samples of each type diaphragm used.

i) Other Functional Rubber Parts – Six samples of the smallest size and six samples of the largest size.

j) Pressure Rating – Maximum pressure rating for the waterflow indicators if higher than the nominal 175 psig (1.21 MPa) normally applied.

k) Drawings – Three drawings each of U-shaped clamping bolts, saddle assemblies and vanes for each size waterflow indicator. Also, a drawing showing horizontal and vertical mounting of indicator in sprinkler piping.

## 16 Normal Operation Test

### 16.1 General

16.1.1 A waterflow indicator shall operate for all of the signaling functions for which it was constructed when actuated as intended.

16.1.2 The switching contacts of a waterflow indicator shall operate as intended while connected in series to an indicating lamp load of between 25 and 50 milliamperes and a 6 volt direct current source. This test is to be conducted on a sample in an ″as received condition″ and on the two samples subjected to the Corrosion Test, Section 24.

16.1.3 A device provided for maintenance testing of the mechanism or contacts of a waterflow indicator shall operate as intended. It shall not be possible to leave the testing means in any condition that will prevent subsequent operation of the indicator without the condition being evident.

16.1.4 It shall be practicable to operate a waterflow indicator constructed to transmit more than one type of signal without:

a) The different signal-initiating means interfering with each other,

b) A false fire alarm signal being transmitted during operation for other signals, and

c) Confusing any other signal with a fire alarm signal.

16.1.5 With the waterflow indicator connected in accordance with 16.1.2, it is to be tested for its intended signaling performance.

### 16.2 Coded waterflow indicators

16.2.1 A coded alarm signal shall consist of at least three complete rounds of the number transmitted.

16.2.2 A coded waterflow indicator shall operate as intended for the number of coded-signal rounds for which it is designed. There shall be no transmission of partial rounds.

16.2.3 A coded mechanism employed as part of a waterflow indicator shall be capable of operation with any speed adjustment and for each complete set of the maximum number of signaling rounds for which it is intended without transmitting confusing signal impulses.

16.2.4 A transmitter mechanism of a waterflow indicator that requires manual rewinding shall be capable of transmitting no fewer than five complete sets of three or more alarm signal rounds when fully wound or shall either indicate when it has been restored to normal after an alarm signal by transmitting a rewind signal or indicate when it is run down by the operation of signaling contacts designed to produce a trouble signal. A mechanism shall not be impaired by the force required to be exerted to provide complete winding.

16.2.5 A coded waterflow indicator having a signal-retard feature shall be capable of operating under any condition of its intended application without being impaired by any setting of the retard time-adjusting means.

16.2.6 A noninterfering circuit feature of a coded waterflow indicator shall be effective only during operation of the indicator for at least three rounds of the fire alarm signal.

16.2.7 A noninterfering shunt or equivalent type of coded waterflow indicator shall operate without loss of signals from the indicator that is electrically nearest to the beginning of the signaling line circuit when two or more indicators connected to the same circuit are operated at or about the same time.

16.2.8 The loss of any part of a signal round or loss of all of the remaining rounds of signal being transmitted by a coded waterflow indicator that was operated prior to the operation of the indicator electrically nearest to the beginning of the signaling line circuit is not considered to be interference.

16.2.9 A noninterfering electromagnet type of coded waterflow indicator shall operate without interference or loss of signals when two or more indicators connected to the same circuit are operated so as to start singly, simultaneously, or consecutively.

16.2.10 Interference is considered to be the loss or confusion of any portion of a coded waterflow indicator signal due to the operation of another indicator connected to the same circuit. The loss of all signals from any indicator that is operated while another indicator is operated is not considered to be interference.

16.2.11 A successive signaling type of coded waterflow indicator shall operate without loss of signals from each indicator operated when the starting levers of two or more indicators connected to the same circuit are operated at or about the same time.

16.2.12 Successive signaling operation is considered to be the transmission of at least three fire alarm signal rounds of the first coded waterflow indicator operated, without interference or confusion of signals caused by the action of any other indicator connected to the same circuit and operated while the first indicator is operating, followed by transmission of the complete number of signal rounds from each of the other indicators operated until all of the operated indicators have completed their signals.

### 16.3 Noncoded waterflow indicators

16.3.1 The contacts of a noncoded waterflow indicator shall remain in the operated condition until the mechanism has been restored to its normal condition by reduction of waterflow to below its actuation setting, but not less than 4 gpm (252 $cm^3$/s).

## 17 Calibration Test – Retard Feature

17.1 The calibration of a retard feature provided on a waterflow indicator shall be such that the measured time of actuation of a waterflow indicator at each setting of the retard shall be within 50 percent of the marked value but in no case shall the retard time exceed 90 seconds.

17.2 Samples of waterflow indicators employing a retard feature are to be tested as follows:

a) One sample tested prior to and after subjection to the Air-Oven Aging Test (27.1.2 and 27.1.3).

b) One sample tested prior to and after subjection to the hydrogen sulphide atmosphere described in the Corrosion Test, Section 24.

c) One sample tested prior to and after subjection to the carbon dioxide and sulfur dioxide atmosphere described in the Corrosion Test, Section 24.

d) One sample tested prior to and after subjection to the Endurance Test – Retard Feature, Section 18.

17.3 The retard is to be mounted in a position which is most likely to result in a malfunction or in a position recommended by the manufacturer, and adjusted in several increments in accordance with the manufacturer's instructions. The delay time of actuation is to be noted for each increment after manual actuation of the vane assembly.

## 18 Endurance Test – Retard Feature

18.1 A retard feature included in a waterflow indicator shall comply with the requirements of the Calibration Test – Retard Feature, Section 17, after being subjected to 500 cycles of operation with the retard set at the maximum delay setting. Each cycle is to consist of operating the indicator for alarm by actuation of the vane assembly followed by restoration to the quiescent condition. One sample of any pipe or tubing size is to be tested.

## 19 Overload and Endurance Test

19.1 The current-interrupting contacts and the operating mechanism of a waterflow indicator shall perform as intended when subjected to the overload and endurance conditions indicated in 19.2 – 19.4. There shall be no electrical or mechanical failure of the indicator assembly, nor undue burning, pitting, or welding of contacts.

*Exception: The overload and endurance tests may be waived if the waterflow indicator employs a single-pole switching device having an ampere rating of not less than twice the ampere rating of the indicator.*

19.2 A coded waterflow indicator is to be operated for 500 cycles by manually operating the actuating means so that the indicator mechanism produces the maximum number of signal impulses obtainable for each operation of the indicator. The test current is to be 150 percent of the rated current for 50 cycles and rated current during the following 450 cycles.

19.3 The contacts of a coded waterflow indicator that control only electromagnets employed for noninterfering signals or for successive signals are to be subjected:

a) To 50 cycles of operation with the overload resulting from operation at 115 percent of the rated current, and

b) To rated current for the following 450 cycles.

19.4 A noncoded waterflow indicator shall be operated manually for 500 cycles of each different set of switching contacts at the rate of 6 cycles per minute making and breaking 150 percent of the rated current and at rated voltage.

19.5 The indicator is to be tested with the load (inductive or noninductive) that the contacts are intended to control, or with the equivalent as follows:

a) An indicator intended and marked for use on alternating current (ac) only is to be tested with ac.

b) An indicator intended for use on direct current (dc) and an indicator not specifically marked for ac only is to be tested with dc.

c) An indicator with a single voltage rating and a single current rating is to be tested at that voltage.

d) An indicator with multiple voltage ratings and a single current rating is to be tested at the highest voltage.

e) An indicator with multiple current ratings is to be tested to cover the conditions of maximum voltage, power, and current interrupted. If the indicator has different current ratings for ac and dc, the indicator is to be tested for each rating. Separate samples are to be used for testing at each different rating.

19.6 For ac signaling circuits, an equivalent inductive test load is to have a power factor of 0.6 or less.

19.7 For dc signaling circuits, an equivalent inductive test load is to have the required dc resistance for the test current and the inductance (calibrated) to obtain a power factor of 0.6 when connected to a 60 hertz rms potential equal to the rated dc test voltage. When the inductive load has both the required dc resistance and the required inductance, the current measured with the load connected to an ac circuit will be equal to 0.6 times the current measured with the load connected to a dc circuit when the voltage of each circuit is the same.

19.8 The load is to be applied so as to obtain a potential difference of 240 volts between contacts that could be employed in that manner.

19.9 A waterflow indicator intended for use on circuits having one conductor grounded is to be tested with the enclosure connected through a 3-ampere cartridge fuse to the grounded conductor.

## 20 Temperature Test

20.1 The materials employed in the construction of a unit shall not be adversely affected by the temperatures attained under any condition of intended operation while connected to a source of rated voltage and frequency.

20.2 A material will be considered as being adversely affected if it is subject to a temperature rise greater than that indicated in Table 20.1.

**Table 20.1**
**Maximum temperature rises**

| Device or material | Normal standby | | Alarm condition | |
|---|---|---|---|---|
| | °C | °F | °C | °F |
| A. COMPONENTS | | | | |
| 1. Capacitors | 25 | 45 | 40 | 72 |
| 2. Fuses | 25 | 45 | 65 | 117 |
| 3. Rectifiers – At any point | | | | |
| a. Germanium | 25 | 45 | 50 | 90 |
| b. Selenium | 25 | 45 | 50 | 90 |
| c. Silicon | 25 | 45 | 75 | 135 |
| 4. Relays and other coils with: | | | | |
| a. Class 105 insulated windings | | | | |
| Thermocouple method | 25 | 45 | 65 | 117 |
| Resistance method | 35 | 63 | 75 | 135 |
| b. Class 130 insulated windings | | | | |
| Thermocouple method | 45 | 81 | 85 | 153 |
| Resistance method | 55 | 99 | 95 | 171 |
| 5. Resistors | | | | |
| a. Carbon | 25 | 45 | 50 | 90 |
| b. Wire wound | 50 | 90 | 125 | 225 |
| 6. Solid-state device | See note a | | | |
| B. INSULATED CONDUCTORS[b] | | | | |
| 1. Appliance wiring material | 25°C (45°F) less than the temperature limit of the wire or tubing | | | |
| 2. Insulating Tubing | | | | |
| C. ELECTRICAL INSULATION | | | | |
| 1. Fiber used as electrical insulation or cord bushings | 25 | 45 | 65 | 117 |
| 2. Phenolic composition used as electric insulation or as parts where deterioration will result in a risk of fire or electric shock | 25 | 45 | 125 | 225 |
| 3. Varnished cloth | 25 | 45 | 60 | 108 |
| D. GENERAL | | | | |
| 1. Mounting surfaces | 25 | 45 | 65 | 117 |
| 2. Wood or other combustible material | 25 | 45 | 65 | 117 |

[a] The temperature of a solid-state device (for example, transistor, SCR, integrated circuits), shall not exceed 50 percent of its rating during the normal standby condition. The temperature of a solid-state device shall not exceed 75 percent of its rated temperature under the alarm condition or any other condition of operation which produces the maximum temperature dissipation of its components. For reference purposes 0°C (32°F) is to be considered as 0 percent. For integrated circuits the loading factor shall not exceed 50 percent of its rating under the normal standby condition and 75 percent under any other condition of operation.



Table 20.1 Continued on Next Page

**Table 20.1 Continued**

| Device or material | Normal standby | | Alarm condition | |
|---|---|---|---|---|
| | °C | °F | °C | °F |
| [b] For standard insulated conductors other than those mentioned, reference should be made to the National Electrical Code, NFPA 70; the maximum allowable temperature rise in any case is 25°C (45°F) less than the temperature limit of the wire in question. | | | | |

20.3 All values for temperature rises apply to equipment intended for use with ambient temperatures not higher than 25°C (77°F). If equipment is intended specifically for use with a prevailing ambient temperature constantly more than 25°C, the test of the equipment is to be conducted at the higher ambient temperature, and the allowable temperature rises specified in Table 20.1 are to be reduced by the amount of the difference between the higher ambient temperature and 25°C.

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

20.5 Except at coils, temperatures are to be measured by means of thermocouples. The preferred method of measuring the temperature of a coil is the thermocouple method, but 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.

20.6 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 No. 30 AWG (0.05 $mm^2$) iron and constantan wires and a potentiometer-type indicating instrument. Such equipment is to be used whenever referee temperature measurements by thermocouples are necessary.

20.7 If the temperature of a copper coil winding is determined by the resistance method, it is to be determined 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:

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



*in which:*

*T = Temperature to be determined in degrees C,*

*t = Known temperature in degrees C.*

*R = Resistance in ohms at the temperature to be determined, and*

*r = Resistance in ohms at the known temperature.*

20.8 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.

20.9 To determine compliance with this test, a unit and related devices are to be connected to a supply circuit of rated voltage and frequency and operated under the following conditions:

a) Standby – 16 hours or until constant temperatures are reached.

b) Normal Signaling, Maximum Rated Load – 1 hour.

c) Abnormal Signaling, Maximum Rated Load – 7 hours.

## 21 Electrical Transient Tests

### 21.1 General

21.1.1 A waterflow indicator using electronic components that are susceptible to transients shall operate as intended after being subjected to 500 supply line transients (high-voltage appliances), and 60 input/output circuit transients (low-voltage appliances) while energized from a source of supply in accordance with Table 15.1. The transients are to be applied with the appliance connected as intended in service and then the appliance is to be energized to determine intended operation.

### 21.2 Supply line transients

21.2.1 A high-voltage ac-operated appliance, when subjected to supply line transients induced directly onto the power supply circuit conductors of the equipment under test shall:

a) Not false alarm; and

b) Operate as described in the Normal Operation Test, Section 16, and the Calibration Test – Retard Feature, Section 17..

21.2.2 A high-voltage ac-operated appliance shall operate as intended after being subjected to transients induced directly into the power supply circuit.

21.2.3 For this test, the appliance is to be connected to a transient generator capable of producing the transients described in 21.2.4. The output impedance of the transient generator is to be 50 ohms.

21.2.4 The transients produced are to be oscillatory at 100 K hertz and are to have an initial peak voltage of 6,000 volts. The rise time is to be less than 1/2 microsecond. Successive peaks of the transient are to decay to a value of not more than 60 percent of the value of the preceding peak.

21.2.5 The appliance is to be subjected to 500 transient pulses induced at a rate of 6 transients per minute. Each transient pulse is to be included 90 degrees into the positive half of the 60-hertz 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.

### 21.3 Input/output circuit transients (low-voltage appliances)

21.3.1 A low-voltage rated appliance shall operate as described in 21.2.1 after being subjected to transients induced into each circuit with the appliance connected as intended in service.

21.3.2 For this test, each circuit is to be subjected to five different transient waveforms having peak voltage levels in the range of 100 to 2,400 volts, as delivered into a 200-ohm load. A transient waveform at 2,400 volts shall have a pulse rise time of 100 volts per microsecond, a pulse duration of approximately 80 microseconds, and an energy level of approximately 1.2 joules. Other applied transients shall have peak voltages from any value in the range of 100 to 2,400 volts, with pulse durations from 80 to 110 microseconds, and energy levels not less than 0.3 joule or greater than 1.2 joules.

21.3.3 The appliance is to be subjected to 60 transient pulses induced at the rate of six pulses per minute as follows:

a) Twenty pulses (two at each transient voltage level specified in 21.3.2) 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 at each transient voltage level specified in 21.3.2) between any two circuit leads or terminals consisting of ten pulses of one polarity and ten of the opposite polarity.

## 22 Dielectric Voltage-Withstand Test

22.1 A waterflow indicator shall withstand for 1 minute, without breakdown, the application of an essentially sinusoidal ac potential of a frequency within the range of 40 – 70 hertz, or a dc potential, as indicated in Table 22.1. Also, see 22.2. The test potential is to be applied between:

a) Live parts and the enclosure,

b) Live parts and exposed dead metal parts, and

c) Live parts of circuits operating at different potentials or frequencies.

**Table 22.1**
**Dielectric voltage-withstand test potentials**

| Unit rating | AC potential | DC potential |
|---|---|---|
| A. 30 volts ac rms (42.4 volts dc or ac peak) or less | 500 volts | 707 volts |
| B. Between 31 and 250 volts ac rms | 1000 volts | 1414 volts |
| C. More than 250 volts ac rms | 1000 volts plus twice the rated voltage | 1414 plus 2.828 times the rated ac rms voltage |

22.2 For the application of a potential in accordance with 22.1(c), the voltage is to be the applicable value specified in item A, B, or C of Table 22.1, 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.

22.3 If an autotransformer is in the circuit, the primary of the transformer is to be disconnected and an ac test potential in accordance with item C of Table 22.1 is to be applied directly to all wiring involving more than 250 volts.

22.4 If the charging current through a capacitor or capacitor type filter connected across the line, or from a line to earth ground, is sufficient to prevent maintenance of the specified ac test potential, the capacitor or filter is to be tested using a dc test potential in accordance with Table 22.1.

22.5 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, the potential is to be increased at a rate of approximately 200 volts per minute until the required test value is reached and is to be held at that value for 1 minute.

22.6 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 reduce the likelihood of destroying them in the case of a malfunction elsewhere in the secondary circuits.



## 23 Electric Shock Current Test

23.1 If the open circuit potential between any part that is exposed only during operator servicing and either earth ground or any other exposed accessible part exceeds 42.4 volts peak, the part shall comply with the requirements of 23.2, 23.3, and 23.4, as applicable.

23.2 The continuous current flow through a 500 ohm resistor shall not exceed the values specified in Table 23.1 when the resistor is connected between any part that is exposed only during operator servicing and either earth ground or any other exposed accessible part.

**Table 23.1**
**Maximum acceptable current during operator servicing**

| Frequency, hertz[a] | Maximum acceptable current through a 500 ohm resistor, milliamperes 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.

23.3 The transient current flowing through a 500 ohm resistor connected as described in 23.2 shall not exceed 809 milliamperes, regardless of duration; and the duration of a transient current shall not exceed the time determined by the following equation:

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

*in which:*

*I is the peak current in milliamperes, and*

*T is the interval, in seconds, between the time that the instantaneous value of the current first exceeds 7.1 milliamperes and the time that the current falls below 7.1 milliamperes for the last time.*

The interval between occurrences shall be equal to or greater than 60 seconds if the current is repetitive. Typical calculated values of maximum acceptable transient current duration are shown in Table 23.2.

**Table 23.2**
**Maximum acceptable transient current duration**

| Maximum peak current (I) through 500 ohm resistor, milliamperes | Maximum acceptable duration (T) of waveform containing excursions greater than 7.1 milliamperes peak |
|---|---|
| 7.1 | 7.26 seconds |
| 8.5 | 5.58 |
| 10.0 | 4.42 |
| 12.5 | 3.21 |
| 15.0 | 2.48 |
| 17.5 | 1.99 |
| 20.0 | 1.64 |
| 22.5 | 1.39 |
| 25.0 | 1.19 |
| 30.0 | 919 milliseconds |
| 40.0 | 609 |
| 50.0 | 443 |
| 60.0 | 341 |
| 70.0 | 274 |
| 80.0 | 226 |
| 90.0 | 191 |
| 100.0 | 164 |
| 150.0 | 92 |
| 200.0 | 61 |
| 250.0 | 44 |
| 300.0 | 34 |
| 350.0 | 27 |
| 400.0 | 23 |
| 450.0 | 19 |
| 500.0 | 16 |
| 600.0 | 12 |
| 700.0 | 10 |
| 809.0 | 8.3 |

23.4 The maximum capacitance between the terminals of a capacitor that is accessible during operator servicing shall comply with the following equations:

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

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

*in which:*

*C is the maximum capacitance of the capacitor in microfarads, and*

*E is the potential in volts across the capacitor prior to discharge. E is to be measured 5 seconds after the capacitor terminals are made accessible, such as by the removal or opening of an interlocked cover, or the like. Typical calculated values of maximum capacitance are shown in Table 23.3.*

23.5 With reference to the requirements of 23.2 and 23.3, the current is to be measured while the resistor is connected between ground and each accessible part individually, 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.

23.6 With reference to 23.5, 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 to be considered to be able to contact parts simultaneously if the parts are within a 4 by 8 inch (102 by 203 mm) rectangle; and two hands of a person are considered to be able to contact parts simultaneously if the parts are not more than 6 feet (1.8 m) apart.

**Table 23.3**
**Electric shock – stored energy**

| Potential in volts, across capacitance prior to discharge | Maximum acceptable capacitance in microfarads |
|---|---|
| 1000 | 0.868 |
| 900 | 1.02 |
| 800 | 1.22 |
| 700 | 1.50 |
| 600 | 1.90 |
| 500 | 2.52 |
| 400 | 3.55 |
| 380 | 3.86 |
| 360 | 4.22 |
| 340 | 4.64 |
| 320 | 5.13 |
| 300 | 5.71 |
| 280 | 6.40 |
| 260 | 7.24 |
| 240 | 8.27 |
| 220 | 9.56 |
| 200 | 11.2 |
| 180 | 13.4 |
| 160 | 16.3 |
| 140 | 20.5 |
| 120 | 26.6 |
| 100 | 36.5 |
| 90 | 43.8 |
| 80 | 53.8 |
| 70 | 68.0 |
| 60 | 89.4 |
| 50 | 124.00 |
| 45 | 150.00 |
| 42.4 | 169.00 |

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

23.8 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.

23.9 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 vacuum tube, separable connector, or similar component in place. These measurements are to be made with controls placed in the position that causes maximum current flow.

## 24 Corrosion Test

24.1 A waterflow indicator shall operate for its intended signaling performance, and there shall be no deterioration of a vane or supporting linkage, after being subjected to the corrosive atmosphere tests described in 24.2 – 24.4.

24.2 One sample is to be exposed to an atmosphere containing approximately 0.1 percent hydrogen sulphide by volume in air saturated with water vapor at room temperature for 10 days.

24.3 One sample is to be exposed to an atmosphere containing approximately 1 percent carbon dioxide and 0.5 percent sulfur dioxide by volume in air saturated with water vapor at room temperature for 10 days.

24.4 The indicators are to be subjected to the Normal Operation Test, Section 16 and the Calibration Test – Retard Feature, Section 17 (if applicable), prior to exposure to the corrosive atmospheres. Twenty-four hours or more after the required exposure the indicators are to be again tested for normal operation and retard calibration.

## 25 Abnormal Tests

25.1 A waterflow indicator that is intended to be operated only for a limited period shall operate continuously under abnormal conditions without resulting in a risk of fire or electric shock.

25.2 The unit is to be operated under the abnormal conditions likely to be encountered in service. There shall be no emission of flame or molten metal or any other manifestation of a risk of fire.

25.3 A circuit-fault condition that is likely to be encountered in service is to be maintained continuously until constant temperatures are attained, or, if the fault does not result in the operation of an overload protective device, until burnout occurs. A single layer of cheesecloth is to be loosely draped over the entire unit with the cloth within 1/8 inch (3.2 mm) of openings in the overall enclosure.

25.4 The test is to be conducted with the unit connected to a source of rated voltage.

## 26 Burnout Test

26.1 If a mercury-tube switch is employed in such a manner that a fault (either a short-circuit or a ground) will cause it to carry current in excess of its maximum normal load, the switch shall withstand a short-circuit as described in 26.2 – 26.4 without introducing a risk of fire.

26.2 The mercury-tube switch is to be connected in series with a protective fuse(s) of the marked maximum rating with which it is intended to be used, as indicated by the marking of the waterflow indicator. The switch is to be tested while mounted in the indicator. All openings in the enclosure of the indicator are to be covered with surgical cotton, and the enclosure, if of metal, is to be connected to ground through a fuse of the same rating as the protective fuse.

26.3 The open-circuit voltage of the test circuit is to be within 5 percent of the rated voltage, as indicated in 15.2.1, of the circuit in which the device is applied, except that a voltage of more than 105 percent of the rated voltage may be employed. The source of current and the test circuit are to be of sufficient capacity to deliver 1000 amperes when the system is short-circuited at the testing terminals.

26.4 Ignition of the cotton or of insulation on circuit conductors, emission of flame or molten metal (mercury excepted) from the enclosure, opening of the fuse in the grounding conductor, damage to other parts of the waterflow indicator, or any manifestation of a risk of fire is considered to be a failure. The burnout of pigtail leads or of a thermal element, or the welding of contacts, is acceptable.

## 27 Tests of Polymeric Materials

### 27.1 Air-oven aging test

27.1.1 The following parts shall be subjected to and comply with the tests described in 27.1.2 and 27.1.3:

a) Polymeric materials employed

1) As an enclosure or part of an enclosure,

2) For sole support of current-carrying parts, or

3) As a functional part of a waterflow indicator, and

b) Thermoplastic materials employed as functional parts of a waterflow indicator, other than as part of an enclosure or for the sole support of current-carrying parts.

27.1.2 There shall be no cracking or crazing of a polymeric component; nor shall there be warping, creeping, or other signs of deterioration that may prevent the intended operation of the waterflow indicator, following air-oven aging at either 90°C (194°F) for 7 days or 70°C (158°F) for 28 days.

27.1.3 Polymeric parts, and sample polymeric components to be aged are to be supported in a full-draft, circulating air-oven that has been preheated at full draft to the aging temperature. A complete indicator assembly, including the plastic components, may be used. The manner of support is to prevent samples from touching one another or the sides of the oven. The specimens are to be aged for the appropriate time period at full draft and then allowed to cool in air at 23 ±2°C (73.4 ±3.6°F) for at least 24 hours before examination. As used in this test, the term ″full draft″ refers to the air flow over the samples in the oven with the air inlet and outlets fully open. The number of fresh air changes in the oven is to be between four and six per minute.