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AUTOMATIC SPRINKLERS FOR FIRE-PROTECTION SERVICE



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ULC/ORD-C199-1994

**AUTOMATIC SPRINKLERS
FOR FIRE-PROTECTION SERVICE**

Prepared and Published by
UNDERWRITERS' LABORATORIES OF CANADA



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UNDERWRITERS' LABORATORIES OF CANADA

FOREWORD

Certification organizations are periodically called upon to respond promptly to a need to provide a certification service for devices, constructions, materials and systems for which no recognized standards of acceptance are available. Accordingly, the certification agency draws upon its experience, existing specifications and requirements in related areas, together with assistance from its advisory councils to develop and prepare an "Other Recognized Document" (ORD) for use in conducting the necessary tests and evaluation investigation.

Underwriters' Laboratories of Canada has over the years prepared many ORD's in response to requests from, and in conjunction with, industry, code writing bodies, regulatory agencies and others prior to inaugurating a certification programme. In many instances such documents have become published ULC Standards and subsequently National Standards of Canada. It is the intention of Underwriters' Laboratories of Canada to continue this practice, as appropriate.

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In Reply
Please Refer to

ULC/ORD-C199-1994

AUTOMATIC SPRINKLERS FOR FIRE-PROTECTION SERVICE

PREFACE

This is the First Edition of ULC/ORD-C199, entitled "Automatic Sprinklers for Fire-Protection Service."

A product which complies with these requirements will not necessarily be acceptable if, when examined and tested, it is found to have features not covered by this document which may impair the result contemplated by these requirements.

A product employing materials or having forms of construction differing from those detailed in these requirements may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be given recognition.

Units of measurement used in this document are Metric SI.

1. SCOPE

1.1 These requirements cover automatic sprinklers intended for installation on sprinkler systems for fire-protection service. Requirements for the installation and use of sprinklers are included in the Standard for the Installation of Sprinkler Systems, NFPA 13.

1.2 Sprinklers are categorized by operating temperature rating, orifice size, installation position, type of coating or plating, and other factors that may have a bearing on use.

2. GLOSSARY

2.1 AUTOMATIC SPRINKLER - A sprinkler intended to open automatically by operation of a heat-responsive element that maintains the discharge orifice closed by means such as the exertion of pressure on a cap (button or disc). A sprinkler is installed on piping so that a spray of water is discharged in a specific pattern for suppression or control of fires.

2.2 COATED, PAINTED, OR PLATED SPRINKLER - A sprinkler that has factory applied coatings, paint, or platings for corrosion protection or decorative purposes.

2.3 CONCEALED CEILING SPRINKLER - A recessed sprinkler assembly having a cover plate installed approximately flush with the ceiling material for aesthetic purposes.

2.4 DISCHARGE COEFFICIENT - K_m - An orifice constant relating pressure to flow as in the formula:

$$Q = K_m \sqrt{P}$$

where: Q = flow, L/min

p = pressure, kPa

NOTE: K_m is a metric Constant and is approximately equivalent to $1.44 \times K$, the corresponding imperial constant.

2.5 DRY-TYPE SPRINKLER - A sprinkler intended for use where the sprinkler or piping system may be exposed to freezing temperatures. It may be an upright, pendent, sidewall, flush, or other type.

2.6 EXTENDED COVERAGE (EC) SPRINKLER - A sprinkler intended:

A For use at greater than standard spacing;

- B To open automatically by operation of a heat responsive element and releasing mechanism having a response time equal to or less than a standard sprinkler used on standard spacings; and
- C To discharge water over a specified coverage area having a ceiling without obstructions at a specified minimum operating water flow rate. An EC sprinkler is intended for use in light hazard occupancies only. The classification of an EC sprinkler specifies the coverage area dimensions, minimum operating water flow rate, orifice size, and the " K_m " factor.

2.7 FLOW CONTROL (FC) SPRINKLER - A sprinkler that is intended to control water flow by automatically cycling open and closed within a specified temperature range.

2.8 FLUSH CEILING SPRINKLER - A sprinkler in which all or part of the body, including the shank thread, is mounted above the lower plane of the ceiling.

2.9 HEAT RESPONSIVE ELEMENT - That portion of a sprinkler that breaks, melts, or otherwise functions to initiate the automatic operation of the sprinkler when exposed to sufficient heat.

2.10 HIGH TEMPERATURE, WAX COATED SPRINKLER - A sprinkler intended to be installed where corrosion resistant, high temperature rated sprinklers are required and where the maximum ambient temperature does not exceed 65.5°C.

2.11 OLD STYLE SPRINKLER - A sprinkler intended for installation in the upright or pendent position, intended to distribute water so that approximately 40% of the discharge is directed upward and 60% is directed downward. When installed in the upright position, this discharge will cover a circle of approximately 3 m in diameter, approximately 3 m below the sprinkler, when the sprinkler is discharging water at the rate of 0.95 L/s. See Subsection 4.22.

2.12 OPEN SPRINKLER - A sprinkler with the heat responsive and activating elements removed, resulting in the discharge orifice being open at all times.

2.13 OPERATING TEMPERATURE - The temperature at which the heat responsive element of a sprinkler operates when subjected to a 0.5°C per minute temperature rise while immersed in a liquid bath.

2.14 ORIFICE - The opening that controls the amount of water discharged from a sprinkler at a given pressure.

2.15 PENDENT SPRINKLER - A sprinkler intended to be installed so that its deflector is located below the orifice and the water flows downward through the orifice, against the deflector.

2.16 QUICK RESPONSE-EXTENDED COVERAGE (QR-EC) SPRINKLER - A sprinkler that:

A Complies with the applicable requirements for such sprinklers in the Sensitivity Tests, Subsection 4.10, when tested and installed in a test room at greater than standard spacings as stated in the installation instructions; and

B Complies with the requirements for EC sprinklers.

2.17 QUICK RESPONSE (QR) SPRINKLER - A sprinkler that complies with the applicable requirements for such sprinklers in the Sensitivity Tests, Subsection 4.10, and that is intended to be installed at standard spacings.

2.18 RECESSED SPRINKLER - A sprinkler assembly in which all or parts of the sprinkler body or frame, other than the shank thread, is mounted within a housing that is recessed within a wall or ceiling.

2.19 SIDEWALL SPRINKLER - A sprinkler intended for installation on or near the wall usually near the ceiling, and intended to discharge most of the water away from the wall on which it is mounted, in a quarter-spherical pattern, with a small portion of the discharge directed at the wall behind the sprinkler.

2.20 STANDARD SPRINKLER - A sprinkler intended for installation only in either the upright or pendent position, designed to distribute water downward in an umbrella-shaped pattern. The discharge from a standard sprinkler having a standard orifice will cover a circle of approximately 5 m in diameter, 1.22 m below the sprinkler, when the sprinkler is discharging water at the rate of 0.95 L/s. See 10-Pan Distribution Test, Subsection 4.20.

2.21 UPRIGHT SPRINKLER - A sprinkler intended to be installed so that its deflector is located above the orifice and the water flows upward through the orifice.

3. CONSTRUCTION

3.1 GENERAL

3.1.1 An automatic sprinkler shall be constructed to effect closure of its water seat for extended periods of time without leakage and to open as intended and release all parts at pressures of 0.034 - 1.21 MPa.

3.1.2 Stampings shall show no cracking or splitting and shall be uniformly smooth and clean cut.

3.1.3 An automatic sprinkler shall be chemically or mechanically staked to maintain the manufacturer's assembly load. The assembly load shall not be able to be changed by the use of common hand tools without causing visible damage to the sprinkler.

3.1.4 Sprinkler types or materials not anticipated by these requirements may require additional tests, such as tests to investigate special metallic or nonmetallic materials.

3.2 INLET THREADS

3.2.1 Sprinklers shall be provided with external pipe threads at the inlet end as specified in Table 1. Inlet end pipe threads shall comply with the Standard for Pipe Threads, General Purpose (Inch), ANSI/ASME B1.20.1-1983, except as outlined in Clauses 3.2.2 through 3.2.5.

TABLE 1
NOMINAL ORIFICE SIZE AND IDENTIFICATION

Orifice Type	Nominal Orifice Size, mm	Discharge Coefficient K_m	External Thread Type NPT	Pintle	Nominal Orifice Size Marked On Frame
Small	6.4	1.8 - 2.2	1/2	Yes	Yes
Small	7.9	2.6 - 2.9	1/2	Yes	Yes
Small	9.5	3.7 - 4.2	1/2	Yes	Yes
Small	11.1	5.8 - 6.3	1/2	Yes	Yes
Standard	12.7	7.6 - 8.4	1/2	No	No
Large	13.5	10.6 - 11.8	3/4 or 1/2	No	No
XL Large	15.9	15.8 - 16.6	1/2 or 3/4	Yes	Yes
XL XL Large	19.1	19.4 - 20.9	3/4	Yes	Yes
Large Drop	15.9	15.8 - 16.6	1/2 or 3/4	Yes	Yes
ESFR	15.9	15.8 - 16.6	3/4	Yes	Yes
	19.1	19.4 - 20.9	3/4	Yes	Yes

3.2.2 Ceiling and dry type sprinklers may be provided with NPS 3/4 or 1 external NPT pipe threads.

3.2.3 Internal taper pipe threads (NPT) of 3/4 or 1 NPS size may be used for large orifice, ceiling type, and dry type sprinklers in lieu of those specified in Table 1.

3.2.4 Sprinklers intended for use in installations where sprinkler fittings incorporate pipe threads other than NPT type threads may be provided with pipe threads complying with a national pipe thread standard compatible with those fittings.

3.2.5 Sprinkler inlets intended for attachment to piping by means other than threads are acceptable if the sprinklers:

- A** Have a nominal orifice size and corresponding discharge coefficient as specified in Table 1;
- B** Are provided with nominal orifice size markings as specified in Clause 5.3; and
- C** Are intended to be attached in a manner that does not involve welding and that permits sprinkler removal from sprinkler piping without the use of special tools or torch cutting equipment.

3.2.6 Threads shall be clean cut and true and free from burrs, scoring or chatter marks.

3.3 TEMPERATURE RATINGS

3.3.1 The temperature ratings and temperature classifications of automatic sprinklers shall be as specified in Table 2. The frame arms of automatic sprinklers or glass bulb heat responsive elements shall be coloured according to the colour code specified in Table 2. See Clause 5.9.

TABLE 2
TEMPERATURE CLASSIFICATION RATINGS
AND COLOUR CODING

	Temperature Rating	Code Colour	
Temperature Classification	Degrees, C	Frame Arms	Glass Bulb
Ordinary	57-77	Uncoloured or Black	Orange or Red
Intermediate	79-107	White	Yellow or Green
High	121-149	Blue	Blue
Extra High	163-191	Red	Purple
Very Extra High	204-246	Green	Black
Ultra High	260-302	Orange	Black

3.4 NORMAL ORIFICE SIZES

3.4.1 A sprinkler shall have an orifice complying with one of the nominal orifice sizes specified in Table 2. The nominal orifice size is to be determined from the discharge coefficient " K_m ", as specified by the Calibration Test, Subsection 4.19.

3.4.2 The dimensional tolerance for a specific nominal orifice size shall provide single " K_m " factor values that are within $\pm 5\%$ of the average " K_m " factor determined at a specific pressure.

EXCEPTION: A small orifice sprinkler may have single " K_m " factor values that are not within $\pm 5\%$ of the average " K_m " factor if the single " K_m " factor value is within ± 0.2 units of the average " K_m " factor value.

3.4.3 The diameter of a discharge orifice or any internal passage of a sprinkler shall be at least 5.3 mm.

3.5 INSTALLATION INSTRUCTIONS

3.5.1 Each package of:

- A Extended coverage, dry type, quick response, sidewall type, and flow control sprinklers; and
- B Sprinklers for installations not specifically outlined in the Standard for Installation of Sprinkler Systems, NFPA 13; shall be provided with design parameter instructions or with a statement indicating that design parameter instructions are available from the manufacturer. The design parameter instructions for an EC sprinkler shall specify the coverage area dimensions, minimum water flow rate, the orifice size, and the "K" factor.

3.5.2 Each box of ceiling type sprinklers shall be provided with installation instructions that specify the method of sprinkler assembly.

3.6 COATINGS AND PLATINGS

3.6.1 The operation and distribution characteristics of a sprinkler shall not be impaired by the application of any factory applied coating, paint, or plating when the sprinkler is tested in accordance with these requirements.

3.6.2 A corrosion resistant coating or plating shall be uniformly applied.

3.6.3 A wax coating shall not be brittle when new nor become brittle with age.

4. PERFORMANCE

4.1 GENERAL

4.1.1 To determine compliance with these requirements a sprinkler shall be subjected to the relevant performance tests described in Subsections 4.3 through 4.41.

4.1.2 When a recessed or concealed sprinkler is tested with an escutcheon during the performance tests, the sprinkler is to be recessed to the maximum depth allowed by the sprinkler/escutcheon combination.

4.2 SAMPLES

4.2.1 The number of samples required for investigation may vary for different sprinkler types. The number of samples required for examination and test are to be determined following a review of detailed drawings, examination of a preliminary sample, or both.

4.3 LOAD ON HEAT RESPONSIVE ELEMENT TEST

4.3.1 The average and maximum design loads exerted on the heat responsive element, and the overall load tolerance based on the design load for the assembly, are to be determined. If the application of the rated working pressure to the inlet end of the sprinkler increases the assembly load by more than 10%, the additional load is to be added to the measured load on the heat responsive element. The information developed is to be used for Strength of Heat Responsive Element Test, Subsection 4.4.

4.3.2 At least twenty-five sprinklers are to be tested to determine the average load. An arrangement for measuring the load on the heat responsive element is to be developed for each specific design.

4.4 STRENGTH OF HEAT RESPONSIVE ELEMENT TEST

4.4.1 Fusible - Alloy Types

4.4.1.1 A heat responsive element in the ordinary temperature rating shall either:

A Sustain a load of 15 times its maximum design load for a period of 100 h; or

B Demonstrate the ability to sustain the maximum design load when tested in accordance with Clauses 4.4.1.2 and 4.4.1.3.

4.4.1.2 Compliance with Item B of Clause 4.4.1.1 is to be determined by subjecting sample heat responsive elements to loads in excess of the maximum design load. A minimum of ten samples are to be loaded at various values as required up to 15 times the design load. At least one heat responsive element shall sustain a load for a time greater than 1000 h. These load and time values shall then be used to derive a least-square, full logarithmic regression curve of time as a function of load, from which the loads at 1 h and 1000 h are to be determined. The design load shall comply with the following equation:

$$L_d \leq 1.02 L_m^2 / L_o$$

where:

L_d is the maximum design load

L_m is the load at 1000 h; and

L_o is the load at 1 h

4.4.1.3 The test samples are to be loaded at a conditioned temperature of $21 \pm 3^\circ\text{C}$.

4.4.2 Frangible - Bulb Types

4.4.2.1 The lower tolerance limit for bulb strength, based on calculations with a degree of confidence of 0.99 for 99% of samples, shall exceed two times the upper tolerance limit for sprinkler assembly load based on calculations with the same degree of precision as for bulb strength. Calculations are to be based on the Normal or Gaussian Distribution except where another distribution can be shown to be more applicable due to manufacturing or design factors. The bulb strength is to be measured by applying a steadily increasing load, utilizing a compression testing machine, until the bulb breaks. This test is to be conducted with the bulb mounted in the seating parts used in the sprinkler and at a rate of loading not exceeding 25 kg/s, or at a rate that deflects the bulb 0.51 mm/min, whichever measurement is convenient for the test apparatus being used. Bulb seatings may be reinforced circumferentially so as not to interfere with the bulb breakage. A minimum of 15 samples of each temperature rating and each bulb type are to be tested. See Appendix A.

4.4.2.2 A sprinkler having a frangible bulb shall withstand the thermal shock of rapid temperature changes 11°C below its marked operating temperature or 11°C below the lowest allowable value of the operating temperature range determined in the Operating Temperature (Bath) Test, Subsection 4.9, whichever is lower. At least five samples of the sprinkler are to be conditioned for 5 min in a liquid bath at 11°C less than their rated operating temperature or minimum permitted operating temperature. The samples then are to be removed and immediately submerged in another liquid bath at 10°C. There shall be no breakage or fracture of the glass bulb.

4.5 LEAKAGE TEST

4.5.1 An automatic sprinkler shall not exhibit any leakage at any pressure from 0 - 3.45 MPa when tested as described in Clauses 4.5.2 and 4.5.3.

4.5.2 At least 20 samples shall be individually tested. The sprinkler inlets are to be filled with water and vented of air.

4.5.3 The pressure is to be increased from 0 to 3.45 MPa at a rate not exceeding 2 MPa/min and held for 1 min. There shall be no visible leakage in any sample.

4.6 HYDROSTATIC STRENGTH TEST

4.6.1 An automatic sprinkler shall withstand for 1 min, without rupture, an internal hydrostatic pressure of 4.8 MPa.

4.6.2 At least 20 samples shall be individually tested. The sprinkler inlets are to be filled with water and vented of air. The pressure is to be increased from 0 to 4.8 MPa at a rate not exceeding 2 MPa/min. The pressure is to be maintained at 4.8 MPa and held for 1 min. The sample shall not rupture, operate, or release any of its operating parts during the pressure increase nor while being maintained at 4.8 MPa for 1 min.

4.7 30-DAY LEAKAGE TEST

4.7.1 When tested as described in Clauses 4.7.2 through 4.7.4, an automatic sprinkler shall:

- A Experience no leakage when subjected to a hydrostatic pressure of 2.07 MPa for 30 d;
- B Not leak when subjected to a pressure of 3.45 MPa or less for 1 min following the 30 d; and
- C Show no distortion or other mechanical damage following the leakage testing, as determined by visual examination.

4.7.2 Five samples are to be installed on a water-filled test line maintained under a constant pressure of 2.07 MPa for 30 days. The samples are to be examined weekly during the test period for evidence of leakage of water at the closure cap.

4.7.3 Following completion of this 30 d test period, the samples are to be tested to verify that they do not leak at 3.45 MPa or less. The pressure is to be increased from 0 to 3.45 MPa at a rate not exceeding 2 MPa/min. The pressure is to be maintained at 3.45 MPa for 1 min, and is then to be decreased to 0 MPa at a rate not exceeding 2 MPa/min.

4.7.4 The samples then are to be visually examined to verify there is no evidence of distortion or other mechanical damage.

4.8 WATER HAMMER TEST

4.8.1 When tested as described in Clauses 4.8.1 through 4.8.5, an automatic sprinkler shall:

- A Experience no leakage when subjected to 3,000 applications of a pressure surge increasing rapidly from 0.34 to 3.45 MPa;
- B Not leak when subjected to a pressure of 3.45 MPa or less for 1 min, following the 3,000 cycles of water hammer; and
- C Show no distortion or other physical damage following the water hammer testing as determined by visual examination.

4.8.2 Five samples are to be installed on a water-filled test line connecting with a small motor operated piston pump that produces a rapid rise in discharge pressure from 0.34 to 3.45 MPa at the rate of 60 cycles/min. The test piping is to be filled so that there is water at the sprinkler seat, and the pump is to be placed in operation and adjusted to produce the specified test pressure cycle.

4.8.3 During the pressure cycling, observations are to be made for evidence of leakage.

4.8.4 Following completion of the pressure cycling, the samples are to be tested to verify that they do not leak at 3.45 MPa or less. The pressure is to be increased from 0 to 3.45 MPa at a rate not exceeding 2 MPa/min. The pressure is to be maintained at 3.45 MPa for 1 min, and is then to be decreased to 0 MPa at a rate not exceeding 2 MPa/min.

4.8.5 The samples then are to be visually examined to verify there is no evidence of distortion or other mechanical damage.

4.9 OPERATING TEMPERATURE (BATH) TEST

4.9.1 An automatic sprinkler shall, when bath tested, operate within a range having a maximum temperature not in excess of either 5°C or 107% of the minimum temperature of the range, whichever is greater. For the purpose of this determination, the marked temperature rating is to be included as one of the values within the range, making a total of eleven values in the range. Upon operation, all operating parts of the sprinkler shall clear the waterway as intended.

4.9.2 At least ten samples of each type of sprinkler produced, including plated, painted, coated, and uncoated types of each temperature rating are to be subjected to this test. A sprinkler that does not require pressure to operate is to be tested at zero gauge pressure. A sprinkler that requires pressure to operate is to be tested while pressurized at 31 ± 3.4 kPa.

4.9.3 The samples are to be placed in an upright position and completely immersed in the water or oil bath. The bath vessel is to be provided with a source for heating the liquid at the prescribed rate and with means to agitate the liquid and measure the temperature of the liquid bath.

4.9.4 Water is to be used in bath tests of sprinklers that have operating temperature ratings of 79°C or lower. Samples having operating temperature ratings of 80 - 302°C are to be bath-tested in an oil having a flash point exceeding the test temperature.

4.9.5 An agitator is to be used as an aid in obtaining uniformity in temperature of the liquid in the bath.

4.9.6 A laboratory mercury thermometer, calibrated in accordance with the Specification for ASTM Thermometers, E 1-86, is to be used to determine temperatures of the liquids in bath tests. The bulb of the thermometer is to be held level with the sprinkler operating parts by a support member.

4.9.7 The temperature of the bath liquid is to be increased at a convenient rate until the liquid is within 11°C of the temperature rating of the device (16°C for 163°C and higher temperature ratings). The rate of temperature rise then is to be controlled at a rate not exceeding 0.5°C/min until operation of the sprinkler or until a temperature 11°C above the rated temperature is reached. The temperature of the liquid and the time of operation, as each sprinkler operates, are to be recorded.

4.10 SENSITIVITY TESTS

4.10.1 General

4.10.1.1 An automatic sprinkler, other than a dry type, shall comply with the requirements in:

- A Clauses 4.10.2.1 and 4.10.3.1 when identified as a quick response sprinkler; and
- B Clause 4.10.2.2 when intended for use as a standard response sprinkler. A sprinkler that complies with Item A but not Item B of Clause 4.10.2.1 is not considered acceptable under the requirements of this document.

4.10.1.2 A coating shall not remain on sprinkler parts in a manner likely to impair operation or distribution at the time of sprinkler operation in Clauses 4.10.2.1 and 4.10.3.1.

4.10.2 Sensitivity - Oven Heat Test

4.10.2.1 A QR sprinkler shall have the following operating time characteristics when tested in the sensitivity test oven as specified in Clauses 4.10.2.3 through 4.10.2.5:

- A Fourteen seconds or less for each sprinkler when subjected to the test in Clause 4.10.2.3;
- B Mean time equal to or less than a 1.30 multiple of the mean time of the sprinkler tested in accordance with Item A after being subjected to the exposure tests specified in Subsections 4.14, 4.17, 4.18 and 4.25.

4.10.2.2 A standard response sprinkler shall have an operating time greater than 14 s and not greater than the maximum operating time specified in Table 3 when tested in the sensitivity test oven as specified in Clauses 4.10.2.3 through 4.10.2.5.

4.10.2.3 Sprinklers of each style are to be tested in the sensitivity test oven in the pendent position with the heat responsive element located at least 25 mm away from the inside surfaces of the oven as follows:

- A For sprinkler designs without frame arms and incorporating symmetrical heat responsive elements and symmetrical sprinkler bodies, ten samples are to be orientated in the pendent position;
- B For sprinkler designs with or without frame arms and incorporating unsymmetrical heat responsive elements or unsymmetrical body designs, ten samples are to be orientated in the pendent position with the heat responsive element upstream of the axis of the sprinkler body;

C For sprinkler designs incorporating frame arms with symmetrical heat responsive elements, ten samples are to be orientated in the pendent position with the frame arms in a plane perpendicular to the direction of air flow;

D For ceiling style sprinkler designs incorporating removable cups, escutcheons, and like removable closure assemblies, ten samples are to be orientated in the pendent position with the closure assemblies removed. For ceiling style sprinkler designs incorporating an integral closure assembly, ten samples are to be orientated in the pendent position with the heat responsive element exposed to the air flow;

TABLE 3

MAXIMUM OPERATING TIME FOR SPRINKLERS
IN SENSITIVITY OVEN

		Maximum Operating Time, Seconds, for Sprinkler Types			
Sprinkler Temperature Rating Degrees C	Oven Temperature, Degrees C	Quick Response Type	Standard Response Type	Ceiling ^a Type	Ceiling ^b Type
57 - 77	135	14	100	100	180
79 - 107	197	14	100	100	180
121 - 149	290	14	100	---	180
163 - 191	407	---	100	---	180
204 - 246	407	---	120	---	180
260 - 302	407	---	180	---	180
^a Ceiling sprinklers include recessed, flush, and concealed types.					
^b Corrosion resistant sprinklers with coated heat responsive elements including wax, lead, teflon, wax over lead, and polyester coatings.					

4.10.2.4 The samples are to be conditioned at $24 \pm 1^\circ\text{C}$ for at least 2 h. The inlet end of each sprinkler sample is to be connected to source of air pressure at 28 ± 7 kPa and quickly plunged into the sensitivity test oven in a pendent position. Each sprinkler is to be observed to determine if operation occurs as intended within the time specified in Clause 4.10.2.1.

4.10.2.5 The sensitivity test oven is to consist of a 203 mm square stainless steel chamber as shown in Figure 1. A constant air velocity of 2.54 ± 0.01 m/s and an air temperature as specified in Table 3 for each temperature rating and style sprinkler are to be established. Air velocity is to be measured using an orifice plate and a manometer or a bi-directional probe and a velometer. The air temperature is to be measured by use of a No. 30 AWG (0.25 mm diameter) thermocouple centred upstream from the sprinkler as shown in Figure 1.

4.10.3 Sensitivity - Room Heat Test

4.10.3.1 An ordinary or intermediate temperature rated QR sprinkler shall have an operating time of 75 s or less for each sprinkler when tested as specified in Clauses 4.10.3.3 through 4.10.3.5.

4.10.3.2 A recessed or concealed sprinkler having a venting escutcheon is to be installed and tested in an unblocked manner, that is, in a manner that will not inhibit air flow through the escutcheon.

4.10.3.3 Sprinklers of each type are to be installed in a test room (See Clause 4.10.3.4) in the following positions and orientations:

- A For pendent and ceiling type sprinkler designs without frame arms and incorporating symmetrical heat responsive elements and symmetrical sprinkler bodies, ten samples are to be installed in their intended position at the ceiling;
- B For pendent and ceiling type sprinkler designs with or without frame arms and incorporating unsymmetrical heat responsive elements, ten samples are to be orientated with the heat responsive element downstream of the axis of the sprinkler body in relation to the direction of the fire source. The samples are to be in their intended position;
- C For pendent and ceiling type sprinkler designs incorporating frame arms with symmetrical heat responsive elements, ten samples are to be orientated with the frame arms in a plane parallel to the direction of the fire source. The samples are to be installed in their intended position;
- D For upright sprinklers having configurations referenced in Items A, B and C, ten samples are to be installed in the pendent position;

- E For sidewall sprinkler designs, ten samples are to be installed in their intended position with the deflector located 102 mm below the ceiling.

4.10.3.4 The sprinkler is to be mounted as specified in Clause 4.10.3.3 on a ceiling or a wall of a closed room having a 2.4 m high ceiling. For a QR sprinkler, the room is to be 4.6 by 4.6 m. For a QR-EC sprinkler, the room size is to be as specified by the manufacturer and be the same dimensions used for the extended coverage tests in these requirements. The sprinkler inlet waterway is to be filled with water having a temperature of $21 \pm 1.6^\circ\text{C}$. The water is to be at a pressure of 31 ± 3.4 kPa.

4.10.3.5 The fire source is to consist of a 305 by 305 by 305 mm sand burner located in one corner of the room with a flow of natural gas of $14.2 \text{ m}^3/\text{h}$ for ordinary temperature rated sprinklers and $17.0 \text{ m}^3/\text{h}$ for intermediate temperature rated sprinklers. A pendent, upright, or ceiling type QR sprinkler is to be installed along a diagonal line on the ceiling at a distance of 5.1 m from the corner of the room where the sand burner is located. A pendent, upright, or ceiling type QR-EC sprinkler is to be installed in the intended position at a point where a diagonal line from the corner having the burner to the opposite corner intersects an arc having a radius equal to the midpoint of the opposite wall. A sidewall sprinkler is to be installed on the distance from the corner having the burner to the midpoint of the furthest wall opposite the corner having the sand burner. The test is to be started when the ambient temperature is $31 \pm 1^\circ\text{C}$ for ordinary temperature rated sprinklers and $49 \pm 1^\circ\text{C}$ for intermediate temperature rated sprinklers, as measured in the centre of the room 254 mm below the ceiling. The gas burner is to be ignited, and the operation time of the sprinkler is to be recorded.

4.11 OPERATION - LODGEMENT TEST

4.11.1 An automatic sprinkler of other than the upright dry type shall operate at service pressures of 48 kPa to 1210 kPa. All operating parts shall release with sharp, positive action. Operating parts intended to be released from the sprinkler assembly shall be thrown clear of the sprinkler frame and deflector so as not to impair the water distribution pattern.

4.11.2 An upright dry type sprinkler of the maximum length shall operate at a pressure of 86 kPa or less to clear from the waterway all internal parts which would adversely affect normal flow. When the minimum pressure required to clear operating parts exceeds 34 kPa, the minimum operating pressure of such a sprinkler shall be designated as two times the minimum pressure required to clear operating parts.

4.11.3 Thirty samples of automatic sprinklers of other than the upright dry type are to be individually tested. Each sample is to be installed in its intended installation position on a rigid piping arrangement and supplied with flowing water at service pressures in accordance with the following: five sprinklers at 48 kPa, five sprinklers at 172 kPa, five sprinklers at 345 kPa,