

**STANDARD FOR DRY CHEMICAL FOR USE IN HAND AND
WHEELED FIRE EXTINGUISHERS**

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STANDARD FOR DRY CHEMICAL FOR USE IN HAND AND WHEELED
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STANDARD FOR DRY CHEMICAL FOR USE IN HAND AND WHEELED FIRE EXTINGUISHERS

PREFACE

This is the Third Edition of the Standard for Dry Chemical for Use in Hand and Wheeled Fire Extinguishers, CAN/ULC-S514.

This Edition of the Standard has been formally approved by the ULC Standards Committee on Portable Fire Extinguishers

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

Appendix A, identified as informative, is for informational purposes only.

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

This Third Edition National Standard of Canada is based on, and now supersedes, the Second Edition.

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

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

The initiation of the review of this Standard will commence within 5 years of the date of publication, unless the Standard is identified as fitting within a stabilized category, whereby the review will commence within the appropriate time frame set out by ULC Standards.

This Standard is intended to be used for conformity assessment.

1. SCOPE

1.1 These requirements cover chemical, physical and performance properties of dry chemical fire extinguishing agents for use in portable fire extinguishing equipment being evaluated to CAN/ULC-S504, Standard for Dry Chemical Fire Extinguishers.

1.2 These requirements are also intended for the evaluation of recharge dry chemical fire extinguishing agents for use in extinguishers meeting the requirements of CAN/ULC-S504, provided the performance of the combination of the extinguisher and recharge agent, including performance during fire tests, can be shown to be equivalent to that of the original extinguisher.

NOTE: Reference to each applicable Test Method for a requirement is indicated by the letters TM and the appropriate Clause or Section number in parentheses in the right hand margin.

2. REFERENCE PUBLICATIONS

The documents shown below are referenced in the text of this Standard. Unless otherwise stated elsewhere in this Standard such reference shall be considered to indicate the edition and/or revisions of the document available at the date on which the Committee approved this ULC Standard.

Documents Published by the American Society for Testing and Materials (ASTM)
100 Barr Harbour Drive, PO Box C700, West Conshohocken, PA 19428-2959 U.S.A.
Telephone: (610) 832-9585
www.astm.org

- ASTM D5-13, Standard Test Method for Penetration of Bituminous Materials
- ASTM D877-13, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
- ASTM D1193-06 (R2011), Standard Specification for Reagent Water

Documents Published by the National Fire Protection Association (NFPA)
1 Batterymarch Park, Quincy, MA 02169-7471 U.S.A.
Telephone: (617) 770-3000
www.nfpa.org

- NFPA HAZ10-2010, Fire Protection Guide to Hazardous Materials
- NFPA 11-2010, Standard for Low-, Medium-, and High-Expansion Foam

Document Published by Underwriters Laboratories of Canada (ULC)
7 Underwriters Road, Toronto, ON M1R 3B4 Canada
Telephone: (416) 757-3611 or 1-866-9373-ULC
www.ulc.ca

- CAN/ULC-S560-06, Standard for Category 3 Aqueous Film-Forming Foam (AFFF) Liquid Concentrates
- CAN/ULC-563-06, Standard for Category 3 Film-Forming Fluoroprotein (FFFP) Foam Liquid Concentrates

Document Published by ULC Standards
171 Nepean Street, Suite 400, Ottawa, ON K2P 0B4
Telephone: (613) 755-2729
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- CAN/ULC-S504-12, Standard for Dry Chemical Fire Extinguishers

3. GENERAL REQUIREMENTS

3.1 A product covered by these requirements shall be in the form of a dry chemical composed chiefly of one of the materials described in Clause 3.4, with other ingredients incorporated to improve fluidity and non caking characteristics.

3.2 The ingredients or their by products when exposed to a fire shall not present a hazard to life or be likely to cause permanent injury or disability to persons under normal usage of the extinguisher. The short duration of exposure, the quantity of dry chemical fire extinguishing agent and infrequent use of the equipment are important factors in evaluating this characteristic.

3.3 Determination of Conformance to Clause 3.2 shall be on the basis of the criteria contained in the Handbook of Dangerous Materials,¹ and NFPA HAZ10, Fire Protection Guide to Hazardous Materials.

3.4 The following generic materials for use in dry chemical extinguishing agents are covered by this Standard:

- A Sodium Bicarbonate (NaHCO_3);
- B Potassium Bicarbonate (KHCO_3);
- C Potassium Chloride (KCl); and
- D Ammonium Phosphate ($\text{NH}_4\text{H}_2\text{PO}_4$).

3.5 The dry chemical fire extinguishing agents shall be identified by reference to the generic material using the terminology " * base"² (See Clause 3.4).

4. DETAIL REQUIREMENTS

4.1 The dry chemical fire extinguishing agent shall comply with the requirements of Clauses 3.2 through 3.5 and the required characteristics listed in Table 1.

4.2 The material shall be free flowing at -54 °C.

¹N.I Sax, published by Reinhold Publishing Corporation, New York, N.Y.

²Basic generic material.

(TM 5.10)

4.3 The dry chemical fire extinguishing agent shall be coloured as follows:

- A Sodium Bicarbonate – Natural (white or off-white) or Light Blue;
- B Potassium Bicarbonate – Purple;
- C Potassium Chloride – Green; and
- D Ammonium Phosphate – Yellow.

NOTE: As other generic materials are introduced, other colours will be assigned.

4.4 Dry chemical fire extinguishing agents intended for use in extinguishers classified for use on fires in energized electrical equipment shall have a dielectric breakdown strength of at least 5000 V.

(TM 5.11)

4.5 Dry chemicals, when designated "Foam Compatible" shall have a minimal effect on protein foam, as indicated by a drainage rate when tested in conjunction with the chemical, of not more than twice that obtained on a foam sample tested without.

(TM 5.12)

5. TEST METHODS

5.1 SAMPLES

5.1.1 Samples to be subjected to these tests shall be selected from containers of not less than 20 kg size, by the insertion of a 25 mm sampling tube to the full depth of the container at not less than five locations.

5.2 MOISTURE CONTENT

5.2.1 In an atmosphere of 50 % relative humidity, or less, and a temperature of 21 ± 3 °C, place a sample of approximately 50 g into a tared aluminum moisture dish (65 mm in diameter and 15 mm deep) and weigh accurately. Place the dish in a desiccator using 95 to 98 % by mass reagent grade sulphuric acid as a drying agent. Maintain the closed desiccator and contents at a temperature of 21 ± 3 °C for 24 h. At the end of this time, remove the test sample, and weigh accurately. Calculate the moisture content of the sample from the following equation:

NOTE: A balance capable of weighing to within ± 0.005 g is considered adequate for this purpose.

$$M=100\times\frac{W-W_1}{W}$$

where:

M = moisture content, in %;
W = original mass of sample, in g;
W₁ = mass of sample, in g, after 24 h drying.

5.3 PARTICLE SIZE

5.3.1 Apparatus

5.3.1.1 The shaker employed shall operate with a single eccentric circular motion at 285 ± 10 r/min and with a tapping action of 150 strokes/min. The shaker shall accommodate the 200 mm diameter Tyler sieves stipulated in Table 1 with one pan and cover.

5.3.2 Procedure

5.3.2.1 In an atmosphere of 50 % relative humidity or less and a temperature of 21 ± 3 °C, place a weighed sample of approximately 50 g in the top sieve of the nested series of 200 mm diameter sieves assembled from top to bottom in order of increasing fineness. Agitate the nested assembly for 10 min. Separate the sieve nest and weigh accurately the amount remaining on each, expressing the results as a percentage of the original sample.

5.4 HYGROSCOPICITY

5.4.1 Fill a tared aluminum moisture dish (65 mm diameter, 15 mm deep) to a level approximately 1 mm and not more than 2 mm below the top edge of the dish, with just enough gentle tapping action on the dish bottom to level the sample in the dish. Cap the dish with its cover and weigh accurately. Remove the cover and place the sample in a humidifier with circulating air as described in Clause 5.7.2 and maintained at 78 % relative humidity and 21 ± 3 °C for a period of 48 h. (See Figure 1). At the end of this period replace the cover and reweigh the sample. Determine the gain in mass and calculate the percentage gain in mass (hygroscopicity) of the sample, as follows:

$$H = 100 \times \frac{W_2 - W_1}{W_1}$$

where:

H = hygroscopicity (gain in mass), in %.
W₁ = original mass, in g.
W₂ = mass after exposure, in g.

5.5 BULK VALUE (APPARENT DENSITY)

5.5.1 Place 100 ± 1 g of sample in a clean, dry 250 mL graduated cylinder, having an internal diameter of approximately 35 mm. Stopper the cylinder and rotate slowly end over end for ten complete cycles within 1 min. Set the cylinder upright, allow to settle for 60 s, read the volume occupied by the sample and report directly as bulk value in mL/100 g.

5.6 PACKED DENSITY

5.6.1 Secure the graduated cylinder containing the sample used for bulk value determination centrally in a Tyler Ro Tap machine, using the fixture shown in Figure 2. Using a single eccentric circular motion at 285 ± 10 r/min and with a tapping action of 150 strokes/min agitate the sample for a period of 30 min. Remove the cylinder from the machine, set upright and read volume occupied by the sample.

5.7 CAKING AND LUMPING

5.7.1 Fill two nickel crucible shaped cups (100 mL capacity, 60 mm diameter at top, 64 mm high). Locate one crucible at a time centrally in a Tyler Ro Tap machine with the fixture shown in Figure 3. Using a single eccentric motion at 285 ± 10 r/min and with a tapping action of 150 strokes/min, agitate the sample for a period of 5 min. Then place the samples in a moving air stream humidifier at 78 % relative humidity and at a temperature of 21 ± 3 °C for 24 h followed by exposure in an air drying oven at 48 °C for 24 h. Determine the degree of caking with a precision Universal Penetrometer as outlined in ASTM D5, Penetration of Bituminous Materials . Conduct the test in duplicate, taking an average of three readings per cup determined in a triangular pattern across the surface of the dry chemical fire extinguishing agent. Penetration is defined as the resistance of the material to the needle under a load of 50 g for 5 s, and expressed as the distance of penetration of the needle in units of 0.10 mm.

5.7.2 Where a desiccator is used as the humidifier, precaution shall be taken to ensure air circulation. A 250 mm diameter desiccator with a saturated ammonium chloride (NH_4Cl) solution in the lower compartment may be used. During operation a circulating air supply of 5 L/min shall be presaturated by bubbling through distilled water and then through a saturated NH_4Cl solution and then introduced into the desiccator through a centre tube with 6 mm internal diameter terminating 20 mm above the centre in the desiccator plate. In addition, the following must be maintained to ensure uniform conditions in an endeavour to produce reproducible results:

- A Strict adherence to the humidification train specified in Figure 1;
- B Adherence to the specified gas washing bottles and ensuring that the liquid level remains between 80 and 100 mm above the bottom of the bubbler tube in each of the two bottles;
- C A uniform flow of the specified volume of air with a device to monitor the relative humidity of the air at the exit vent; and
- D The specified temperature range.

5.8 PACKED POWDER DISCHARGE

5.8.1 The packed powder discharge of the extinguishing agent shall be not less than that specified in Table 1, calculated as the mean of three discharges with no discharge less than 85 %, when tested in accordance with Clauses 5.8.2 through 5.8.4.

5.8.2 The equipment for these tests shall consist of the following:

- A Three cartridge operated extinguishers, as described in Figures 4, 5 and 6, conforming to the following specifications:
 - i) Nominal Capacity equal to 2 kg;
 - ii) Expellant Gas (CO_2) equal to 40 g;
 - iii) Container Internal Length equal to 375 mm;
 - iv) Container Internal Diameter equal to 90 mm;
 - v) Discharge Hose Internal Diameter equal to 10 mm;
 - vi) Discharge Nozzle Diameter equal to 4 mm; and

- B An impact machine, as described in Figure 7, capable of subjecting charged extinguishers to repetitive shock pulses by dropping them from a height of 25 ± 1.5 mm onto a solid surface, covered with an elastomeric material of 1.5 mm thickness. The dropping operation shall be guided and have an acceleration approaching a free fall.

5.8.3 Charge three tared extinguishers with an amount of the dry chemical fire extinguishing agent under test equal to $2250 \times 100/D$ grams (where D is the bulk value of the agent as determined by the test method in Subsection 4.5) and determine the mass of each of the charged extinguishers.

5.8.4 Assemble an uncharged CO₂ cartridge to the extinguisher head, then in turn affix head tightly to extinguisher. Position extinguisher(s) on the impact machine and impact at a rate of 25 times/min for a total of 250 times. After impactation, loosen heads of extinguishers and place in a conditioning oven at 49 ± 1 °C for 16 h (overnight has been found suitable). Weigh three cartridges containing 40 ± 4 g of carbon dioxide. Remove extinguishers from the oven after the elapsed time and immediately attach the charged CO₂ cartridge to each extinguisher. Secure extinguisher heads. Puncture the cartridge, allow 5 s for pressurization, then discharge the contents as quickly as possible. Remove each of the cartridges, weigh the extinguishers and calculate the packed powder discharge for each extinguisher as follows:

$$D = 100 \times \frac{W_1 - W_2}{W_1}$$

where:

D = Packed Powder Discharge, in %,
W1 = Initial Mass, in g; and
W2 = Final Mass, in g.

5.9 COMPOSITION

5.9.1 Sodium or Potassium Bicarbonate Content

5.9.1.1 General

5.9.1.1.1 This method is intended to determine the bicarbonate content of sodium bicarbonate or potassium bicarbonate dry chemical fire extinguishing agents which may contain waterproofing and fluidizing agents and other materials required for satisfactory performance. This method assumes that all bicarbonate is present as the sodium salt or the potassium salt, as applicable.

5.9.1.2 Apparatus

5.9.1.2.1 The following apparatus shall be used:

- A Analytical balance, capable of weighing accurately to 0.1 mg;
- B Aluminum moisture dishes, 65 mm diameter by 44.5 mm high with closely fitting slip over cover. (Canlab catalogue number D2153-2 or equivalent);
- C Glass desiccators - one containing 95 to 98 % by mass reagent grade sulphuric acid as a drying agent; another containing molecular sieves or "Drierite" as a drying agent;
- D Oven, capable of operating in the range of 250°C; and
- E Sodium bicarbonate or potassium bicarbonate ACS (American Chemical Society) reagent grade, as applicable.

5.9.1.3 Procedure

5.9.1.3.1 Heat a clean, capped aluminum moisture dish in an oven at 250 °C for 30 min, transfer quickly to a desiccator containing "Drierite" or molecular sieves. Allow contents to cool to room temperature, then weigh the capped dish quickly to 0.1 mg. This is the tare mass of the dish.

5.9.1.3.2 Transfer 2.5 to 3 g of sample into the aluminum moisture dish, weigh to the nearest 0.1 mg, and place separated cap and container in a desiccator over sulphuric acid. Dry to constant mass. This mass, less the tare mass of the dish, is the dry sample mass.

5.9.1.3.3 Heat the capped moisture dish with the dry sample in an oven at 250 °C until loss in mass becomes constant (16 h or overnight has been found suitable). Every time the hot, capped moisture dish is removed from the oven to check progress of mass loss, it shall be quickly transferred to a desiccator containing fresh "Drierite" or molecular sieves as the drying agent. After cooling to room temperature, the capped moisture dish must be weighed to an accuracy of ± 0.1 mg as quickly as possible.

5.9.1.3.4 Sampling, drying, heating and cooling conditions, and weighing technique shall be verified as necessary, using ACS reagent grade sodium bicarbonate, or potassium bicarbonate, in place of the dry chemical fire extinguishing agent sample. A value over 99.0 % NaHCO_3 for reagent sodium bicarbonate, or over 99.0 % KHCO_3 for reagent potassium bicarbonate, shall constitute verification of the test procedure.

5.9.1.4 Calculation

5.9.1.4.1 Calculate the percentage of sodium bicarbonate, or potassium bicarbonate, in the dry sample as:

$$\%\text{NaHCO}_3 = 270.9 \times \frac{a}{b}$$

or

$$\%\text{KHCO}_3 = 322.8 \times \frac{a}{b}$$