

metal cylinder. The furnace is heated by three elements as follows: (i) A circumferential heater embedded in the refractory cylinder; (ii) a top or toroidal-neck heater that surrounds the neck of the test flask; and (iii) a flat base heater on which the test flask rests. The temperature of each heating element shall be controlled independently by an autotransformer. Means shall be provided for applying thermocouples at the neck, mid-section, and base of the test flask, which shall be inserted upright in the furnace.

(c) *Test procedures*—(1) *Temperature control.* Each autotransformer shall be so adjusted that the temperature at the neck, mid-section, and base of the test flask is uniform within  $\pm 2$  °F. of the desired test temperature.

(2) *Sample injection and timing.* A 0.07 cc. test sample shall be injected into the heated test flask with the hypodermic syringe, and the syringe shall be withdrawn immediately. Measurement of time shall start at the instant the sample is injected.

(3) *Observations.* (i) If flame does not result in 5 minutes or more after injection of the test sample, the sample shall be considered nonflammable at the test temperature, and the timer shall be stopped. The test flask shall then be flushed well with clean dry air and, after a lapse of 15 minutes or more, the test shall be repeated with the test flask temperature raised 50 °F.  $\pm 2$  °F. above the first test temperature.

(ii) If ignition (flame) is observed in 5 minutes or less after the injection of the test sample (0.07 cc.), the time lag (time interval) shall be noted. After an ignition occurs the temperature of the test flask shall be reduced 5 °F., and the test procedure repeated in decrements of 5 °F. until ignition no longer occurs and this temperature shall be noted as the first nonignition test temperature for the 0.07 cc. sample.

(iii) The temperature shall be increased 50 °F.  $\pm 2$  °F. above the first nonignition test temperature, and the ignition-temperature test procedure shall be repeated with a 0.10 cc. test sample injected into the heated test flask.

(iv) If the lowest temperature at which ignition occurs with the 0.10 cc. sample (in decrements of 5 °F.) is lower than that obtained with the 0.07 cc. sample, the ignition-temperature test procedure shall be repeated using a test sample of 0.12 cc., then 0.15 cc., and so on by increments of 0.03 cc. until the lowest ignition temperature is obtained.

(v) If the lowest temperature at which ignition is obtained with the 0.10 cc. sample is greater than that obtained with the 0.07 cc. sample, the ignition temperature test procedure shall be repeated by reducing the test sample to 0.05 cc. and then to 0.03 cc. until the lowest ignition temperature is obtained.

(d) *Appraisal of test.* A fluid shall be considered fire-resistant, according to the test requirements of this section: *Provided,* That in no instance of the ignition-temperature test procedure, as stated in this section, shall the ignition temperature of the test sample be less than 600 °F.

#### § 35.21 Temperature-pressure spray-ignition tests.

(a) *Purpose.* The purpose of this test shall be to determine the flammability of a hydraulic fluid when it is sprayed over three different sources of ignition which are described in paragraph (b)(4) of this section.

(b) *Description of apparatus.* (1) A 3-quart pressure vessel, with the necessary connections, valves, and heating elements, shall be used for containing and heating the fluid under the test conditions as specified hereinafter.

(2) An atomizing round-spray nozzle, having a discharge orifice of 0.025-inch diameter, capable of discharging 3.28 gallons of water per hour with a spray angle of 90 degrees at a pressure of 100 p.s.i., shall be connected to the pressure vessel.

(3) A commercial pressurized cylinder, containing nitrogen with the customary regulators, valves, tubing, and connectors, shall be used to supply nitrogen to the pressure vessel described in paragraph (b) (1) of this section.

(4) Three igniting devices shall provide three different sources of ignition as follows:

(i) A metal trough with a metal cover in which cotton waste soaked in kerosene is ignited.

(ii) An electric arcing device in which the arc is produced by a 12,000-volt transformer.

(iii) A propane torch—Bernzomatic or equivalent.

(5) A means of measuring distances from the nozzle tip to the igniting device shall be provided.

(c) *Test procedures.* (1) A 2½-quart sample of the fluid shall be poured into the pressure vessel and heated to a temperature of 150 °F. The temperature shall be maintained at not less than 145 °F. or not more than 155 °F. during the test.

(2) Nitrogen shall be introduced into the vessel at 150 p.s.i.g.

(3) The fluid shall be sprayed at each igniting device, described in paragraph (b) (4) of this section, which is moved along the trajectory of the spray. Each igniting device shall be held in the spray at different distances from the nozzle tip for one minute or until the flame or arc is extinguished (if less than one minute) to determine this fire-resistant characteristic of the fluid.

(d) *Appraisal of tests.* If the test procedures in paragraph (c) of this section do not result in an ignition of any sample of fluid or if an ignition of a sample does not result in flame propagation for a time interval not exceeding 6 seconds at a distance of 18 inches or more from the nozzle tip to the center of each igniting device, it shall be considered fire resistant, according to the test requirements of this section.

**§ 35.22 Test to determine effect of evaporation on flammability.**

(a) *Purpose.* The purpose of this test shall be to determine the effect of evaporation on the reduction of fire resistance of a hydraulic fluid.

(b) *Description of apparatus*—(1) *Petri dish.* Standard laboratory Petri dishes, approximately 90 mm. by 16 mm., shall be used to contain the test samples.

(2) *Oven.* A gravity convection air oven, capable of maintaining the specified evaporation temperature constant within ±2 °F., shall be used in the test.

(3) *Pipe cleaner.* An ordinary smoker's pipe cleaner (U.S. Tobacco Co., Dill's or

equivalent) shall be used in the test procedure, described in paragraph (c) of this section.

(c) *Test procedures.* (1) Three 30-milliliter samples of the fluid shall be placed in uncovered Petri dishes. Two of these samples shall be inserted in the oven, that shall have been heated to a temperature of 150 °F., ±2 °F., which shall be maintained throughout this test. The third sample shall remain at room temperature.

(2) An electrically operated cycling device, such as an automobile windshield wiper mechanism, shall be oscillated in a horizontal plane, 25±2 cycles per minute. A pipe cleaner shall be attached to the device so that it will enter and leave a flame of a standard (Bunsen or equivalent) laboratory burner, which is adjusted to provide a nonluminous flame approximately 4 inches in height without forming a sharp inner cone. The cycling device shall be so arranged that when a 2-inch length of pipe cleaner is attached thereto the exposed end shall describe an arc with a radius of 4 inches ±½ inch. The cycling device shall be so arranged that when the 2-inch length of pipe cleaner is attached thereto, its midpoint shall be in the center of the flame at one extreme end of the cycle.

(3) Each of five 2-inch lengths of pipe cleaner shall be soaked separately for a period of 2 minutes in the test sample that remained at room temperature. Each pipe cleaner shall then be removed from the test sample and permitted to drain freely until all excess fluid is expelled from it. Each soaked pipe cleaner shall be attached to the cycling device, the mechanism started, and the pipe cleaner permitted to enter and leave the burner flame, as described in paragraph (c) (2) of this section, until a self-sustaining flame shall be observed on the pipe cleaner. The number of cycles necessary to obtain a self-sustaining flame shall be noted and averaged for each of the five soaked pipe cleaners.

(4) After one test sample has remained in the oven for a period of 2 hours, the Petri dish containing it shall be removed from the oven and allowed to cool to room temperature, after which 5 lengths of 2-inch pipe cleaner shall be soaked separately in