



# Standard Test Method for Deposition on Glassware During Mechanical Dishwashing<sup>1</sup>

This standard is issued under the fixed designation D 3556; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers a procedure for measuring performance of a mechanical dishwashing detergent in terms of the buildup of spots and film on glassware. It is designed to evaluate household automatic dishwasher detergents but can be used as a screening test for institutional dishwashing products.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Summary of Test Method

2.1 Glass tumblers are given multiple washes in a mechanical dishwasher in the presence of food soil and the levels of spotting and filming allowed by the detergents under test are compared visually.

## 3. Significance and Use

3.1 This test method is intended as a laboratory screening test to determine performance of the detergent under actual use conditions, but will not necessarily predict performance under all end-use conditions.

## 4. Apparatus

4.1 *Automatic Dishwasher(s)*—Typical household machines should be selected. If more than one machine is required, pairs with consecutive production numbers are recommended. For further refinement, two or more pairs of differing makes, models, or ages (pair to pair) may be used.

4.2 *Clear Undecorated Glass Tumblers*,<sup>2</sup> from 8 to 15 per machine, a larger number being used if it is planned to remove one tumbler at intervals throughout the test (see Section 6). Ten tumblers simplify scoring.

4.2.1 Before each use, even if new, the glass tumblers may be cleaned in a machine, first in a 1 % solution of citric acid and then with a household automatic dishwashing detergent at the manufacturer's recommended use level, each in a normal

wash cycle. Use deionized or distilled water for the rinses during this cleaning procedure. Do not use the drying cycle of the machine until the tumblers appear to be free of soil or film. No "water break" should be evident when the tumblers have been rinsed. Any other procedure (such as hand washing and polishing) which yields tumblers that are spot- and film-free may be used.

4.3 *Standard Tableware* (Note 1) (optional, see Section 6):

4.3.1 Suggested tableware is as follows, *Dinner plates*, 10-in. diameter, *Salad plates*, 7-in. diameter, *Cereal bowls*, 6-in. diameter, *Saucers*, 6-in. diameter, and *Cutlery*, stainless steel.

NOTE 1—A mixture of china and plastic dishes is recommended but is not essential; any standard quality type of dishware is satisfactory.

4.3.2 For each machine used, six dinner plates, six knives, six forks, and six spoons are required, plus optionally enough of the other dishes to fill the lower rack of each machine (see Section 6).

4.4 *Light Box for Visual Evaluation of Tumblers*—A typical light box is rectangular, open to the front, and has dead black inside surfaces. It is large enough to hold up to 15 tumblers side by side. Fluorescent lights are mounted in the base of the box in such a manner that light passes up through the tumblers. It is preferable to have the light come only through the tumblers and have the area surrounding them blocked out by suitable means.

## 5. Materials and Manufacture

5.1 *Standard Food Soil Components*:<sup>3</sup> nonfat powdered milk, margarine, and wheat-based cooked cereal (optional).

5.2 *Standard Food Soil Preparation*—A mixture of 80 weight % of margarine and 20 weight % of powdered milk is prepared. The margarine is warmed until fluid (not over 100°F (37.8°C)) and the powdered milk is sifted in and mixed thoroughly. The mixture should be refrigerated when not in use and not kept more than 2 weeks.

5.3 *Optional Food Soil Preparation*—This mixture consists of 70 % margarine, 15 % powdered milk, and 15 % cooked cereal. The cooked cereal is separately prepared as follows: Add 45 g of cereal to 228 g of water, heat to boiling, and boil for 5 min. Dissolve 100 g of powdered milk in 500 g of water and stir this solution into the cooked cereal. Continue stirring as portions are removed to be combined with margarine and

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<sup>2</sup> Libby No. 53, 10-oz (300-mL) size or Federal No. 812, 10.5-oz, (310-mL) size, have been found satisfactory.

<sup>3</sup> Any commercial brand of these items is satisfactory.

powdered milk that have been blended as in 5.2. This mixture should be made up as required. (Use of this optional soil makes the test more realistic by adding another difficult-to-remove component.)

## 6. Procedure

6.1 Distribute a total of 40 g of food soil on the six dinner plates, using a spatula or a food brush. Load the machine as follows: In the lower (plate) rack, distribute the six soiled dinner plates uniformly with the smaller plates and bowls, if used (Note 2), placed alternately about the dinner plates until the rack is fully loaded. In the upper (glass) rack, distribute the glass tumblers evenly. If eight or ten are used, place them along each side, four or five to a side. Optionally, use extra tumblers, so that one can be removed periodically for comparative purposes.

NOTE 2—Optionally the smaller chinaware pieces may be omitted and only dinner plates used.

6.1.1 In the silverware rack or holder, place six each of the stainless steel knives, forks, and spoons.

6.2 *Water Temperature*—Maintain a water temperature of  $130 \pm 5^\circ\text{F}$  ( $54.4 \pm 3.8^\circ\text{C}$ ) in the dishwasher. (The water supply may have to be controlled at a higher temperature because of heat losses in the piping etc.) Preheat the machine by running a preliminary cycle with the machine empty. Allow the contents of the machine to cool to about  $75^\circ\text{F}$  ( $23.9^\circ\text{C}$ ) before making evaluations or starting another wash cycle.

6.3 *Water Quality*—Use water of consistent hardness and well-defined composition. If only one test is made, use a level of 150 ppm (about 9 grains/gal). Test in both hard and soft (0 to 50 ppm) water, since water hardness is a very critical factor in these tests. It is preferable to make up a synthetic hard water using deionized or distilled water to which calcium and magnesium salts have been added. Use a 2:1 ratio of calcium to magnesium ion. If natural water is used it should be characterized as to total hardness (ppm), bicarbonate content (ppm), Ca:Mg mole ratio, total solids, and content of trace

metals such as iron, all of which can affect test results. There shall be mutual agreement between laboratories as to the quality and hardness of the water used.

6.4 *Detergent Concentration*—Use the quantity of detergent specified by the manufacturer. For a thorough investigation, evaluate at over and under usage.

6.5 *Number of Cycles*—Multiple cycles, with the food soil reapplied after each one, are needed to obtain significant comparisons. From 5 to 15 cycles are usually required.

6.6 *Rating*—Rate the tumblers visually after each cycle for film and spotting. For these evaluations, view the tumblers upside down in the light box described in 4.4 (in handling, pick up the tumblers by the base to avoid fingerprints on the sides). Use the following scale for rating the tumblers:

Rating	Spotting	Filming
1	no spots	none
2	spots at random	barely perceptible
3	about ¼ of surface covered	slight
4	about ½ of surface covered	moderate
5	virtually completely covered	heavy

6.6.1 When several machines and sets of tumblers are used in the same test series, rate each set of tumblers against the other.

6.6.2 Obtain number ratings by averaging the ratings for individual tumblers, keeping spotting and filming results separate. Levels of acceptability may be agreed upon by the laboratories involved. Photographs of the tumblers in the light box make reasonably accurate standards for comparison.

6.6.3 Use 8 tumblers throughout the test, or optionally, 15 may be used initially with one representative tumbler being removed periodically, as for example after the fourth, sixth, eighth, tenth, etc. cycles.

## 7. Precision and Bias

7.1 Since the variability that is inevitable when natural soils are used is inherent in this test, it does not have the precision or reproducibility of an analytical determination.

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