SOA V-500 Cleaning Effectiveness of Vacuums

1. Scope

1.1. This test method covers the use of X-ray Fluorescence (XRF) to measure the average percent removed of a set of compounds used to soil carpet.

1.2. This test method applies to all vacuums tested in the SOA program.

1.3. This test method applies to both commercial and residential vacuums.

2. Safety

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

3. References

3.1. SOA Test Carpet Specifications

4. Terminology

4.1. X-ray fluorescence – an emission spectrographic technique that detects chemical elements by ionizing the constituent atoms and recording the characteristic energy signatures of photons given off by the elements.

4.2. XRF Soil - the combination of five particulate compounds designed to provide a consistent dry soiling media for use in the SOA program for evaluating cleaning effectiveness. See Table 1 for specific compounds.

5. Apparatus and Materials

5.1. X-ray Fluorescence Instrument – capable of detecting elemental concentrations of specified compounds through XRF spectral analysis

5.2. Customized software that quantifies the percentage of XRF soil removed

5.3. Conveyor with a bed length of 10 feet, stroke of 5 feet and bed width of 35 inches. Conveyor must be capable of maintaining specified test speed both forward and reverse. Conveyor must be equipped with brackets to hold the test equipment stationary and exert no horizontal or vertical force.

5.4. XRF conveyor with a bed length of 8 feet, stroke of 4 feet and bed width of 28 inches

5.5. Tachometer used to measure conveyor speed in feet/second

5.6. Voltage Meter Regulator

5.7. Carpet mounting platform comprised of the same material as test carpet with an 10 inch by 40 inch cut-out to be mounted on the conveyor

5.8. XRF Instrument Stand – the instrument stand maintains the XRF at a fixed height of approximately 4 inches above the conveyor

5.9. Control Vacuum – upright-type, SOA specified with a rotating brush
5.10. Weighing scale accurate to 0.01 gram and having a capacity of at least 2000 grams
5.11. Polyamide pellets having a maximum size of 2-3 mm
5.12. Chrome alloy ball bearings 9.5 mm (0.375") diameter
5.13. Custom soiling drum
5.14. Jar Mill
5.15. Bell Jar
5.16. Tape – double sided pressure sensitive adhesive, 2.0 in. (50 mm) width
5.17. Test Room – temperature and humidity maintained in standard laboratory conditions, 50% (+/- 5%) relative humidity and 70 (+/- 5) degrees in which all conditioning and testing is performed
5.18. Plexi-glass grid riser capable of compensating for varying pile heights of test carpets by raising the test carpet level a minimum of a 0.25 inches above the conveyor metal bed plate
5.19. XRF Soiling Compounds:

Soiling Compounds	
Iron Oxide	Fe3O4
Zinc Oxide	ZnO
Strontium Carbonate	SrCO3
Yttrium Oxide	Y2O3
Zirconium Boride	ZrB2

6. Test Specimen

6.1. Test Carpet Description: Cut Pile (Residential or Commercial as specified on the COC) and Loop Pile (See SOA Test Carpet Specifications)
6.2. Cut three cut pile carpets and three loop pile carpets to fit the inside wall of the soiling drum (10 in. by 40 in.) The long dimension should be parallel to the machine direction.
6.3. Mark the test specimens with the test identification number.
6.4. Prepare carpet for testing by clipping selvedge edge and vacuuming to remove loose fibers with the control vacuum, using 10 passes at 1.8 ft/second
6.5. Condition prepared samples in test room a minimum of 16 hours prior to soiling.

7. Test Format

7.1. Preparation of soiled pellets for each XRF compound
7.1.1. Place grams of XRF soil compound (specified in Table 1) with 1000 (+/- 2) grams of polyamide pellets in Jar Mill.

7.1.2. Mix the XRF soil compounds and pellets in the Jar mill for 10 minutes then reverse direction for an additional 10 minutes for a total of 20 minutes mixing to ensure a homogenous mixture of soil and polyamide pellets.

7.1.3. XRF Soiling Compounds (USE THE SAME RECIPE FOR ALL TEST CARPET TYPES)

Table 1 – XRF Soiling Compounds		Target Amount
Iron Oxide	Fe_3O_4	6.0 g +/- 0.1 g
Zinc Oxide	ZnO	6.0 g +/- 0.1 g
Strontium Carbonate	$SrCO_3$	3.0 g +/- 0.1 g
Yttrium Oxide	Y_2O_3	6.0 g +/- 0.1 g
Zirconium Boride	ZrB_2	6.0 g +/- 0.1 g

7.1.4. Store each XRF soiled pellet type individually in glass jars. Stored soiled pellets must be used within 4 weeks.

7.2. Soiling of Test Carpet

7.2.1. Secure the carpet to the inside wall of the custom soiling drum (double-sided tape may be used.) Rotate the drum so that the seam is located at the top of the drum.

7.2.2. Place 1193 (+/- 2) grams of chrome alloy ball bearings into the drum.

7.2.3. Place into the drum 50 (+/- 0.1) grams of each of the 5 different soiled pellets from each compound listed in Table 1 in the order that the soiling compounds are listed in Table 1. Spread the soiled pellets uniformly across the width of the carpet.

7.2.4. Start the drum and allow it to rotate for 30 minutes changing direction after 15 minutes.

7.2.5. Remove the test carpet and physically remove steel balls and any loose pellets from the carpet without disturbing XRF soil.

7.2.6. Label the soiled test carpets with the date soiled. All soiled test carpets must be used within 72 hours.

7.3. Initial Scan of Soiled Carpet

7.3.1. Label each test sample with XRF test number.

7.3.2. Brush soiled carpet sample with carpet pile comb to erect the pile.

7.3.3. Place the carpet sample on the plastic riser under the XRF unit mounted on the XRF conveyor.

7.3.4. Use the plexi-glass grid riser to raise the carpet sample to the height setting listed in Table 3.

Table 3 – Height Settings	Residential Cut Pile	Commercial Cut Pile	Loop Pile
	0.15 to 0.19 inches	0.14 to 0.18 inches	0.14 to 0.18 inches

7.3.5. Start XRF and conveyor at the same time. Conveyor operates at a speed of 0.33 ft/sec for each pass. After each pass the XRF moves across the width in one inch increments until 10 passes are completed to provide a scan of the complete carpet.

7.3.6. Repeat Steps 7.3.1 to 7.3.5 for each test carpet.

7.3.7. Verify the concentration level of each XRF soil compound is within the required range for testing in Table 2. If a soil concentration is outside of the required range below the out of spec sample must be discarded. If soiling of carpet was completed on a previous day, all three test carpets of the same type must be discarded and a new set of test carpets prepared. If the soiling of the set is completed on the same day as scanning, the out of spec sample is discarded and replaced with a new soiled sample.

Table 2 – XRF Soil Concentrations		**Residential Cut Pile**	**Loop Pile**	**Commercial Cut Pile**
Iron Oxide	Fe3O4	0.73 to 1.07 g/m^2	0.44 to 0.66 g/m^2	0.59 to 0.75 g/m^2
Zinc Oxide	ZnO	0.56 to 0.70 g/m^2	0.34 to 0.48 g/m^2	0.46 to 0.64 g/m^2
Strontium Carbonate	SrCO3	0.40 to 0.68g/m^2	0.24 to 0.38 g/m^2	0.25 to 0.37 g/m^2
Yttrium Oxide	Y2O3	0.70 to 0.98 g/m^2	0.52 to 0.73 g/m^2	0.63 to 0.84 g/m^2
Zirconium Boride	ZrB2	0.80 to 1.19 g/m^2	0.63 to 0.80 g/m^2	0.62o 0.81 g/m^2

7.4. Clean Carpet with Vacuum

7.4.1. Condition Test Vacuum (unless previously conditioned in prior testing)

7.4.1.1. Energize test vacuum in a stationary position at the rated voltage +/- 1% and rated frequency with filter in place for 30 minutes.

7.4.1.2. If vacuum is equipped with a brush roll, the brush roll should not be engaged with the floor surface during conditioning.

7.4.1.3. Canister type vacuums shall be conditioned with the hose attached to the unit.

7.4.1.4. Condition a battery vacuum or battery attachment for 30 minutes.

7.4.2. Mount test carpet sample on carpet mounting platform using double sided tape. Present test carpet with pile lay towards the vacuum.

7.4.3. Install vacuum with new bag on the conveyor.

7.4.3.1. Position vacuum on the carpet mounting platform 4-6 inches in front of the carpet test specimen.

7.4.3.2. Mount the vacuum unit in place on the conveyor with the handle in an inclined operating position at the vertical handle height of 31.5 inches above the test material.

7.4.3.3. If vacuum has adjustable height settings, then adjust height so vacuum contacts carpet surface without pressing into the pile.

7.4.4. Vacuum Test Carpet

7.4.4.1. Verify conveyor speed is at the specified 1.8 feet per second.

7.4.4.2. Energize test vacuum for 2 minutes at rated voltage prior to activating conveyor.

7.4.4.3. Activate continuous back and forth conveyor movement until 4 passes are achieved. Make sure that each pass begins and ends on the mount and not on the test carpet. (Note: Center Drive Belt Vacuums paths are shifted by one inch on last two passes to ensure soil removal across the entire width.)

7.4.4.4. Return vacuum to starting position, de-energize vacuum and remove test sample once total number of passes are achieved.

7.5. Remove test sample and Repeat 7.4 for additional 5 samples. (Total of 3 Cut Pile and 3 Loop Pile samples)

7.6. Final Scan of Cleaned Carpet

7.6.1. Brush cleaned carpet sample with carpet pile comb to erect the pile.

7.6.2. Place the carpet sample on the plastic riser under the XRF unit mounted on the XRF conveyor.

7.6.3. Use the plexi-glass grid riser to raise the carpet sample to the height setting listed in Table 3.

Table 3 – Height Settings	Residential Cut Pile	Commercial Cut Pile	Loop Pile
	0.15 to 0.19 inches	0.14 to 0.18 inches	0.14 to 0.18 inches

7.6.4. Start XRF and conveyor at the same time. Conveyor operates at a speed of 0.33 ft/sec for each pass. After each pass the XRF moves across the width in one-inch increments until 8 passes are completed to provide a scan of the complete carpet.

7.6.5. Repeat Steps 7.6.1 to 7.6.4 for each test carpet.

8. **Evaluation**

8.1. Subtract final scan of cleaned carpet from initial scan of soiled carpet for amount of soil removed.

8.2. Calculate the % of soil removed by dividing the amount of soil removed by the initial scan amount of soiled carpet.

8.3. Repeat Steps 8.1.and 8.2 for each compound in Table 2 for each sample. (Total of 3 cut pile and 3 loop pile samples)

8.4. Calculate the average % of soil removed for all compounds from all cut pile samples (excluding Zinc Oxide)

8.5. Calculate the average % of soil removed for all compounds from all loop pile samples (excluding Zinc Oxide)

8.6. Calculate the grand average % of soil removed from all samples (cut pile and loop pile.) (excluding Zinc Oxide)

9. Report

9.1. The identifying information for the vacuum (Manufacturer, product name and model, COC number, serial number and description of any attachments and spray tips used.)
9.2. Record date the pellets for each compound was soiled.
9.3. Record date the carpet was soiled.
9.4. Record date of the initial scan of soiled carpet.
9.5. Record date the carpet was cleaned.
9.6. Record date of the final scan of cleaned carpet.
9.7. Record vacuum test speed and voltage.
9.8. Record number of vacuum passes.
9.9. Record the Initial Scan of Soiled carpet, Final Scan of Cleaned carpet and % Soil Removal for each compound for each sample.
9.10. Record the average % Soil Removal for each compound for all cut pile samples.
9.11. Record the average % Soil Removal for all compounds (excluding Zinc Oxide).
9.12. Record the average % Soil Removal for each compound for all loop pile samples.
9.13. Record the average % Soil Removal for all compounds (excluding Zinc Oxide).
9.14. Record the grand average % of soil removed from all samples (cut pile and loop pile.)
9.15. Report any deviations from this test method.