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Procedures for Integral Electronic Compact Fluorescent Lamp Sample Preparation and the TCLP

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Contents

		Page
	Foreword	ii
Section 1	General	1
	1.1 Scope	1
	1.2 References	1
	1.3 Definitions	1
Section 2	General Requirements	3
Section 3	Safety Considerations	5
Section 4	Lamp Preparation	7
Section 5	Leaching	11
Section 6	Filtration	13
Section 7	Storage of the Leachate	15
Section 8	Vessel Cleaning	17

Foreword

Much attention continues to be focused on the disposal of mercury containing lamps, particularly fluorescent lamps. The United States Environmental Protection Agency's (EPA) Toxicity Characteristic Leaching Procedure (TCLP) is used at the Federal level and by most states to determine whether or not spent fluorescent lamps should be classified as hazardous waste. This NEMA Standards Publication was developed by technical experts in the lamp industry in order to establish a uniform method of sample preparation for integral electronic compact fluorescent lamps in order to minimize the inherent variability associated with TCLP testing of such lamps. This document also specifies other important aspects related to the leaching process that are not specifically defined for lamps by the EPA SW-846, "Test Methods for Evaluating Solid Waste (Physical/Chemical Methods)," but that have been shown in practice to contribute to test variability, if not properly controlled.

For integral electronic compact fluorescent lamps, this standard is intended to supplement the generalized EPA test procedure contained in SW-846 and is designed to improve both the accuracy and repeatability when the TCLP test is applied to common lamp types.

This standard was developed at the request of the NEMA Lamp Section by its Technical Committee and a special Task Force on TCLP Testing. Section approval of the standard does not necessarily imply that all section members voted for its approval or participated in its development. At the time it was approved, the Lamp Section was composed of the following members

Duralite, Incorporated—Fairfield, NJ
EYE Lighting International of North America—Mentor, OH
GE Lighting—Cleveland, OH
OSRAM SYLVANIA Products Incorporated—Danvers, MA
Philips Lighting Company—Somerset, NJ
Supreme Corporation—Mullins, SC
Venture Lighting International, Incorporated—Solon, OH

In the preparation of this Standards Publication, input of users and other interested parties has been sought and evaluated. Inquiries, comments, and proposed or recommended revisions should be submitted to the concerned NEMA product Subdivision by contacting the:

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Section 1
GENERAL

1.1 SCOPE

Procedures for preparation of integral electronic compact fluorescent lamps for Toxicity Characteristic Leaching Procedure (TCLP) are presented below. These guidelines are intended to supplement the TCLP by supplying specific instructions for size reduction of integral electronic compact fluorescent lamps.

This standard specifically covers integral electronic compact fluorescent lamp types. Additional standards have been and are in preparation for pin-based compact fluorescent lamps, linear fluorescent lamps, high intensity discharge lamps, and other types that require specific sample preparation instructions because of their design or construction.

The most discernable difference between integral electronic and magnetic compact fluorescent lamps is that the electrical part of the electronic lamp consists of a large number of relatively small and light-weight electronic components (e.g., resistors, capacitors, switching devices, coils, transistors, etc.), while the electrical part of the magnetic lamp consists of one relatively big and heavy copper-iron transformer and some small components (e.g., diodes, capacitors, and resistors). Electronic lamps operate at a frequency which is much higher (typically 20 kHz or higher) than the mains frequency, whereby magnetic lamps operate at a frequency that is approximately the same as the mains or input frequency (60 Hz).

The protocol that follows is grouped to include general requirements, safety considerations, lamp preparation, leaching, filtration, storage, and leaching vessel reuse.

1.2 REFERENCES

The following publications may be used to answer questions not covered by this standard.

"Toxicity Characteristic Leaching Procedure (TCLP)," 55 FR 126, pp. 26987-26998, June 29, 1990.
"Test Methods for Evaluating Solid Waste (Physical/Chemical Methods)," SW-846, United States Environmental Protection Agency.

1.3 DEFINITIONS

compact fluorescent lamp: A low pressure mercury electric-discharge source in which a fluorescing coating transforms some of the ultraviolet energy generated by the mercury discharge into visible light. These sources are intended to replace many incandescent lamps. There are two broad classes of compact fluorescent lamps, integral and pin-based.

integral electronic compact fluorescent lamp: This class combines a lamp, electronic ballast, and adapter (usually as a screw-in base which fits an incandescent lamp's holder or socket) in a single sealed assembly, which must be discarded when the lamp burns out. See Figure 1 for examples of integral electronic compact fluorescent lamps.

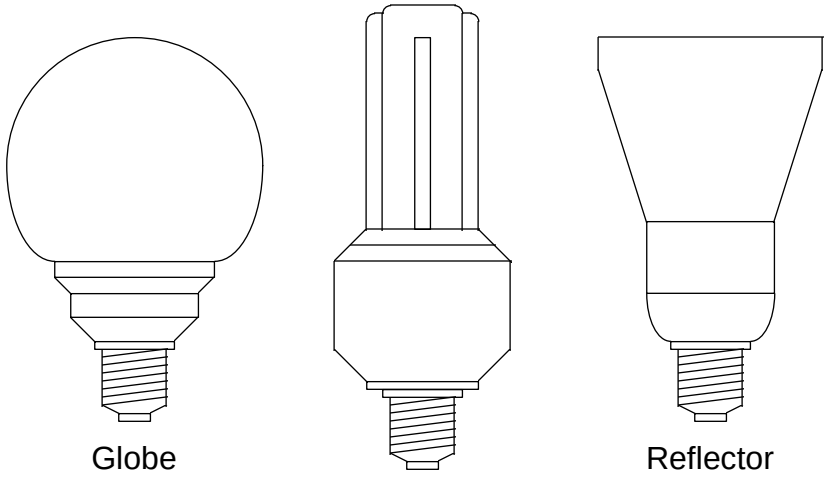

Figure 1-1 Examples of Integral Electronic Compact Fluorescent Lamps

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Section 2
GENERAL REQUIREMENTS

TCLP must be performed on the entire lamp in a single leaching vessel large enough to contain an amount equal to 20 times the weight of the lamp. In cases where the weight of a single whole lamp is less than 100 grams, a number of whole lamps must be combined to provide a sample of at least 100 grams. All lamp components must be reduced in size to pass through a 0.95 cm (3/8 in) sieve.

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Section 3
SAFETY CONSIDERATIONS

Integral compact fluorescent lamps with electronic ballasts contain a great variety of components for proper operation of the circuit. Some of these components are capacitors. Before attempting any work on the circuit, these capacitors must be discharged by a short across their leads with a piece of metal, such as a screwdriver with an insulated handle.

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Section 4
LAMP PREPARATION

4.1 WARNING! Safety procedures shall be observed in carrying out the procedures given in this section. Safety glasses, gloves, and laboratory coats shall be worn at all times.

4.2 Clean the exterior of the lamp using a paper towel, wetted with water and/or an 80 percent water and 20 percent acetone combination. This solution is useful to remove any debris, particularly if wax or grease is present on the surface of the lamp. Wipe the surface dry with a second paper towel.

4.3 Weigh the lamp(s) [in g]. A photocopy of the monogram may be made for record keeping if necessary.

4.4 Obtain the weight (in tare) of a suitably sized leaching vessel, with corresponding lid, such as but not limited to those in Table 4-1.[1]

Table 4-1 Suitable Vessels for Leaching

Volume	Manufacturer	Catalog number
2 L	Nalgene	2115-2000 (PP)
4 L	Cole Parmer	H-06025-70 (HDPE)
8 L	Cole Parmer	H 06029-50 (PP)
8 L	Bel Art	F10917 (PP)

4.5 Perform the following steps to transfer the entire contents of the lamp(s) to the leaching vessel:

4.5.1 Place the lamp on a clean sheet of plastic lined laboratory bench paper (an example of which is Fisher, catalog number 12-007-186) approximately 25.4 cm (10 in) wide by 61 cm (24 in) long, with the plastic side toward the lamp. With a pair of pliers, remove the screw-in base from the end of the lamp by rotating it and pulling it out. Cut the base into pieces which will pass a 0.95 cm (3/8 in) sieve and place the pieces in a leaching vessel. Carefully rinse the plastic-lined paper with leaching fluid (normally fluid #1) to transfer all the pieces to the vessel.

4.5.2

4.5.2.1 If the lamp does not have an outer cover, using wire cutters or similar, cut through the plastic shell until it is released from the lamp.

4.5.2.2 If the lamp has an outer cover made of glass, using wire cutters or similar, cut through the plastic shell until it is released from the lamp. The outer cover will also be released.

4.5.2.3 If the lamp contains a plastic outer cover, use a flat blade and cut along the junction between the outer bulb and the shell in order to get them loose from the lamp.

[1] Suitable vessels may be made of borosilicate glass, high density polyethylene (HDPE), polypropylene (PP), polyvinyl chloride (PVC) and polytetrafluoroethylene (PTFE), and should be of 2, 4 or 8 liter capacity. Suitable vessels include (but are not limited to) those in Table 4-1.

4.5.3

4.5.3.1 If the outer cover is made of glass, wrap it in a loose envelope of bench paper and strike it with a heavy object to break it into pieces which would pass through a 0.95 cm (3/8 in) sieve.

4.5.3.2 If the outer cover is made of plastic, use a wire cutter or similar and cut all the plastic to size such that the pieces pass a 0.95 cm (3/8 in) sieve.

4.5.4 Cut the circuit leads from the lamp.

4.5.5 Discharge the capacitors in the circuit by a short across each with a piece of metal.

4.5.6 Using wire cutters or similar, cut off and remove all of the circuit components from the printed circuit board. Cut all components free of lead wires. Cut the printed circuit board to size such that the pieces would pass a 0.95 cm (3/8 in) sieve.

4.5.7 Place all circuit components which pass through the 0.95 cm (3/8 in) sieve into the leaching vessel. Wrap the rest of the circuit components in a loose envelope of plastic-lined bench paper and strike them with a heavy object to break them or reduce them in size into small pieces which would pass a 0.95 cm (3/8 in) sieve. If some circuit components still do not pass, use a wire cutter or similar and cut them to size such that the pieces would pass through the same size sieve. Carefully rinse the plastic-lined paper with leaching fluid (normally fluid #1) to transfer all the pieces to the vessel.

4.5.8 Using wire cutters or similar, break the basing cement, if any, and place it in the leaching vessel. This will release the plastic base from the lamp. Cut all the plastic to size such that the pieces pass a 0.95 cm (3/8 in) sieve.

4.5.9 Crush the fused nipple to bring the lamp to atmospheric pressure; this should leave the lamp glass fully intact.

4.5.10 Wrap the lamp glass in a loose envelope of bench paper and strike it with a heavy object to break it into pieces which pass a 0.95 cm (3/8 in) sieve.

4.5.11 Lift the bench paper and gently shake to move all material to the center. Fold the paper into a chute and pour to transfer all material into the vessel. Rinse the plastic-lined paper with leaching fluid (normally fluid #1) to transfer all the pieces to the vessel.

4.6 Next, weigh and add the appropriate amount (twenty times the lamp weight in the vessel) of leaching fluid (normally fluid #1) so that the total weight of the vessel includes the amount of extraction fluid used in 4.5.1 and 4.5.11. Refer to SW-846, Method 1311 for details.

4.7 The threads of the lid shall be wiped before tightening. A strap wrench can be used to tighten the lid and duct tape (on the outside of the cap) or Teflon tape (on the threads) may also be applied to prevent leakage.

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Section 5
LEACHING

5.1 The vessels shall be placed in a rotary tumbler (end-over-end) and be tumbled at a rate of 30 ± 2 revolutions per minute for 18 ± 2 hours.

5.2 The temperature of the room shall be 23 ± 2° C.

5.3 After approximately one hour, examine the vessel(s) and if foaming is present crack the seal to relieve any excess pressure.

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Section 6
FILTRATION

6.1 Samples may be left to settle for as long as 30 minutes to allow for easier filtration. Immediately decant, after settling, an appropriate amount (a minimum of 150 ml), and filter as soon as possible, but not more than two hours after the leaching has been completed.

6.2 Filtering shall be performed using pressure filtration per standard EPA TCLP procedure using recommended materials.

6.3 The pH of the filtered leachate shall be recorded prior to storage at 4° C or prior to analysis (if immediately analyzed).

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Section 7
STORAGE OF THE LEACHATE

7.1 All samples should be acidified to a pH of less than 2 and held at 4° C until analysis. Acidify using approximately 2 ml concentrated nitric acid to 150 ml of leachate; then test with pH paper. Samples may be held in this manner for as many as 28 days.

7.2 Warm to room temperature (around 20° C) prior to taking an aliquot for analysis.

7.3 Analysis of the samples shall be made according to EPA's SW-846 procedure.

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Section 8
VESSEL CLEANING

The leaching vessel shall be cleaned prior to use or re-use by using the following procedure:

8.1 Add 100-150 ml concentrated nitric acid to the vessel (depending on vessel volume), then rotate the vessel so as to wet all surfaces with the acid.

8.2 Add 900 ml of water, mix, and repeat rotating the vessel.

8.3 Rinse at least 3 times with deionized water.

8.4 Rinse with methanol and air dry.

8.5 A blank leaching run should be made with each vessel every 20 uses to check for contamination. If the test result is greater than 1 percent of the regulatory threshold for any of the analyzed elements, the vessel should either be re-cleaned or no longer used.