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02/27/04 03:17 PM

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 Subject: final draft of Appendices B thru F and of telomers Appendix A.2

Colleagues,

Attached is a PDF file for the final draft set of appendices for Appendices B thru G.

(See attached file: Appendices B through G draft 2-27-04.pdf)

This set would be the same for both telomers and fluoropolymers.

As agreed by the Agency during our recent meeting and call, the minor revisions of the appendices are not redlined. However, I have highlighted the non-editorial revisions during the most recent call or in the next paragraph of this cover memo.

Note that the first paragraph of Appendix C.2.4.6 has been revised to indicate that bubbler sampling in Phase II may slightly different from what is described in Appendix D.1 if contingent testing in Appendix C.1 is found to be necessary and able to achieve the transport efficiency threshold. Additionally, the opening part of Appendix C.2.5 has been revised to introduce new Appendix E.3, and Appendix C.2.4.7.1 has been revised slightly to add mention of EPA Method 300.0 for ion chromatography. I have adjusted the right margin as necessary in certain parts of Appendix C.2 to assure reasonable page breaks.

Pursuant to John's excellent question on Appendix D.4.3, I have verified with the municipal incinerator people that carbon injection is the right term to use. Additionally, I have corrected the typos and made minor editorial fixes (e.g., adding line numbers) and clarifications in Appendix D.4 as promised. Most of these fixes were to clarify % oxygen as dry basis where the reference clearly documented dry vs. wet basis for % oxygen.

Electronically compiling these appendices into a single document attached above has taken longer than expected.

Attached is Telomers A.2 separately as requested by Rich. Please note that this is the same (except for header and footer format) as the January version as there were no comments on the January version.

(See attached file: App A.2 telomers incin test draft 2-27-04.pdf)

I am still working on the other Appendix A things that I owe. I have not received comments on the draft Appendix E.3 sent out yesterday.

I suggest that we all take the time to review all of these documents (including the revised ECA cover document) prior to them being sent out next week.

I look forward to our discussion on the morning of Monday March 1. In the meantime, if you have any questions, please let me know.

Best Regards,

Robert Giraud

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Appendices B through G draft 2-27-04, App A.2 telomers incin test draft 2-27-04.

1 **APPENDIX B.1**2 **GUIDELINE FOR THERMOGRAVIMETRIC ANALYSIS**

3  
4 ASTM E 1868-02 "Standard Test Method for Loss-On-Drying by  
5 Thermogravimetry" will be used as the guideline for conducting  
6 the analysis described in Appendix C.2.3 with the following  
7 modifications for this testing program:

Section	Modification
2.1	<ul style="list-style-type: none"> <li>Standard practices at the University of Dayton Research Institute (UDRI) may be used as references throughout the standard in place of the ASTM standards noted in this section.</li> </ul>
4.1	<ul style="list-style-type: none"> <li>The loss-on-drying value specified in the second through fifth sentences of this section will not be recorded.</li> </ul>
7.1.3	<ul style="list-style-type: none"> <li>The programming rate of the furnace will be set at 10 to 25°C/min, rather than 5°C/min. Pursuant to section 11.6, the temperature program rate will be documented in the report.</li> <li>The isothermal temperature within the range of 25 to 1000°C will be maintained <math>\pm 3^\circ\text{C}</math>, rather than <math>\pm 2^\circ\text{C}</math>.</li> </ul>
7.1.4	<ul style="list-style-type: none"> <li>The specimen atmosphere control system will be capable of supplying dry air in addition to "inert dry gas (usually purified grade nitrogen)".</li> </ul>
7.1.7	<ul style="list-style-type: none"> <li>The temperature program rate will be set at 10 to 25°C/min, rather than 5°C/min. Pursuant to section 11.6, the temperature program rate will be documented in the report.</li> <li>The temperature program rate will be controlled to within the range of <math>\pm 3^\circ\text{C}/\text{min}</math>, rather than <math>\pm 0.1^\circ\text{C}/\text{min}</math>.</li> <li>Within the range of 25 to 1000°C, the isothermal temperature will be maintained within <math>\pm 3^\circ\text{C}</math>, rather than <math>\pm 2^\circ\text{C}</math>.</li> </ul>
11.4	<ul style="list-style-type: none"> <li>The mass of the test specimen noted in the first sentence of this section will be 0.005 to 5 mg, rather than <math>10 \pm 1</math> mg (i.e., 9 to 11 mg).</li> </ul>
11.6	<ul style="list-style-type: none"> <li>The test specimen heating rate will be set at 10 to 25°C/min, rather than 5°C/min noted in the first sentence of this section. Pursuant to section 11.6, the temperature program rate will be documented in the report.</li> </ul>
11.9	<ul style="list-style-type: none"> <li>Termination criteria will follow Test Method A as outlined in section 11.10.1.</li> </ul>

11.10.1	<ul style="list-style-type: none"><li>• The "fixed period of test time" mentioned in this section will be set at 5 min.</li></ul>
11.10.1.1	<ul style="list-style-type: none"><li>• Loss-on-drying values will not be recorded.</li></ul>
12.1	<ul style="list-style-type: none"><li>• The loss-on-drying value will not be calculated.</li></ul>
13.1.1	<ul style="list-style-type: none"><li>• The "identification and description of the material being tested" will be consistent with the information known to the analyst.</li></ul>
13.1.5	<ul style="list-style-type: none"><li>• The loss-on-drying value will not be included in the report.</li></ul>
14.2	<ul style="list-style-type: none"><li>• This section is not applicable because the Test Method A termination criteria will be used.</li></ul>

9

10

11

**Reference**

12

ASTM E 1868-02 "Standard Test Method for Loss-On-Drying by

13

Thermogravimetry", ASTM International. For referenced ASTM

14

standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM

15

Customer Service at [service@astm.org](mailto:service@astm.org). For Annual Book of ASTM

16

Standards volume information, refer to the standard's Document

17

Summary page on the ASTM website.

1 **APENDIX C.1**2 **PFOA TRANSPORT TESTING**3  
4 C.1.1 Significance

5  
6 Testing will be performed to verify that potential PFOA  
7 emissions from the combustion testing described in Appendix  
8 C.2 can be quantitatively transported from the high  
9 temperature reactor into the exhaust gas sampling apparatus  
10 (aqueous solution bubblers).

11  
12 Acceptable PFOA transport will be demonstrated if the  
13 transport efficiency (as computed in one or more of the  
14 formulas below) is greater than or equal to 70%.

15  
16 C.1.2 Experimental Plan17  
18 C.1.2.1 Base Plan

19  
20 Transport of PFOA across the laboratory-scale thermal  
21 reactor system described in Appendix C.2.4 and into the  
22 exhaust gas bubblers described in Appendix D.1 will be  
23 quantitatively determined as an indication of transport  
24 from the high temperature reactor into the bubblers.

25  
26 A PFOA standard of known purity greater than or equal to  
27 97% will be gasified at 150 to 250 °C (based on  
28 thermogravimetric analysis of PFOA) with transfer line and  
29 reactor temperatures 0 to 100 °C higher than the  
30 gasification temperature.

31  
32 Three replicate transport efficiency test runs will be  
33 conducted. A minimum of one blank run will be conducted  
34 prior to each transport efficiency test run.

35  
36 The sample size of the PFOA standard to be gasified will be  
37 less than 5 mg. The reactor exhaust gas will be collected  
38 into bubbler aqueous solution as described in Appendix D.1  
39 (including an HPLC water rinse of the flexible tubing [used  
40 to connect the thermal reactor system and the bubbler  
41 assembly] into the aqueous solution composite), which will  
42 be analyzed for PFOA as described in Appendix D.2. In  
43 order to provide a second way of demonstrating quantitative  
44 transport, this aqueous solution composite will also be  
45 analyzed for total fluorine as described in Appendix D.3.  
46 (Testing for total fluorine is included due to possibility  
47 of thermal degradation of PFOA under transport test

1 conditions.) Therefore, for this transport testing the  
2 amount of PFOA fed to the thermal reactor system will be  
3 sufficiently high to assure that the total fluorine input  
4 to the thermal reactor system will be greater than 140% of  
5 the mass corresponding to the limit of quantitation (LOQ)  
6 for total fluorine in the aqueous solution composite. (The  
7 LOQ for total fluorine in aqueous solution is much higher  
8 than the LOQ for PFOA in aqueous solution.)  
9

10 The amount of PFOA and total fluorine in the thermal  
11 reactor system exhaust gas will be determined via analysis  
12 of the aqueous solution composite as noted above.  
13

14 The amount of PFOA fed to the thermal reactor system will  
15 be known based on measurement prior to gasification and  
16 will be verified by weighing the pyroprobe insert cartridge  
17 before and after each test run. The amount of fluorine  
18 input to the system will be calculated from the amount of  
19 PFOA fed, the known purity of the PFOA, and the known  
20 fluorine fraction of the PFOA standard.  
21

22 PFOA transport efficiency (TE) as a percentage will be  
23 computed as follows:  
24

$$25 \quad \% \text{ PFOA TE} = \frac{\text{mass of PFOA in aqueous solution composite}}{\text{mass of PFOA fed to thermal reactor system}} * 100 \quad (1)$$

26  
27

28 Total fluorine (TF) transport efficiency as a percentage  
29 will be computed as follows:  
30

$$31 \quad \% \text{ Total F TE} = \frac{\text{mass of total F in aqueous solution composite}}{\text{mass of total F fed to thermal reactor system}} * 100 \quad (2)$$

32  
33

#### 34 C.1.2.2 Contingent Testing

35

36 If the transport efficiencies for both PFOA (equation 1)  
37 and total fluorine (equation 2) are less than or equal to  
38 70%, then additional work will be performed. This  
39 additional work will be performed in a step-wise fashion to  
40 determine if consideration of one or more of the following  
41 procedural revisions enables achievement of 70% transport  
42 efficiency as follows:  
43

44 Step 1. The flexible tubing between the thermal reactor  
45 system and the bubbler assembly from the experiment  
46 described in Section C.1.2.1 would be  
47 quantitatively rinsed with methanol. This methanol  
48 rinsate would be analyzed for PFOA (as described in

1 Appendix D.2) and/or for total fluorine (as  
2 described in Appendix D.3). Revised transport  
3 efficiency (TE) as a percentage for PFOA (equation  
4 3) and/or total fluorine (equation 4) would be  
5 computed by including the mass of analyte in the  
6 methanol rinse in the numerator as follows:

$$7$$

$$8$$

$$9 \quad \% \text{ PFOA TE} = \frac{\text{mass}_{\text{PFOA out}}}{\text{mass}_{\text{PFOA in}}} * 100 \quad (3)$$

$$10$$

$$11$$

12 where  $\text{mass}_{\text{PFOA out}}$  = mass of PFOA in bubbler  
13 aqueous solution composite  
14 + mass of PFOA in methanol  
15 rinse

16 and  $\text{mass}_{\text{PFOA in}}$  = mass of PFOA fed to thermal  
17 reactor system

$$18$$

$$19$$

$$20$$

$$21 \quad \% \text{ Total F TE} = \frac{\text{mass}_{\text{total F out}}}{\text{mass}_{\text{total F in}}} * 100 \quad (4)$$

$$22$$

$$23$$

24 where  $\text{mass}_{\text{total F out}}$  = mass of total F in  
25 bubbler aqueous  
26 solution composite  
27 + mass of total F in  
28 methanol rinse

29 and  $\text{mass}_{\text{total F in}}$  = calculated mass of  
30 total F in PFOA fed to  
31 thermal reactor system

32  
33  
34 Step 2 (if necessary) The experiment described in Section  
35 C.1.2.1 would be repeated with  
36 reagent(s) (e.g. NaOH) added to the  
37 bubbler aqueous solution to determine  
38 if reagent addition enhances analyte  
39 absorption, thereby improving transport  
40 efficiency. Transport efficiency would  
41 be calculated using equation (1) and/or  
42 (2) above. The impact of reagent  
43 addition on LOQ for PFOA analysis  
44 described in Appendix D.2 would be  
45 determined.

#### 46 47 C.1.3 Reporting of Results

48  
49 Following completion of PFOA transport testing as described  
50 in this appendix and prior to beginning incineration  
51 testing described in Appendix C.2, a letter report will be

1 submitted to EPA with the transport efficiency result(s)  
2 and indication of what contingent testing, if any, was  
3 performed.  
4  
5 If Appendix C.2 incineration testing is performed, the  
6 detailed results of Appendix C.1 transport testing will be  
7 included in the final report for Appendix C.2 incineration  
8 testing. If Appendix C.2 incineration testing is not  
9 performed, the detailed results of Appendix C.1 transport  
10 testing will be provided in a test report for Appendix C.1  
11 transport testing.



1 **APPENDIX C.2**  
2 **INCINERATION TESTING**

3  
4 **C.2.1 ELEMENTAL ANALYSIS**

5  
6 C.2.1.1 Introduction

7  
8 Elemental analysis as described in Section C.2.1 will be  
9 performed for each test substance composite to aid in  
10 preparation for combustion testing described in Section  
11 C.2.4.

12  
13 As Kissa (1998) points out, technique strongly affects  
14 analytical results for fluorinated organic compounds such  
15 as fluorinated surfactants and fluorinated polymers due to  
16 the carbon-fluorine bond:

17  
18 Fluorine in organic compounds is usually  
19 determined by converting organic fluorine to an  
20 inorganic fluoride. Various combustion methods  
21 are routinely used for this purpose. However,  
22 the carbon-fluorine bond is exceptionally strong,  
23 and extremely vigorous conditions are needed for  
24 a quantitative mineralization. Conventional  
25 combustion conditions used for the determination  
26 of carbon and hydrogen in nonfluorinated organic  
27 compounds are not adequate for a quantitative  
28 analysis of fluorinated surfactants.

29  
30 Therefore, total fluorine analysis will be performed using  
31 "extremely vigorous conditions" as described in Section  
32 C.2.1.2, and the commercially available conventional  
33 technique used for empirical determination of carbon and  
34 hydrogen content (described in Section C.2.1.3) will  
35 provide estimated values.

36  
37 C.2.1.2 Total Fluorine

38  
39 Each test substance composite will be characterized via  
40 analysis of total fluorine content.

41  
42 Based on manufacturing process knowledge, the levels of  
43 total fluorine in the components of test substance  
44 composites are orders of magnitude higher than the  
45 potential trace level of inorganic fluoride in these  
46 materials. Therefore, for this test program, the total  
47 organic fluorine value for each test substance composite

1 will be considered to be the same as the total fluorine  
2 value.

3  
4 Total fluorine content will be measured via the Wickbold  
5 Torch method; see Appendix D.3.

### 6 7 C.2.1.3 Carbon and Hydrogen

8  
9 In order to provide information for stoichiometric  
10 calculations in Section C.2.2, the carbon and hydrogen  
11 content of each test substance composite is needed. Based  
12 on manufacturing process knowledge of the polymers in this  
13 program, levels of sulfur, and nitrogen are expected to be  
14 less than 0.1% and to thereby have negligible effect on  
15 stoichiometric calculations.

#### 16 17 C.2.1.3.1 Theoretical Determination

18  
19 Where the elemental composition of a test substance  
20 composite is known from the identity of the components in a  
21 given composite, the carbon and hydrogen content of the  
22 test substance composite can be calculated.

23  
24 For example, where each of the components of a test  
25 substance composite are polytetrafluoroethylene (PTFE), the  
26 carbon and hydrogen can be determined knowing the molecular  
27 formula for PTFE is  $(C_2F_4)_n$  as follows:

	number	atomic weight	weight %
carbon (C)	2	12	24
hydrogen (H)	0	1	0
fluorine (F)	4	19	76
total			100

#### 28 29 30 C.2.1.3.2 Empirical Determination

31  
32 Where compositional information on carbon and hydrogen  
33 content is not known from the identity of the components in  
34 a given composite, each such test substance composite will  
35 be analyzed for carbon and hydrogen.

36  
37 As noted in Section C.2.1.1, empirical determination of  
38 carbon in test substance composites via commercially  
39 available conventional techniques is expected to  
40 underestimate the carbon content of the test substance  
41 composites due to the strength of the carbon-fluorine bond.  
42 Similarly, empirical determination of hydrogen in test

1 substance composites via commercially available  
2 conventional techniques is expected to overestimate the  
3 hydrogen content of the test substance composites.

4  
5 The carbon content of the test substance composite can be  
6 measured by determining the carbon dioxide (CO<sub>2</sub>) generated  
7 by the oxidation of the sample. This oxidation may be  
8 accomplished by high temperature combustion, catalytic  
9 combustion, or wet chemical oxidation. The CO<sub>2</sub> is measured  
10 directly by an infrared detector or a thermal conductivity  
11 detector, via absorption into a suitable solution (e.g.,  
12 potassium hydroxide) and gravimetric determination, or by  
13 conversion to methane for measurement via a flame  
14 ionization detector.

15  
16 The hydrogen content of the sample can be determined by  
17 difference with knowledge of the fluorine content and  
18 carbon content of the sample where the moisture content and  
19 chlorine content of the sample are negligible or known.  
20 Alternatively, the hydrogen content of the sample is  
21 measured by determining the water generated by high  
22 temperature combustion of the sample. Measurement of water  
23 in the combustion gas for this analysis may be accomplished  
24 by techniques such as use of an infrared detector or  
25 absorption on a dessicant with gravimetric determination.  
26 With empirical hydrogen determination, it is important to  
27 correct for the water in the combustion gas attributable to  
28 the moisture content in the sample to obtain the hydrogen  
29 content of the sample; see Section C.2.1.4.

30  
31 Manufacturing process knowledge of the polymers will be  
32 used to review the elemental analysis results and to form  
33 the basis for interpreting non-detects. For example, if  
34 the hydrogen analytical result for a perfluorinated polymer  
35 is less than a quantitation limit of 0.1%, then the  
36 analytical result will be replaced with 0.

#### 37 38 C.2.1.4 Moisture

39  
40 Where preparation (as described in Appendix A.4) for a  
41 given test substance composite has involved dewatering, the  
42 moisture (or solids) content of each such test substance  
43 composite will be determined in order to provide a dry  
44 basis for calculations as needed.

45  
46 Moisture is determined by measuring the loss of weight of  
47 the sample when heated under controlled conditions. A

1 representative sample is weighed and placed in a crucible  
2 (or dish) and evaporated to dryness in an air or nitrogen  
3 atmosphere at a defined temperature setpoint (e.g., 103 °C  
4 to 105 °C) in the range of 100 °C to 125 °C. The moisture  
5 value is calculated as the loss in weight (difference  
6 between the starting weight of sample and the final weight  
7 of sample) divided by the starting weight of sample.  
8 Similarly, a solids value can be calculated as the final  
9 weight of sample divided by the starting weight of sample.

10

### 11 C.2.2 COMBUSTION STOICHIOMETRY

12

13 Combustion stoichiometry calculations as described in  
14 Section C.2.2 will be performed to aid in preparation for  
15 combustion testing described in Section C.2.4

16

17 First, the weight percent values from Section C.2.1 are  
18 converted to molar quantities on a dry basis.

19

20 Second, based on Chapter 3 of *Combustion Fundamentals for*  
21 *Waste Incineration* (American Society of Mechanical  
22 Engineers, 1974), the reaction products for these molar  
23 quantities are calculated assuming complete combustion with  
24 the following rules:

25

- 26 a) All carbon (C) in feed converts to carbon dioxide (CO<sub>2</sub>)



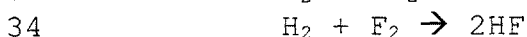
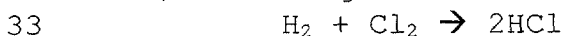
28

- 29 b) All sulfur (S) in feed converts to sulfur dioxide (SO<sub>2</sub>)



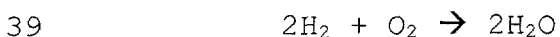
31

- 32 c) The halogens (Cl, F) in feed convert to hydrogen halides



35

- 36 d) Hydrogen (H) present in feed in excess of that  
37 required to yield products in item c) above will be  
38 converted to water



40

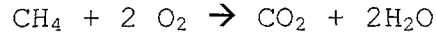
- 41 e) Nitrogen (N) from feed or air is emitted as molecular  
42 nitrogen



44

45 Third, with these rules, the balanced chemical reaction for  
46 combustion of a compound can be written.

1 For example, the resulting reaction equation for a  
2 hydrocarbon like methane (CH<sub>4</sub>) is



4  
5 Note that the term feed in the preceding rules (a through  
6 e) includes both material being combusted and the fuel  
7 source of hydrogen such as methane or methanol.  
8 Additionally, stoichiometric calculations as described  
9 above presume that the compounds undergoing combustion are  
10 essentially free of inorganic constituents.

11  
12 These calculations provide the theoretical amount of oxygen  
13 needed for the overall combustion reaction for the feed  
14 based on the available information used in the  
15 calculations. The initial estimate for the amount of  
16 oxygen to be used in combustion testing will be determined  
17 from this theoretical amount with adjustments for target  
18 oxygen level in thermal reactor system exhaust gas. The  
19 actual amount of oxygen to be used in combustion testing  
20 will be based oxygen monitoring described in Section C.2.4.

21  
22 These stoichiometric calculations will also be used as  
23 needed to initially estimate and adjust experimental  
24 conditions for combustion testing in Section C.2.4.

### 25 26 **C.2.3 THERMOGRAVIMETRIC ANALYSIS**

27  
28 Thermogravimetric analysis (TGA) will be conducted to  
29 determine the temperature range required for gasification  
30 of each test substance composite. TGA will be conducted in  
31 flowing air from room temperature to 1000°C as described in  
32 Appendix B.1.

33  
34 The TGA weight-loss profile for each test substance composite  
35 will be evaluated to determine the temperature at which the  
36 weight loss reaches a final asymptote across the temperature  
37 range investigated. This temperature corresponds to the  
38 point at which no further gasification (under test  
39 conditions) occurs for the material and will be considered  
40 the temperature for complete gasification of the material.

### 41 42 **C.2.4 Combustion Testing**

#### 43 44 **C.2.4.1 Test Objective**

45  
46 The objective of the testing program described in Appendix  
47 C.2 is to assess the potential for waste incineration of

1 each test substance composite to emit PFOA, based on  
2 quantitative determination of potential exhaust gas levels  
3 of PFOA from laboratory-scale combustion testing under  
4 conditions representative of typical municipal waste  
5 combustor operations in the U.S.

6

## 7 C.2.4.2 Experimental Apparatus

8

9 Combustion testing will make use of the Advanced Thermal  
10 Reactor System (ATRS) at the University of Dayton Research  
11 Institute (UDRI). The ATRS is a laboratory-scale, non-  
12 flame, batch-charged, continuous flow thermal reactor  
13 system. The use of this non-flame thermal reactor system  
14 gives a conservative representation of full-scale waste  
15 incineration prior to air pollution controls.

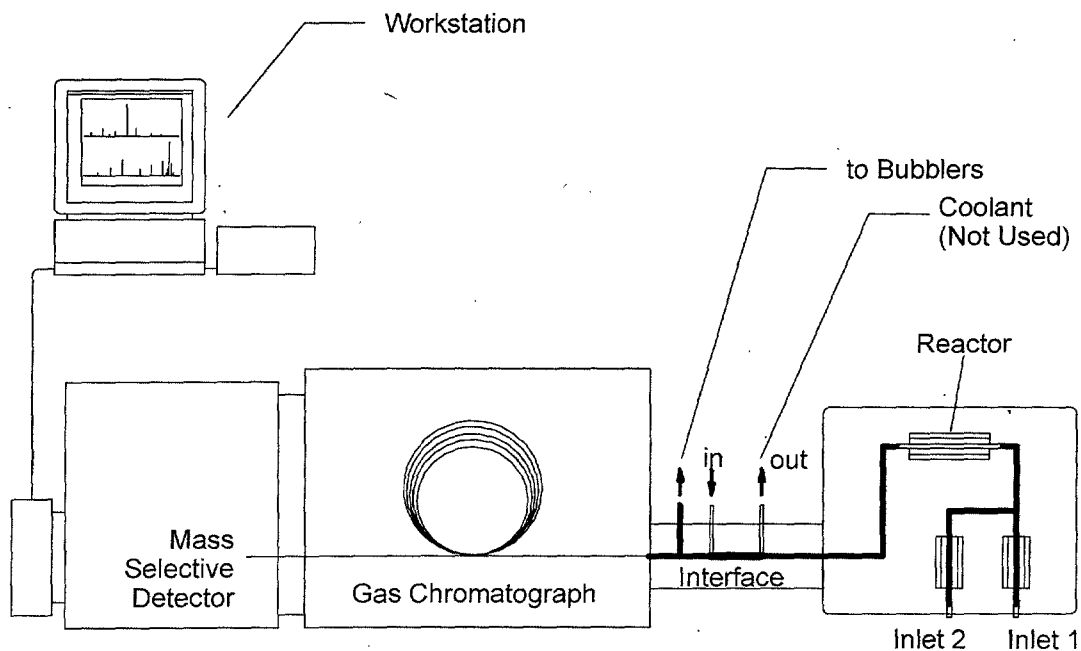
16

17 In the ATRS, the test sample is gasified and transported to a  
18 high temperature reactor. In the high temperature reactor,  
19 the sample vapors are subjected to controlled conditions for  
20 residence time and temperature. As described in Sections  
21 C.2.4.5 and C.2.4.6, combustion products will be monitored or  
22 collected for quantitative analysis.

23

24 A schematic of the ATRS as configured for this test program  
25 is shown in Figure C.2-1.

26

27 **Figure C.2-1. Schematic of ATRS for this Test Program**

28

1 The ATRS consists of a reactor assembly and in-line gas  
2 chromatograph/detector system connected via an interface.  
3 The reactor assembly consists of a thermally insulated  
4 enclosure housing the sample introduction, reactor, and  
5 transfer line systems.

6  
7 Sample introduction for solid materials (Inlet 1) employs a  
8 pyroprobe, a device designed to gasify samples by heating  
9 them at a fixed rate. The main gas flow will also be fed  
10 via Inlet 1, and Inlet 2 will be used to feed supplemental  
11 flow.

12  
13 During combustion tests, the transfer line between the  
14 pyroprobe and the reactor is heated and maintained above  
15 200 °C. The reactor is housed within its own small tube  
16 furnace and may be independently heated to as high as 1100  
17 °C. (Actual conditions for this test program are presented  
18 in Section C.2.4.3.) The transfer line from the reactor to  
19 the interface is heat traced to greater than 200 °C to  
20 prevent cool regions where reactor products could otherwise  
21 be lost through condensation.

22  
23 The interface routes the combustion exhaust gas to the in-  
24 line gas chromatograph (GC) and mass selective detector  
25 (MSD) or to sample collection for off-line analysis. For  
26 combustion testing in this test program, the interface will  
27 also be maintained above 200 °C. Exhaust gas monitoring for  
28 this program is described in Section C.2.4.5.

### 29 30 C.2.4.3 Combustion Test Experimental Conditions

31  
32 Each test substance composite will be subjected to  
33 laboratory-scale incineration using the experimental  
34 apparatus described in Section C.2.4.2.

#### 35 36 C.2.4.3.1 Combustion Air

37  
38 Synthetic air (mixture of 21% oxygen and 79% nitrogen) will  
39 be used in place of compressed air to prevent potential  
40 interference in the experimental system due to background  
41 levels of CO<sub>2</sub> in compressed air.

#### 42 43 C.2.4.3.2 Fuel

44  
45 Methanol will be used, as needed, as a supplemental fuel to  
46 ensure the presence of sufficient hydrogen to convert

1 fluorine to hydrogen fluoride (HF) and chlorine to hydrogen  
2 chloride (HCl).

3  
4 As noted in *Municipal Solid Waste in the United States:  
5 2000 Facts and Figures* (EPA, 2002), paper and paper  
6 products (made from wood) make up the largest component of  
7 municipal solid waste (MSW). The sum of paper and paper  
8 products with wood in MSW makes up over 30% of MSW.

9  
10 During the 19<sup>th</sup> century, methanol was produced from wood and  
11 was known as wood alcohol. Therefore, methanol can be used  
12 in this experimental program as a surrogate for the paper  
13 and wood fraction of MSW.

#### 14 C.2.4.3.3 Operating Conditions

15  
16  
17 The target operating conditions for the high temperature  
18 reactor during the combustion tests for each test substance  
19 composite identified in Appendix A.3 are presented in Table  
20 C.2-1.

21  
22

**TABLE C.2-1. COMBUSTION TEST TARGET OPERATING CONDITIONS**

Temperature	1000 °C
Residence Time	2 sec
O <sub>2</sub> concentration in exhaust gas	10%
H <sub>2</sub> O concentration in exhaust gas	15%
Number of replicate runs	3

23  
24 These conditions are conservatively representative of  
25 typical furnace operating conditions of municipal waste  
26 combustors (MWCs) and of typical secondary chamber  
27 operating temperatures for medical waste incinerators in  
28 the U.S. See Appendix D.4 for supporting information.

29

30 Temperature and residence time values in Table C.2-2 will  
31 be fixed setpoints for these experiments. The temperature  
32 of the high temperature reactor will be controlled within  
33  $\pm 10$  °C to assure isothermal operation.

34

35 The amount of each test substance composite fed to the ATRS  
36 in this testing program will be a measured amount less than  
37 5 mg. The actual amount fed, gasification rate (determined  
38 from TGA), air supply, and fuel supply will be adjusted to  
39 assure that the oxygen level in the exhaust will be greater  
40 than or equal to the concentration in Table C.2-1  
41 throughout each test to be representative of typical MWC  
42 conditions. The fuel supply and air supply will also be



1 adjusted as needed to approach the target H<sub>2</sub>O concentration  
2 in exhaust gas in Table C.2-1.

3  
4 The pyroprobe section final temperature (at end of  
5 temperature ramp-up) will be 750 °C or as needed to assure  
6 this section is 50 to 100 °C above the highest temperature  
7 for complete gasification across the test substance  
8 composites as determined from the TGA results; see Section  
9 C.2.3. This is necessary to assure complete gasification  
10 of the sample of test substance composite and a common set  
11 of experimental conditions across the test materials during  
12 combustion testing.

#### 13 14 C.2.4.3.4 Blanks

15  
16 A minimum of one thermal blank will be run prior to each  
17 set of three combustion test runs for a given test  
18 substance composite. Each thermal blank run will be at the  
19 corresponding combustion test conditions with all feeds  
20 except for the test substance.

#### 21 22 C.2.4.4 Process Monitoring

23  
24 ATRS process parameters in Table C.2-2 will be monitored  
25 for each combustion test at key points during the test as  
26 noted in the table. Each combustion test will be a minimum  
27 of 5 minutes in duration. If the duration of a combustion  
28 test is greater than 15 minutes, each parameter in Table  
29 C.2-2 will be recorded at least once every 15 minutes.

30  
31 **TABLE C.2-2. COMBUSTION TEST MONITORING**

Parameter	Key Time for Recording
Temperature-Reactor	Before & after gasification
Temperature-Transfer line	Before & after gasification
Temperature-Inlet 1	After gasification
Temperature-Inlet 2	Before & after gasification
Gas flow rate-Inlet 1	Before & after gasification
Gas flow rate-Inlet 2	Before & after gasification
Total Gas Flow rate	Before & after combustion test
Make-up Gas (He) Flow rate	Before & after combustion test
Pressure-Reactor	Before & after gasification

32  
33 Temperature-Inlet 1 will be recorded at the end of the  
34 temperature ramp-up for gasification to monitor the  
35 pyroprobe final temperature.

1 The flow rate of the exhaust gas routed to the bubblers  
2 (see Section C.2.4.5.2) will be determined based on the  
3 flow measurements listed in Table C.2-2.

4  
5 The amount of material fed to the system will be verified  
6 by weighing the pyroprobe insert cartridge before and after  
7 each experiment.

8  
9 Exhaust gas monitoring is described in Section C.2.4.5.

#### 10 11 C.2.4.5 Exhaust Gas Monitoring

12  
13 Combustion exhaust gas will be continuously monitored for  
14 oxygen during each combustion test via in-line MSD or via  
15 an oxygen monitor. CO<sub>2</sub> in exhaust gas will be monitored via  
16 in-line GC, in-line MSD, or a continuous monitor; or  
17 exhaust gas will be collected in Tedlar® bags for off-line  
18 analysis of CO<sub>2</sub>. Carbon monoxide (CO) in exhaust gas will  
19 be monitored via in-line GC or a continuous monitor; or  
20 exhaust gas will be collected in Tedlar® bags for off-line  
21 analysis of CO. Tedlar® bag samples may be collected at  
22 the exit of the bubblers described in Section C.2.4.6.

#### 23 24 C.2.4.6 Exhaust Gas Sampling

25  
26 Gas samples for off-line analysis will be collected as  
27 described in Appendix D.1, revised as necessary pursuant to  
28 Appendix C.1.2.2 if applicable.

29  
30 A minimum of 60 mL of bubbler aqueous solution composite is  
31 expected from each combustion test. Of this, a minimum of  
32 45 mL will be directed to PFOA analysis, and the remainder  
33 will be directed to fluoride ion analysis.

#### 34 35 C.2.4.7 Exhaust Gas Analysis

##### 36 37 C.2.4.7.1 Fluoride Ion

38  
39 A portion of the composite bubbler aqueous solution sample  
40 from each combustion test collected as described in Section  
41 C.2.4.6 will be analyzed for fluoride ion via ion  
42 chromatography using EPA Method 300.0.

##### 43 44 C.2.4.7.2 PFOA

45  
46 A portion of the composite bubbler aqueous solution sample  
47 from each combustion test collected as described in Section

1 C.2.4.6 will be analyzed for PFOA via LC/MS/MS as described  
2 in Appendix D.2.

3  
4 As described in Appendix D.2, composite bubbler aqueous  
5 solution sample results less than method detection limit  
6 (MDL) will be reported as not detected (ND), results  
7 between MDL and the limit of quantitation (LOQ) will be  
8 reported as not quantifiable (NQ), and numerical values  
9 will not be reported.

10  
11 Due to background levels of PFOA, the analytical laboratory  
12 will only report numerical values for PFOA concentration in  
13 the aqueous solution greater than or equal to the LOQ.  
14 This is required to assure that the reported concentration  
15 value is attributable to the aqueous solution sample rather  
16 than to background.

17  
18 C.2.5 Reporting of Results

19  
20 C.2.5.1 Elemental Analysis Results

21  
22 The results of elemental analysis for each test substance  
23 composite (as noted in Section C.2.1) will be reported.  
24 The laboratory reports will be included in an appendix to  
25 the final report for incineration testing (test report).

26  
27 C.2.5.2 Combustion Stoichiometry Results

28  
29 Combustion stoichiometry (as noted in Section C.2.2)  
30 calculations for each test substance composite will be  
31 included in an appendix to the test report.

32  
33 C.2.5.3 TGA Results

34  
35 The temperature for complete gasification and the TGA  
36 graphical results for each test substance composite (as  
37 noted in Section C.2.3) will be included in an appendix to  
38 the test report.

39  
40 C.2.5.4 Combustion Test Results

41  
42 C.2.5.4.1 Process Monitoring

43  
44 Process monitoring data (as noted in Section C.2.4.4)  
45 recorded for each combustion test will be reported in  
46 tabular form.

47

## 1 C.2.5.4.2 Exhaust Gas Monitoring

2

3 Exhaust gas O<sub>2</sub>, CO and CO<sub>2</sub> monitoring results will be  
4 reported as the integrated or average value for each  
5 combustion test. CO will be reported in terms of parts per  
6 million by volume (ppmv). O<sub>2</sub> and CO<sub>2</sub> will be reported in  
7 terms of percent by volume (%).

8

## 9 C.2.5.4.3 Exhaust Gas Analytical Results

10

11 Results of analyses noted in Section C.2.4.7 will be  
12 reported for each replicate of each combustion test.

13

14 The analytical result for each analyte in Section C.2.4.7  
15 will be reported in terms of concentration (mass per  
16 volume) in the bubbler aqueous solution. For each analyte,  
17 this value will be used with the associated exhaust gas  
18 volume to compute an exhaust gas concentration and with the  
19 associated test substance mass to compute mass of analyte  
20 per mass of test substance composite.

21

## 22 C.2.5.4.3.1 Fluoride

23

24 Fluoride ion in the exhaust gas will be reported on the  
25 basis of mass of fluoride ion per mass of test substance  
26 composite. The corresponding hydrogen fluoride value for  
27 each will also be computed and reported for reference.

28

## 29 C.2.5.4.3.2 PFOA

30

31 PFOA results for the bubbler aqueous solution samples will  
32 be reported as described in Section C.2.4.7.2. PFOA  
33 results for associated blanks will also be reported.

34

35 If present in the bubbler aqueous solution at a  
36 concentration above the matrix-specific LOQ, PFOA in the  
37 exhaust gas will be reported on the basis of mass of PFOA  
38 per mass of test substance composite.

39

## 40 C.2.5.5 Release Assessment

41

42 In the event that PFOA is reported for the exhaust gas  
43 bubbler aqueous solution at a concentration at or above the  
44 LOQ (as defined in Appendix D.2) for two or more of the  
45 three runs for a given test substance composite, a release  
46 assessment report for the full-scale waste incineration of  
47 products represented by the test substance composite will

- 1 be prepared following the outline in Appendix E.2 and will
- 2 be included in the test report.

1 **APPENDIX D.1**  
2 **EXHAUST GAS SAMPLING VIA BUBBLERS**

3  
4 Gas samples for off-line analysis will be collected from a  
5 vent line off the interface of the thermal reactor system  
6 described in Appendix C.2.4. Flexible (silicone or  
7 equivalent) tubing will connect the vent line and a set of  
8 bubblers.

9  
10 Gas absorption via these bubblers will provide aqueous  
11 solution (of documented content) to analyze for prescribed  
12 parameters. Two to four bubblers (low pressure drop  
13 impingers) in series will be used. Each bubbler will  
14 contain a predetermined amount of aqueous solution, and the  
15 total amount of solution at the beginning of each test run  
16 will be a minimum of 55 mL. The temperature of the gas  
17 exiting the last bubbler will be monitored.

18  
19 An additional bubbler (which is empty) will be added to the  
20 front end of this series of bubblers to serve as a knock-  
21 out pot if calculations or preliminary measurements  
22 indicate that greater than 10 mL of water will be produced  
23 during the testing for a given material.

24  
25 Upon completion of sample collection, the amount in each  
26 bubbler will be weighed and recorded, and the contents of  
27 the bubblers will be composited for subsequent analysis.  
28 Additionally, the flexible tubing will be rinsed with 5 mL  
29 of HPLC water to collect potential condensate in the  
30 tubing; this rinsate will be combined with the bubbler  
31 composite prior to analysis.

32  
33 Bubbler aqueous solution composites will be conveyed to  
34 analytical laboratory(ies) in polyethylene, polypropylene,  
35 or glass container(s).

**APPENDIX D.2****PFOA ANALYSIS BY LC/MS/MS**

## D.2.1 Introduction

Samples to be analyzed for PFOA in this study will be subjected to Liquid Chromatography with Tandem Mass Spectrometry (LC/MS/MS) in accordance with "Method of Analysis for the Determination of Ammonium Perfluorooctanoate (APFO) in Water Revision 1" (Exygen method) revised per the section-by-section comments listed in Section D.2.4 below. These revisions are necessary to adapt a method originally developed for liter quantity water samples to samples related to testing described in Appendix C.

The testing programs described in Appendix C are expected to generate samples of aqueous solution, methanol (e.g., as used for extraction or rinsing), and corresponding blanks. The expected sample size for aqueous solution samples (from exhaust gas bubbler sample collection) available for analysis via this method is approximately 50 mL.

## D.2.2 Method Summary

PFOA is extracted from water using a disposable C<sub>18</sub> solid phase extraction (SPE) cartridge. PFOA is eluted from the cartridge with methanol. Quantification of PFOA is accomplished by electrospray liquid chromatography/tandem mass spectrometry (LC/MS/MS) analysis.

## D.2.3 Reporting

The target limit of quantitation (LOQ) for this study with this method is 50 ng/L based on prior work with water samples where an 8-fold concentration via extraction using C<sub>18</sub> SPE cartridge has been demonstrated. The actual LOQ will be matrix dependent; for samples (e.g., methanol rinsate) where the 8-fold concentration cannot be performed, the target LOQ for this study is 400 ng/L.

Sections 4.5.4 and 5 of the Exygen method explain reporting for field samples such as bubbler aqueous solution composites, which are distinct from blanks and spikes, as follows:

Field samples in which either no peaks or peaks

1 less than the MDL are detected at the corresponding  
 2 analyte retention time will be reported as ND (not  
 3 detected). Samples in which peaks are detected at  
 4 the corresponding analyte retention time that are  
 5 less than the LOQ and greater than or equal to the  
 6 MDL will be reported as NQ (not quantifiable).  
 7  
 8 Therefore, sample results less than method detection limit  
 9 (MDL) will be reported as ND, and sample results between  
 10 MDL and the limit of quantitation (LOQ) will be reported as  
 11 NQ. Numerical values will not be reported for such  
 12 samples. Only concentrations above the LOQ, where the  
 13 reported concentration is attributable to the sample rather  
 14 than to background, are reported with numerical values.  
 15  
 16 Additionally, if the PFOA anion is found in a sample at a  
 17 concentration above the LOQ for the matrix but is less than  
 18 5 times the concentration found in the associated blank,  
 19 the result will be flagged and treated as ND.  
 20  
 21 D.2.4 Study-Specific Comments on the Method  
 22

Section	Comment
1	<ul style="list-style-type: none"> <li>• The concentration of PFOA found will be reported directly and the mathematical conversion for reporting as APFO mentioned in the 4<sup>th</sup> sentence of the 2<sup>nd</sup> paragraph will not be performed.</li> <li>• Since the 8-fold concentration described in the 2<sup>nd</sup> sentence 4<sup>th</sup> paragraph (which forms the basis for the LOQ in the 3<sup>rd</sup> paragraph and the MDL in the 4<sup>th</sup> paragraph) is dependent on having a minimum of 40 mL of aqueous sample amenable to extraction using the C<sub>18</sub> SPE cartridge described in section 4.4 of the method, the LOQ and MDL in the method will be a factor of 8 higher than reported where less than 40 mL of sample is available or where the sample is not amenable to extraction using the C<sub>18</sub> SPE cartridge described in section 4.4 of the method (e.g., methanol).</li> </ul>
3.3 Note at top of page 8	<ul style="list-style-type: none"> <li>• The note stating "Equivalent materials may be substituted for those specified in this method if they can be shown to produce satisfactory results" will not be used in the analysis for this testing program.</li> </ul>



3.3 Notes, Note 1	<ul style="list-style-type: none"> <li>The following text will be used in place of Note 1 with respect to the PFOA analysis conducted for this testing program:  In order to avoid contamination, the use of disposable labware (tubes, pipets, etc.) is required.</li> </ul>
3.3 Notes, Note 4	<ul style="list-style-type: none"> <li>The following text will be used in place of Note 4 with respect to the PFOA analysis conducted for this testing program:  Solvents (e.g., methanol) used for this analysis must be checked for the presence of contaminants by LC/MS/MS before use.</li> </ul>
3.5 opening text prior to 3.5.1	<ul style="list-style-type: none"> <li>Where the available amount of sample is expected to be much less than 1 liter, insufficient sample is available to prepare the fortified matrix spikes described in the opening text of section 3.5. In this case, the analytical standards discussed in this opening text will be limited to two purposes since the third purpose (matrix spike) stated in the method cannot be done.</li> </ul>
4.3, item b	<ul style="list-style-type: none"> <li>Where the available amount of sample is expected to be less than 80 mL (= 2 * 40), the replicate extraction noted in the first sentence of this item cannot be performed.</li> <li>If the sample is not an aqueous sample amenable to extraction using the C<sub>18</sub> SPE cartridge described in section 4.4 of the method, then section 4.4 is skipped such that the sample is analyzed directly. (Note: For such samples, the LOQ and MDL will be 8 times higher than the values quoted in the method.)</li> </ul>
4.3, item c	<ul style="list-style-type: none"> <li>As noted in comment on section 3.5 opening text above, fortified matrix spikes will not be prepared when the available amount of sample is much less than 1 liter.</li> <li>Where the available amount of sample is expected to be less than 80 mL (= 2 * 40), the conditional repeat fortification and extraction described in the third sentence of this item cannot be performed.</li> </ul>
4.4	<ul style="list-style-type: none"> <li>Extraction using the C<sub>18</sub> SPE cartridge requires a suitable aqueous sample. This extraction and the corresponding 8-fold concentration</li> </ul>

	pointed out in the NOTE at the end of this section cannot be performed on non-aqueous (e.g., methanol) samples.
4.4, item 1	<ul style="list-style-type: none"> <li>In order to measure out the 40 mL mentioned in this item, it is necessary to have at least 45 mL of sample to enable pipet transfer.</li> </ul>
4.5.4, item g	<ul style="list-style-type: none"> <li>A storage stability study for PFOA in water performed independently of the development of the method indicates that PFOA may be stored in glass, polystyrene, polypropylene, or polyethylene containers without measurable degradation for up to 68 days prior to extraction. Therefore, the total holding time between sample collection and analysis for aqueous PFOA samples in this study may exceed the 14 day limit noted in the first sentence of this item provided that the sample is not held for greater than 68 days unless additional storage stability testing justifies a longer hold time.</li> </ul>
4.6, item 3	<ul style="list-style-type: none"> <li>As noted in comment on section 3.5 opening text above, fortified matrix spikes will not be prepared when the available amount of sample is much less than 1 liter. In this case, acceptance criteria for matrix spike recoveries will not be considered.</li> </ul>
5, item c	<ul style="list-style-type: none"> <li>The calculation in equation 3 in this section will not be performed since it is not necessary to convert the PFOA analytical results to APFO for this study.</li> </ul>

1

2 D.2.5 Reference

3

4 Flaherty, J. and K. Risha, "Method of Analysis for the  
5 Determination of Ammonium Perfluorooctanoate (APFO) in  
6 Water Revision 1", Exygen Method No. 01M-008-046 Revision  
7 1, January 2003. (EPA Docket ID OPPT-2003-0012-0040)

1 **APPENDIX D.3**  
2 **WICKBOLD TORCH METHOD FOR TOTAL FLUORINE**

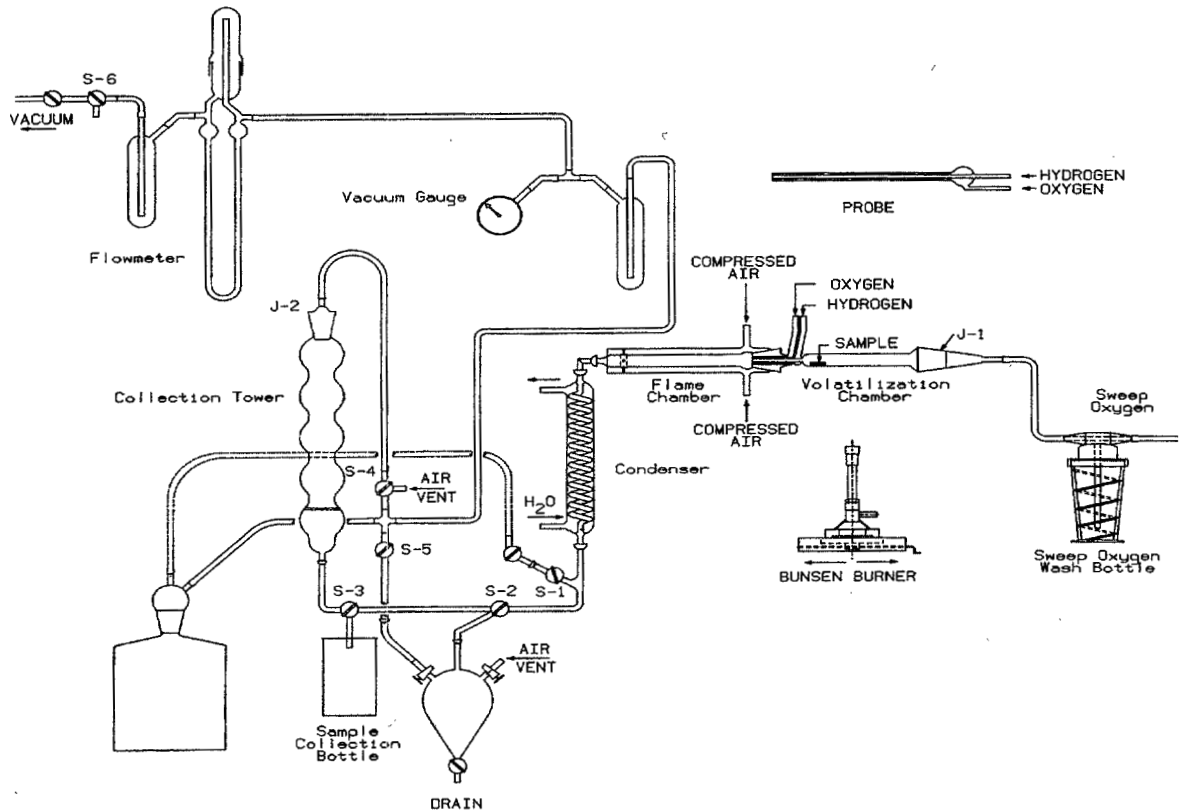
3  
4 D.3.1 Introduction

5  
6 "The carbon-fluorine bond is exceptionally strong, and  
7 extremely vigorous conditions are needed for quantitative"  
8 analysis of fluorine in organic compounds. (Kissa, 1998)  
9 The "most vigorous" technique for measurement of fluorine  
10 in organic compounds is "combustion in an oxyhydrogen  
11 flame" referred to as the Wickbold torch. (Kissa, 1998)

12  
13 D.3.2 Apparatus

14  
15 A typical configuration for the Wickbold oxyhydrogen torch  
16 apparatus as described by Sweetser (1956) is shown in  
17 Figure D.3-1.

18  
19  
20 **FIGURE D.3-1. WICKBOLD OXYHYDROGEN TORCH APPARATUS**



## 1 D.3.3 Method Description

2

3 The sample size for the standard sample boat is up to 20 mg  
4 for a solid or up to 5 mL for a liquid.

5

6 With the oxyhydrogen torch in operation, the sample is  
7 pyrolyzed or vaporized with a Bunsen burner moving on a  
8 rail below the volatilization chamber. The vapors and  
9 pyrolysis products are swept through the oxygen-hydrogen  
10 flame chamber operating at up to approximately 2000 °C to  
11 mineralize the fluorine in the sample to fluoride ion. The  
12 resulting fluoride ion is absorbed in the collection tower  
13 containing water or an alkaline solution.

14

15 The absorbed fluoride ion is measured via fluoride ion-  
16 selective electrode or ion chromatography.

17

18 The reported limit of quantitation for total fluorine via  
19 the Wickbold Torch method is 0.5 ppm (0.5 mg/kg). The  
20 accuracy of this method for determination of total fluorine  
21 in fluorinated polymers is exemplified by total fluorine  
22 values of 75.35% to 75.84% for PTFE with known total  
23 fluorine content of 76.0%. (Sweetser, 1956)

24

## 25 D.3.4 Safety Considerations

26

27 Use of hydrogen presents a potential fire and explosion  
28 hazard. Use of oxygen presents a potential fire hazard.  
29 Safe operation of the oxyhydrogen torch is assured by the  
30 use of specialized equipment with shielding and elaborate  
31 safety devices by well-trained personnel at a qualified  
32 laboratory.

33

## 34 D.3.5 References

35

36 Kissa, E. "Analysis of Anionic Fluorinated Surfactants",  
37 Chapter 8 in Anionic Surfactants: Analytical Chemistry -  
38 2nd Edition, Revised and Expanded, edited by John Cross.  
39 Marcel Dekker Surfactant Science Series, volume 73, 1998.

40

41 Sweetser, P. B. "Decomposition of Organic Fluorine  
42 Compounds by Wickbold Oxyhydrogen Flame Combustion Method",  
43 Analytical Chemistry, vol. 28, pp. 1766-1768, 1956.

1 **APENDIX D.4**  
2 **WASTE INCINERATION AND OPERATION CONDITIONS**

3  
4 Polymers of the sort being investigated in this testing  
5 program may be present at trace to low concentrations in  
6 the feedstreams to municipal waste combustors and/or  
7 medical waste incinerators in the U.S.

8  
9 **D.4.1 Types of Incinerators**

10  
11 D.4.2.1 Municipal Waste Combustors

12  
13 According to the Integrated Waste Services Association  
14 (IWSA), there are a total of 98 waste-to-energy facilities  
15 operating municipal waste combustors (MWCs) in the U.S. as  
16 of 2002. (IWSA 2002) Table D.4-1 summarizes the number and  
17 annual capacity of these units by type of technology  
18 employed.

19  
20 **Table D.4-1. MWCs in 2002**

Type	Number of Facilities	Annual Capacity (million Ton/year)	Fraction of Waste
Mass Burn	68	22.5	76.5%
Refused Derived Fuel (RDF)	18	6.4	21.8%
Modular	12	0.5	1.7%
Total	98	29.4	100.0%

21  
22 D.4.1.2 Hospital/Medical/Infectious Waste Incinerators

23  
24 Although earlier reports indicated approximately 2400  
25 medical waste incinerators in the U.S. in the 1990s burning  
26 approximately 846 thousand tons of hospital and  
27 medical/infectious waste (EPA 1997), the current EPA Office  
28 of Air Quality, Planning, and Standards (OAQPS) inventory  
29 indicates that there are 116 hospital/medical/infectious  
30 waste incinerators (HMIWIs) in the U.S. as of July 28,  
31 2003. (EPA 2003)

32  
33 This represents a greater than 90% reduction in the number  
34 of operating HMIWIs in the U.S. Many medical waste  
35 incinerators were closed rather than upgraded to meet new  
36 emission standards, as hospitals improved their programs to  
37 segregate infectious ("red bag") waste burned in HMIWIs  
38 from non-infectious ("black bag") waste handled as  
39 municipal solid waste after it leaves the hospital.  
40 Consequently, the amount of segregated infectious waste

1 burned in HMIWIs is expected to be less than 0.3 million  
2 tons per year.

3  
4 EPA notes that over 97% of medical waste incinerators are  
5 controlled air modular units (EPA 2000a). Recent  
6 communication with EPA OAQPS indicates that virtually all  
7 existing HMIWIs are controlled air modular (two-chamber)  
8 units.

9  
10 **D.4.2 Incinerator Operating Conditions**

11  
12 Many incinerators for municipal solid waste are designed to  
13 operate in the combustion zone at 1800 °F (982 °C) to 2000  
14 °F (1093 °C) to ensure good combustion. (EPA 1995) EPA's  
15 new source performance standards (NSPS) and emission  
16 guidelines for both municipal waste combustors (MWCs) and  
17 hospital/medical/infectious waste incinerators (HMIWIs) are  
18 based on the use of "good combustion practices" (GCP). (EPA  
19 1997, EPA 2000b, EPA 2000c, Van Remmen 1998)

20  
21 Referring to MWCs, Donnelly notes, "Design of modern  
22 efficient combustors is such that there is adequate  
23 turbulence in the flue gas to ensure good mixing, a high-  
24 temperature zone (greater than 1000 °C) to complete burnout,  
25 and long enough residence time at high temperature (1-2  
26 sec) for complete burnout." (Donnelly 2000) The term "flue  
27 gas" here refers to the gas above the grate.

28  
29 With respect to HMIWIs, Van Remmen states "any unit which  
30 presently [prior to compliance date] has a [secondary  
31 chamber] residence time less than two seconds at 1000 °C  
32 does not meet the requirement for good combustion under the  
33 new regulations." (Van Remmen 1998)

34  
35 Similarly, most MWCs operate with a 2 second gas residence  
36 time in the high temperature zone in order to assure  
37 compliance with emission standards on carbon monoxide (CO)  
38 and dioxins.

39  
40 **D.4.2.1 MWC Operating Conditions**

41  
42 **D.4.2.1.1 Mass Burn MWC**

43  
44 Review of the IWSA Directory (IWSA 2002) indicates that  
45 almost all of these mass burn units are mass burn water  
46 wall furnaces. Nearly all mass burn water wall furnaces

1 have reciprocating grates or roller grates to move the  
2 waste through the combustion chamber. (EPA 1996a)

3  
4 Studies on the Millbury, Massachusetts mass burn water wall  
5 MWC produced gas temperature versus residence time results.  
6 (Scavuzzo, Strempek, and Strach 1990) Calculations based  
7 on Figure 6 of this paper indicate a time-averaged  
8 temperature of 2238 °F (1226 °C) over a 2 second. The  
9 corresponding gas temperature at the 2 second level from  
10 this figure is 1750 °F (954 °C).

11  
12 A report on the Warren County, New Jersey mass burn water  
13 wall MWC indicates that the design gas temperature between  
14 the grate and secondary air inject was greater than 2000 °F  
15 (1093 °C) over a gas residence time of an additional 2.2  
16 seconds. (Schuetzenduebel and Nobles 1990) This report  
17 also shows that this MWC was designed for 2 seconds  
18 residence time above 1800 °F (982 °C) between the  
19 introduction of secondary air and the exit of the furnace  
20 section. (Schuetzenduebel and Nobles 1990) The temperature  
21 profile (Figure 21) in the temperature correlation test  
22 report (Schuetzenduebel 1989) for this MWC shows the full  
23 load gas temperature at the secondary air injection point  
24 is 2650 °F, and the gas temperature at the 2-second point is  
25 1850 °F. Therefore, testing indicates an average  
26 temperature of 2250 °F (1232 °C) over this 2 second gas  
27 residence time for the Warren County unit. A related  
28 report for the Warren County MWC by the design firm  
29 indicates that the exhaust gas oxygen concentration is  
30 nominally 10% (dry basis). (Blount Energy Resource Corp.  
31 1989)

32  
33 Information from these 2 MWCs demonstrates that the average  
34 gas temperature across a 2 second residence time for mass  
35 burn MWCs is conservatively expected to be greater than  
36 1100 °C.

37  
38 Test report data from a typical mass burn MWC (Fairfax,  
39 Virginia) indicates typical average furnace exit gas  
40 concentrations are 10.8% oxygen (dry basis) and 18.4%  
41 moisture (water). (Clean Air Engineering, 1997)

42  
43 As indicated in Table D.4.1, mass burn units account for  
44 over 76% of the municipal solid waste incinerated in the  
45 U.S.

1  
2 D.4.2.1.2 RDF MWC  
3

4 Furnace temperatures as well as flue gas oxygen and moisture  
5 (H<sub>2</sub>O) levels for the Mid-Connecticut RDF combustor during  
6 performance tests while operating under good combustion  
7 conditions across a range of steam loads (Finklestein and  
8 Klicius 1994) are summarized in Table D.4-2.  
9

10 **Table D.4-2. RDF MWC - Mid-Connecticut**

Steam load	low	low	inter- mediate	inter- mediate	normal	normal	normal	high
test number	PT-13	PT-14	PT-10	PT-02	PT-09	PT-08	PT-11	PT-12
Furnace temperature (°C)	965	1004	1012	1022	1033	1015	1026	1049
flue gas O <sub>2</sub> (%)	10.1	9.6	9.2	9.1	7.6	7.5	7.9	6.4
flue gas moisture	12.4	11.1	12.3	15.4	15.1	16.3	14.1	16.2

11  
12 The average operating conditions for this RDF unit across  
13 the range of steam loads are 1016 °C, 8.4% O<sub>2</sub> (dry basis),  
14 and 14.1% moisture.  
15

16 Examination of the report and MWC temperature monitoring  
17 practices indicates that these temperatures are effectively  
18 combustion zone exit temperatures. Therefore, in order to  
19 determine the average MWC combustion zone temperature  
20 across a 2 second gas residence time, it is necessary to  
21 understand the time-temperature profile of the MWC.  
22

23 Since waste combustion in this and most other RDF units in  
24 the U.S. involves burning on the grate (EPA 1996a) similar  
25 to the operation of mass burn MWCs, the time-temperature  
26 profile in an RDF unit is expected to be similar to that  
27 described in Section D.4.2.1.1 above. Based on this  
28 similarity and the temperatures in Table D.4-2, the average  
29 gas temperature across a 2 second residence time for RDF  
30 units is conservatively expected to be greater than 1100 °C.  
31

32 As indicated in Table D.4.1, RDF units account for  
33 approximately 22% of the municipal solid waste incinerated  
34 in the U.S.  
35

36 D.4.2.1.1 Modular MWC  
37

38 Modular MWCs are generally small dual-chamber units,  
39 accounting for less than a total of 2% of the municipal  
40 solid waste incinerated in the U.S. in 2002. Modular MWCs  
41 are generally equipped with auxiliary fuel burners in the



1 secondary chamber. (EPA 1996a) EPA notes that the  
2 secondary chamber exit temperature of modular MWCs is  
3 maintained at typically 980 to 1200 °C. (EPA 1996a)  
4

5 A typical modular MWC in Polk County, Minnesota is operated  
6 with a gas residence time of 2 seconds, in the secondary  
7 chamber, a secondary chamber exit temperature in the range  
8 of 1800 °F (982 °C) to 2000 °F (1093 °C), flue gas oxygen  
9 concentrations in the range of 10% to 13% (dry basis), and  
10 flue gas moisture in the range of 10% to 15% (Pace  
11 Analytical 2003).  
12

13 Since the secondary chamber exit temperature is expected to  
14 be the minimum gas-phase temperature for the chamber, the  
15 secondary chamber average gas temperatures for modular MWCs  
16 are expected to be 1000 °C or greater.  
17

18 As indicated in section D.4.1, such modular units are  
19 generally small MWCs and account for less than a total of  
20 2% of the municipal solid waste incinerated in the U.S.  
21

#### 22 D.4.2.1.4 MWC Summary 23

24 Considering the relative quantities of municipal waste  
25 burned annually in each type of MWC and the data in this  
26 section, typical operating conditions for the high  
27 temperature zone of most MWCs are >1000 °C average  
28 temperature across 2 second residence time with exit gas  
29 concentrations of 10% O<sub>2</sub> (dry basis) and >15% moisture.  
30

#### 31 D.4.2.2 HMIWI Operating Conditions 32

33 The range of temperatures for the secondary chamber of  
34 controlled air medical waste incinerators has been reported  
35 as 980 to 1200 °C. (Theodore 1990) EPA notes that auxiliary  
36 fuel (e.g., natural gas) is burned in the secondary chamber  
37 of medical waste incinerators to sustain temperatures in  
38 the range of 985 to 1095 °C and that combustion air at 150  
39 to 250 % of the stoichiometric requirement is usually added  
40 to the secondary chamber. (EPA 2000a, EPA 1994a)  
41

42 In its model plant description background document, EPA  
43 notes that the average moisture content in HMIWI flue gas  
44 was about 10 % based on available data, and EPA states  
45 "limited data show that older [HMIWI] units typically have  
46 residence times that range from essentially 0 seconds up to  
47 about 1 second." (EPA 1994b) However, as noted above, a

1 more recent report indicates that HMIWIs still in operation  
2 have secondary chamber temperatures greater than or equal  
3 to 1000 °C with a gas residence time of 2 seconds. (Van  
4 Remmen 1998) For example, EPA studied the incinerator at  
5 Weeks Hospital in New Hampshire as a typical HMIWI with a  
6 design residence time of 2 seconds in the secondary  
7 chamber. (EPA 1996b) During this testing, the average exit  
8 secondary chamber exit temperature was 1024 °C, and the flue  
9 gas oxygen concentration was 13.5%. (dry basis) (EPA 1996b)

10  
11 Review of test reports for all HMIWIs in the EPA docket for  
12 the HMIWI NSPS and EG rulemakings that are listed in EPA's  
13 current HMIWI inventory (EPA 2003) does not refute Van  
14 Remmen's statement above on residence time and temperature  
15 and indicates HMIWI flue gas oxygen concentrations for  
16 these units in the range of 10 to 15% (dry basis) and stack  
17 moisture concentrations as high as 30% (after wet  
18 scrubbing). (Environmental Laboratories Inc. 1993, EPA  
19 1996, HDR Engineering 1994a, HDR Engineering 1994b, METCO  
20 Environmental 1992, Technical Services, Inc. 1993,  
21 Technical Services, Inc. 1994a, Technical Services, Inc.  
22 1994b) Apparently, the older HMIWIs referred to in EPA's  
23 model plant description background document either have  
24 been shut down or upgraded to operate with secondary  
25 chamber exit temperatures higher than 1000 °C at a gas  
26 residence time of 2 seconds.

27  
28 Secondary chamber temperature of HMIWIs is monitored near  
29 the secondary chamber outlet. (EPA 1994) Hence, when the  
30 auxiliary burner (located on the end opposite from the  
31 outlet) is in use, the average gas temperature in an HMIWI  
32 secondary chamber is greater than the outlet temperatures  
33 noted above. Therefore, secondary chamber average gas  
34 temperatures for HMIWIs are expected to be 1000 °C or  
35 greater with a gas residence time of 2 seconds.

36  
37 In summary, typical operating conditions for the secondary  
38 chamber of operating HMIWIs in the U.S. are 1000 °C average  
39 temperature across 2 second residence time with exit gas  
40 concentrations of 13% O<sub>2</sub> (dry basis) and >10% moisture.

#### 41 42 **D.4.3 Pollution Control Equipment**

43  
44 Over 99% of large MWC capacity operates with a spray dryer  
45 absorber/scrubber. (IWSA 2003) Approximately 80% of large  
46 MWC capacity operates using carbon injection as part of the  
47 pollution control system. (IWSA 2003) Due to requirements

1 in the NSPS (EPA 2000b) and EG (EPA 200c) for small MWCs,  
2 small MWCs planning continued operation are generally  
3 upgrading or have upgraded their pollution control  
4 equipment to add spray dryer absorbers or other acid gas  
5 control and carbon injection.

6  
7 Review of EPA's HMIWI inventory (EPA 2003) indicates that  
8 essentially all HMIWIs have some form of wet or dry  
9 scrubbing for acid gas control.

10

#### 11 **D.4.4 Summary**

12

13 Approximately 30 million tons per year of municipal solid  
14 waste was combusted in the United States annually in waste-  
15 to-energy municipal waste combustors in 2003.

16 Approximately 0.3 million tons per year of segregated  
17 medical waste was combusted annually in the United States  
18 in hospital/medical/infectious waste incinerators in 2003.  
19 Considering the relative amounts of waste combusted  
20 annually, typical operating conditions for waste  
21 incineration in the U.S. across these two classes of units  
22 are as follows:

23

Average Temperature	>1000 °C
Residence Time	≥2 sec
O <sub>2</sub> concentration in exhaust gas	10% (dry basis)
H <sub>2</sub> O concentration in exhaust gas	15%

24

25 EPA emission regulations currently in place or in place by  
26 2005 require that operating municipal waste combustors and  
27 hospital/medical/infectious waste incinerators have or will  
28 have air pollution control equipment such as wet or dry  
29 scrubbing for acid gas control.

30

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1 **APPENDIX E.1**2 **OUTLINE FOR INTERIM PROGRESS REPORTING**

3

4

5 Title: Enforceable Consent Agreement for the Laboratory-  
6 Scale Incineration Testing of Fluorotelomer Based  
7 Polymers - Interim Report

8

9 OPPT Docket ID No: OPPT-2004-0001

10

11 Date of Interim Report: [ date ]

12

13

14

15 This Report covers the period from [date] to [date]

16

17

18 1) List or description of significant ECA Test Program  
19 milestones during this period:

20

21

22

23

24

25 2) Description of Difficulties: (If none indicate N/A)

26

27

28

29

30

31

32

33 3) Actions taken in response to difficulties: If none  
34 indicate N/A)

35

36

37

38

39

40

41 4) Other information relevant to the progress of the  
42 testing program: (If none indicate N/A)

43

1 **APPENDIX E.1 (continued)**  
2 **OUTLINE FOR INTERIM PROGRESS REPORTING**

3  
4  
5 Title: Enforceable Consent Agreement for the Laboratory-  
6 Scale Incineration Testing of Fluoropolymers -  
7 Interim Report

8  
9 OPPT Docket ID No: OPPT-2003-0071

10  
11 Date of Interim Report: [ date ]

12  
13  
14  
15 This Report covers the period from [date] to [date]

16  
17  
18 1) List or description of significant ECA Test Program  
19 milestones during this period:

20  
21  
22  
23  
24  
25 2) Description of Difficulties: (If none indicate N/A)

26  
27  
28  
29  
30  
31  
32  
33 3) Actions taken in response to difficulties: If none  
34 indicate N/A)

35  
36  
37  
38  
39  
40  
41 4) Other information relevant to the progress of the  
42 testing program: (If none indicate N/A)



**APPENDIX E.2****OUTLINE FOR RELEASE ASSESSMENT REPORT**

As described in Appendix C.2.5.5 of this ECA, if PFOA is reported for the exhaust gas bubbler aqueous solution at a concentration at or above the LOQ (as defined in Appendix D.2) for two or more of the three runs for a given test substance composite, then the potential for release from full-scale municipal and/or medical waste incineration, as applicable, (including application of air pollution controls) of products represented by the test substance composite in the United States will be assessed to put the data into perspective. At a minimum, the report will follow the general outline described below and will state assumptions, document the basis for the assumptions made, quantitatively estimate the variability of calculated estimates (based on the variability of the parameters in the evaluation), and qualitatively discuss the uncertainty of calculated estimates.

**1.0 Introduction**

- Statement of objective for combustion testing of test substance composites.
- Applicability of the laboratory-scale combustion testing to full-scale municipal waste combustors (MWCs) and/or medical waste incinerators (as applicable) in the United States.

**2.0 Summary of study results**

- A listing of exhaust gas analytical results reported for each applicable test substance composite.
- A listing of test substance composite analytical results reported for each applicable test substance composite.

**3.0 Discussion**

- Description of the combustion section of the applicable waste incineration process(es) being evaluated (MWC and/or medical waste incinerator) including the rationale for selecting test target temperature(s) and description of typical

1 operational parameters. Cross-reference to or  
2 submission of relevant parts of Appendix D.4 of this  
3 ECA can satisfy this provision.  
4

- 5 • Description of the post-combustion air pollution  
6 control equipment (e.g., lime scrubbing, carbon  
7 adsorption) employed by typical operating full-scale  
8 waste incineration process(es) as applicable.  
9

10 **4.0 Extrapolation of laboratory test results to the**  
11 **typical waste incineration process(es), as applicable,**  
12 **described in Section 3.0 (above) for each test**  
13 **substance composite to be evaluated.**  
14

- 15 • The relevance of the subject test substance  
16 composite to MWCs and/or medical waste incinerators.  
17
- 18 • The estimated concentration of the subject test  
19 substance composite to the applicable type(s) of  
20 waste incinerator. Available information on  
21 hydrogen fluoride concentration in waste incinerator  
22 exhaust can provide the basis for an upper bound on  
23 this estimated concentration.  
24
- 25 • A description of the extrapolation.  
26
- 27 • A description of any assumptions used.  
28
- 29 • Any unique qualitative or quantitative descriptors  
30 of the test, the testing equipment, and the results  
31 deemed necessary for informative review of the test  
32 and test results.  
33

34 **5.0 Sensitivity Analysis**  
35

- 36 • Assessment of the impact of variability  
37 (quantitative) and uncertainty (qualitative) in each  
38 parameter on the evaluation results.  
39

40 **6.0 Conclusions**  
41

42 **7.0 References**

1 **APPENDIX E.3**  
2 **OUTLINE OF TEST REPORT\***

3  
4  
5 I. Phase I PFOA Transport Testing

- 6  
7 1. Experimental Apparatus  
8 2. Description of Test Conditions  
9 3. Documentation of PFOA Standard  
10 4. Analytical Results  
11 3.1 PFOA  
12 3.2 Total Fluorine  
13 5. Transport Efficiency  
14 4.1 PFOA  
15 4.2 Total Fluorine  
16 6. Discussion of Results  
17 7. Conclusions  
18

19  
20 II. Phase II Incineration Testing

- 21  
22 1. Elemental Analysis Results  
23 2. Combustion Stoichiometry Results  
24 3. TGA Results  
25 4. Combustion Testing  
26 4.1 Experimental Apparatus  
27 4.2 Description of Test Conditions  
28 4.3 Combustion Testing Results  
29 4.3.1 Process Monitoring  
30 4.3.2 Exhaust Gas Monitoring  
31 4.3.2 Exhaust Gas Sampling and Analysis  
32 4.3.2.1 PFOA  
33 4.3.2.2 Fluoride  
34 4.4 Discussion of Results  
35 4.5 Conclusions  
36

37  
38 III. Quality Assurance Report  
39  
40  
41  
42  
43  
44  
45

46 \* Test Report will include this information (as applicable) but  
47 not necessarily in this format

1 **APPENDIX F**  
 2 **ECA INCINERATION TESTING QUALITY ASSURANCE PROJECT PLAN (QAPP):**  
 3 **REQUIRED CONTENT**  
 4

EPA QA/R-5 QAPP Guidance Element	Required Content of QAPP(s) for ECA Incineration Testing
<b>A: PROJECT MANAGEMENT</b>	
A1 Title and Approval Sheet	to be included in QAPP
A2 Table of Contents	to be included in QAPP
A3 Distribution List	to be included in QAPP
A4 Project/Task Organization	to be included in QAPP
A5 Problem Definition/ Background	to be satisfied by cross-reference to ECA (Parts I, IV) and Appendix A, C.1, or C.2, as applicable
A6 Project/Task Description	see element A5
A7 Quality Objectives and Criteria	to be satisfied by cross-reference to Appendix A, C.1, or C.2 (as applicable) and to Appendix D.2 and/or D.3, as applicable
A8 Special Training/ Certifications	for facilities subject to GLP (40 CFR Part 792) under this ECA, QAPP shall state that this element is satisfied by compliance with applicable GLP requirements; for compositing facilities, to be to be satisfied by providing a statement of the qualifications for each such facility
A9 Documentation and Records	to be satisfied by cross-reference to ECA Part XIV and Appendix E
<b>B: DATA GENERATION AND ACQUISITION</b>	
B1 Sampling Process Design (Experimental Design)	see element A5
B2 Sampling Methods	to be satisfied by cross-reference to Appendix C.1 or C.2 (as applicable) and to Appendix D.1
B3 Sample Handling and Custody	to be included in QAPP consistent with Appendix A
B4 Analytical Methods	to be satisfied by cross-

	reference to analytical method descriptions in Appendices C.2, D.2, and D.3, as applicable
B5 Quality Control	to be satisfied by cross-reference to QC provisions (e.g., blanks) in Appendices A, C.1, C.2, D.2, and D.3, as applicable
B6 Instrument/Equipment Testing, Inspection, and Maintenance	to be included in QAPP in summary form for chemical analysis equipment for the analytical methods for element B4 above
B7 Instrument/Equipment Calibration and Frequency	to be included in QAPP in summary form for chemical analysis equipment for the analytical methods for element B4 above
B8 Inspection/Acceptance of Supplies and Consumables	for facilities subject to GLP (40 CFR Part 792) under this ECA, QAPP shall state that this element is satisfied by compliance with applicable GLP requirements; not applicable to other facilities
B9 Non-direct Measurements	to be satisfied by cross-reference to Appendix C.2.2
B10 Data Management	for facilities subject to GLP (40 CFR Part 792) under this ECA, QAPP shall state that this element is satisfied by compliance with applicable GLP requirements; for compositing facilities, to be to be satisfied by cross-reference to Appendix A.4
<b>C: ASSESSMENT AND OVERSIGHT</b>	
C1 Assessments and Response Actions	for facilities subject to GLP (40 CFR Part 792) under this ECA, QAPP shall state that this element is satisfied by compliance

	with applicable GLP requirements; for other facilities, to be included in QAPP
C2 Reports to Management	for facilities subject to GLP (40 CFR Part 792) under this ECA, QAPP shall state that this element is satisfied by compliance with applicable GLP requirements; for other facilities, to be included in QAPP
D: DATA VALIDATION AND USABILITY	
D1 Data Review, Verification, and Validation	to be satisfied by cross-reference to Appendix A, C.1, or C.2 (as applicable) and to Appendix D.2 and/or D.3, as applicable
D2 Verification and Validation Methods	for facilities subject to GLP (40 CFR Part 792) under this ECA, QAPP shall state that this element is satisfied by compliance with applicable GLP requirements; for other facilities, to be included in QAPP consistent with Appendices A, C.1, C.2, D.2, D.3 as applicable
D3 Reconciliation with User Requirements	to be satisfied by cross-reference to Appendices C.2.5.5 and E.2, as applicable

1

1 **APPENDIX G**  
2 **COPY OF EPA ORDER**

3  
4  
5 **UNITED STATES**  
6 **ENVIRONMENTAL PROTECTION AGENCY**

7  
8 **TESTING CONSENT ORDER FOR THE LABORATORY-SCALE INCINERATION**  
9 **TESTING OF FLUOROTELOMER BASED POLYMERS**

10  
11 **Docket No. OPPT-2004-0001**  
12

13  
14 Under the authority of section 4 of the Toxic Substances  
15 Control Act (TSCA), 15 U.S.C. 2603, the United States  
16 Environmental Protection Agency (EPA) issues this testing  
17 consent order (Order) to take effect on the date of publication  
18 of the notice in the Federal Register announcing the issuance of  
19 this Order. This Order incorporates the enforceable consent  
20 agreement (ECA) for the laboratory-scale incineration testing of  
21 fluorotelomer based polymer test substance composites listed in  
22 Appendix A of the ECA.  
23

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27  
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30  
31 \_\_\_\_\_  
Date

32 \_\_\_\_\_  
Stephen L. Johnson,  
33 Assistant Administrator  
34 For Prevention, Pesticides,  
35 And Toxic Substances

1 **APPENDIX G (continued)**  
2 **COPY OF EPA ORDER**

3  
4  
5 **UNITED STATES**  
6 **ENVIRONMENTAL PROTECTION AGENCY**

7  
8 **TESTING CONSENT ORDER FOR THE LABORATORY-SCALE INCINERATION**  
9 **TESTING OF FLUOROPOLYMERS**

10  
11 Docket No. OPPT-2003-0071  
12  
13

14 Under the authority of section 4 of the Toxic Substances  
15 Control Act (TSCA), 15 U.S.C. 2603, the United States  
16 Environmental Protection Agency (EPA) issues this testing  
17 consent order (Order) to take effect on the date of publication  
18 of the notice in the Federal Register announcing the issuance of  
19 this Order. This Order incorporates the enforceable consent  
20 agreement (ECA) for the laboratory-scale incineration testing of  
21 fluoropolymer test substance composites listed in Appendix A of  
22 the ECA.  
23  
24  
25  
26  
27  
28  
29  
30

31 \_\_\_\_\_  
Date

32 \_\_\_\_\_  
Stephen L. Johnson,  
33 Assistant Administrator  
For Prevention, Pesticides,  
34 And Toxic Substances



1 **APPENDIX A.2**2 **RATIONALE FOR SELECTING COMPOSITES TO BE TESTED**3  
4 A.2.1 Summary

5  
6 The two test substance composites described in Appendix A.1  
7 were selected because the polymeric constituents in  
8 telomer-based polymeric products (TBPPs) applied to paper  
9 and textiles are expected to be present in the feedstreams  
10 to municipal waste combustors and/or medical waste  
11 incinerators.

12  
13 A.2.2 Background

14  
15 The three major product applications for TBPPs are paper,  
16 textiles, and carpet. Based on publicly available  
17 information, paper and textiles treated with TBPPs are  
18 expected to be present in municipal and/or medical waste  
19 incinerated in the U.S., and carpet is not expected to be  
20 present in significant quantities in waste incinerated in  
21 the U.S.

22  
23 As noted in Table 3 of *Municipal Solid Waste in the United*  
24 *States: 2000 Facts and Figures* (EPA 2002), paper and  
25 textiles collectively make up over 30% of materials  
26 discarded into the municipal waste stream destined for  
27 landfill or combustion. In addition, some medical textiles  
28 are treated with TBPPs, and these medical textiles are  
29 expected to be present in the feedstreams to medical waste  
30 incinerators.

31  
32 The January 2002 Memorandum of Understanding for Carpet  
33 Stewardship between the Carpet Industry, the States, and  
34 EPA indicates very little carpet going to waste-to-energy  
35 municipal combustion facilities in 2002.

36 ([www.carpetrecovery.org/about/mou.asp](http://www.carpetrecovery.org/about/mou.asp)) Data from the  
37 Carpet and Rug Institute (in the summary of negotiated  
38 outcomes for discarded carpet in the appendix to this  
39 Memorandum of Understanding) indicates that the percentage  
40 of carpet being fed to waste-to-energy municipal combustion  
41 facilities will reach 1% of total carpet discards by 2012.  
42 This projected 2012 amount corresponds to approximately  
43 0.1% of the total U.S. municipal waste combustion capacity  
44 noted in Appendix D.4.

45  
46 Based on the very small relative contribution of carpet to  
47 the municipal waste stream destined for municipal waste

1 combustion, measurable levels of polymeric constituents in  
2 telomer-based products applied to carpet are not expected  
3 to be present in the feedstreams to municipal waste  
4 combustors in the U.S.