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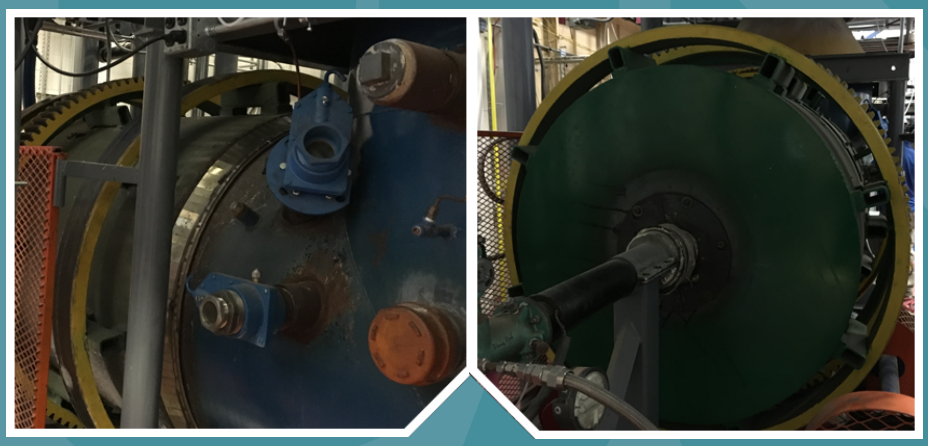
The Use of Combustion Process Modification to Capture Cesium from Combustion of Contaminated Biomass



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The Use of Combustion Process Modification to Capture Cesium from Combustion of Contaminated Biomass

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Disclaimer

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Acronyms and Abbreviations

°C	Degrees Celsius
°F	Degrees Fahrenheit
µm	Micrometer(s)
Al	Aluminum
Ba	Barium
Br	Bromine
Btu	British thermal unit(s)
C	Carbon
Ca	Calcium
CEM	Continuous Emission Monitor
Cl	Chlorine
cm	Centimeter(s)
CMAD	EPA CBRN Consequence Management Advisory Division
Cs	Cesium
CsCl	Cesium chloride
D	Diameter
DAS	Data acquisition system
EPA	United States Environmental Protection Agency
ESP	Electrostatic Precipitator
Fe	Iron
FGCS	Flue gas cleaning system
g	Gram(s)
GE	General Electric
GLI	Galbraith Laboratories, Inc.
h	Hour(s)

H	Hydrogen
ICP-MS	Inductively Coupled Plasma – Mass Spectrometry
IFRF	International Flame Research Foundation
JTI	Jacobs Technology, Inc.
K	Potassium
kg	Kilogram(s)
kW	Kilowatt(s)
L	Length
L	Liter(s)
LPM	Liters per minute
lb	Pound(s)
m	Meter(s)
mg	Milligram(s)
Mg	Magnesium
min	Minute(s)
Mn	Manganese
MOUDI	Micro-Orifice Uniform Deposit Impactor
Na	Sodium
ng	Nanogram(s)
nm	Nanometer(s)
NHSRC	EPA National Homeland Security Research Center
NRMRL	EPA National Risk Management Research Laboratory
O	Oxygen
OEM	EPA Office of Emergency Management
OLEM	EPA Office of Land and Emergency Management
ORD	EPA Office of Research and Development
P	Phosphorus

PM	Particulate matter
ppm	Part(s) per million
PSD	Particle size distribution
QA	Quality Assurance
QC	Quality Control
RDD	Radiological Dispersal Device
RKIS	Rotary Kiln Incinerator Simulator
S	Sulfur
SCC	Secondary Combustion Chamber
scfm	Standard cubic feet per minute
Si	Silicon
Sr	Strontium
XRF	X-Ray Fluorescence
Zn	Zinc

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Executive Summary

In the aftermath of a wide-area radiological contamination incident in an urban setting, there is the potential for the generation of significant quantities of contaminated biomass waste. For example, the 2011 nuclear power plant accident at the Fukushima Daiichi plant in Japan resulted in an estimated 7.8 million cubic meters of combustible waste, most of which was biomass (Osako, 2015). These wastes are likely candidates for incineration as a means of volume reduction, due to the costs associated with disposal of low-level radioactive waste. Cesium (Cs), an alkali metal element, is a radionuclide that might possibly be used in a radiological dispersal device or may be the predominant long-term radionuclide contaminant from a nuclear power plant accident. Cs presents problematic behavior in combustion systems due to its volatility and solubility in water. Many wastes and fossil fuels contain trace metallic constituents. Although high-temperature combustion or incineration systems cannot destroy the elemental metal constituents, these environments may induce metal transformations. These transformations may exacerbate difficulties in controlling the radionuclides of interest because many of the metal species, including Cs, vaporize readily within the combustion environments. This saturated vapor will subsequently nucleate and condense downstream of the flame, forming a fume of submicron (i.e., aerodynamic diameter < 1 micrometer [µm]) aerosol with a mean volume aerodynamic diameter between 100 and 200 nanometers (nm). These condensed particles, because of their small size, are difficult to collect in pollution control systems, particularly those using an electrostatic precipitator. Emissions of particulate-bound radioactive isotopes such as ^{137}Cs from combustion systems are highly undesirable (Parajuli et al., 2013). Chlorinated metal species that are collected often exhibit increased volatility (Yang et al., 2002). Moreover, chlorinated and sulfated metals may exhibit increased water solubility and subsequent leachability with disposal in landfill environments.

The objective of this research was to:

- Examine the behavior and transformations of biomass-bound Cs in an incinerator environment; and
- Determine whether combustion modifications, including sorbent injection into the post-combustion zone of practical incinerators and combustors, could be used to convert biomass-bound Cs into easily collected forms.

1.0 Introduction

In the aftermath of a wide-area radiological contamination incident in an urban setting, there is the potential for the generation of significant quantities of contaminated biomass waste. For example, the 2011 nuclear power plant accident at the Fukushima Daiichi plant in Japan resulted in an estimated 7.8 million cubic meters of combustible waste, most of which was biomass (Osako, 2015). These wastes are likely candidates for incineration as a means of volume reduction, due to the costs associated with disposal of low-level radioactive waste. Cesium (Cs), an alkali metal element, is a radionuclide that might possibly be used in a radiological dispersal device (RDD) or may be the predominant long-term radionuclide contaminant from a nuclear power plant accident, and Cs presents problematic behavior in combustion systems due to its volatility and solubility in water. Many wastes and fossil fuels contain trace metallic constituents. Although high-temperature combustion or incineration systems cannot destroy the elemental metal constituents, these environments may induce metal transformations. These transformations may exacerbate difficulties in controlling the radionuclides of interest because many of the metal species, including Cs, vaporize readily within the combustion environments. This saturated vapor will subsequently nucleate and condense downstream of the flame, forming a fume of submicron (i.e., aerodynamic diameter < 1 micrometer [µm]) aerosol with a mean volume aerodynamic diameter between 100 and 200 nanometers (nm). These condensed particles, because of their small size, are difficult to collect in pollution control systems, particularly those using an electrostatic precipitator (ESP). Emissions of particulate-bound radioactive isotopes such as ^{137}Cs from combustion systems are highly undesirable (Parajuli et al., 2013). Chlorinated metal species that are collected often exhibit increased volatility (Yang et al., 2002). Moreover, chlorinated and sulfated metals may exhibit increased water solubility and subsequent leachability after disposal in landfill environments.

Past work examining the behavior of Cs in natural gas-fired combustion systems has shown that Cs could be reactively scavenged onto dispersed kaolinite powders (Yoo et al., 2005). By adsorbing Cs onto larger (2-10 µm) kaolinite sorbent particles, the Cs can be captured much more effectively by conventional particulate control devices such as ESPs or fabric filters, which are very effective at capturing particulate matter (PM) with sizes greater than 1 µm. Further, Cs chemisorbed onto kaolinite may well resist leaching in landfill environments. This initial work found that there was an optimal temperature between 1400 and 1500 kelvins (K) where maximum sorption (approaching 80%) on the kaolinite occurs. The presence of chlorine (Cl) was found to inhibit Cs sorption.

Subsequent work showed that this mechanism was still valid in a combustion environment using biomass as the fuel (Lemieux et al., 2013). In these tests, corncob flour was used as 50% of the fuel load in the same pilot-scale combustor used in previous studies (Yoo et al., 2005), operating under the same conditions using a similar kaolinite sorbent material. Approximately 65% of the Cs was captured onto the sorbent particles in spite of the elevated chlorine (Cl), sodium (Na) and potassium (K) present in a biomass combustion environment (Jenkins et al., 1998). Na and K, as alkali metals, behave similarly to Cs and could potentially compete with Cs for active sites on the sorbent particles. In addition, cesium chloride (CsCl) is a common Cs species that could be used in an RDD (Musolino et al., 2011; Nuclear Regulatory Commission, 2010; U.S. Department of Homeland Security, 2007), and some biomass may contain varying levels of Cl (Jenkins et al., 1998), which may inhibit sorption of Cs onto the sorbent particles.

The objective of this research was to:

- Examine the behavior and transformations of biomass-bound Cs in an incinerator environment; and
- Determine whether combustion modifications, including sorbent injection into the post-combustion zone of practical incinerators and combustors, could be used to convert biomass-bound Cs into easily collected forms.

Pertinent mechanisms were inferred by:

- Examining metal aerosol properties (particle size distribution [PSD] and chemistry) as a function of fuel/waste composition and incinerator operating parameters;
- Determining how sorbent injection modifies the submicron size distribution of the metal aerosol in the exhaust; and
- Interpreting detailed morphological and chemical analyses of size-segregated particulate matter extracted from the exhaust.

The successful demonstration of the Cs capture in a biomass combustion environment led to the question of whether this degree of success would be maintained when other biomass types were being burned due to the variation in the amounts of different alkali metals and chlorine. Due to the prevalence of pine as a common type of tree found in many urban areas, a similar set of tests was performed in a combustion system that used finely ground pine wood (pine flour) as the biomass fuel. After those experiments, another set of experiments was performed using pelletized hardwood biomass in a pilot-scale rotary kiln incinerator simulator (RKIS) system. This report presents those results.

2.0 Experimental

The experiments were performed in two distinct series:

- Experiments on a down-fired vertical tunnel combustor burning a mixture of natural gas and powderized biomass while injecting kaolinite sorbent near the combustor exit;
    - with powderized corncob as the biomass;
    - with powderized pine as the biomass; and
- Experiments on a rotary kiln incinerator simulator (RKIS) burning a mixture of natural gas and pelletized oak biomass while injecting kaolinite sorbent in the secondary combustion chamber.

2.1 Powderized Biomass Tests in Down-Fired Vertical Tunnel Combustor

2.1.1 Combustor Description

The first set of experiments was performed using a vertical-fired refractory-lined laboratory-scale furnace, located at EPA's research facility in Research Triangle Park, NC. This experimental system was used previously (Yoo et al., 2005) (see Figure 1). Normally, this furnace operates solely on a natural gas flame. The natural gas fuel was supplemented with very finely ground biomass to utilize the same combustion system and combustion conditions similar to the conditions that successfully demonstrated sorbent injection to control Cs from a natural gas combustion system. The furnace is currently configured with the following components, which are described below:

- Combustion chamber;
- Flame safety interlock system;
- Natural gas supply system;
- Biomass supply system;
- Sorbent injection system; and
- Data acquisition system.

The furnace is an 82 kilowatt (kW) (280,000 British thermal units/hour [Btu/h]) rated vertically-fired combustor equipped with an International Flame Research Foundation (IFRF)-type variable-air swirl burner and is discussed elsewhere (Linak et al., 2004; Linak et al., 1994). The furnace is designed to simulate the time and temperature characteristics of a variety of incineration devices. The primary use of the furnace is to examine hazardous air pollutants like those produced in boilers and waste incinerators. The vertical part of the furnace spans 457 centimeters (cm) (15 feet) and consists of a burner section with a 52 cm (20.5-inch) inside diameter that simulates the near-burner zone aerodynamics of a variety of natural gas and fuel oil flames, and a 26.7 cm (10.5-inch) inside diameter section that extends 305 cm (10 feet). The furnace then turns into a 26.7 cm (10.5-inch) inside diameter horizontal duct to allow for additional sampling locations. The furnace is refractory-lined and has evenly spaced sampling ports that span the full length of the furnace to facilitate gas and aerosol sampling as well as temperature measurements. The exhaust exits the furnace vertically with additional sampling ports located along the insulated 21 cm (8.25-inch) diameter stainless steel duct.

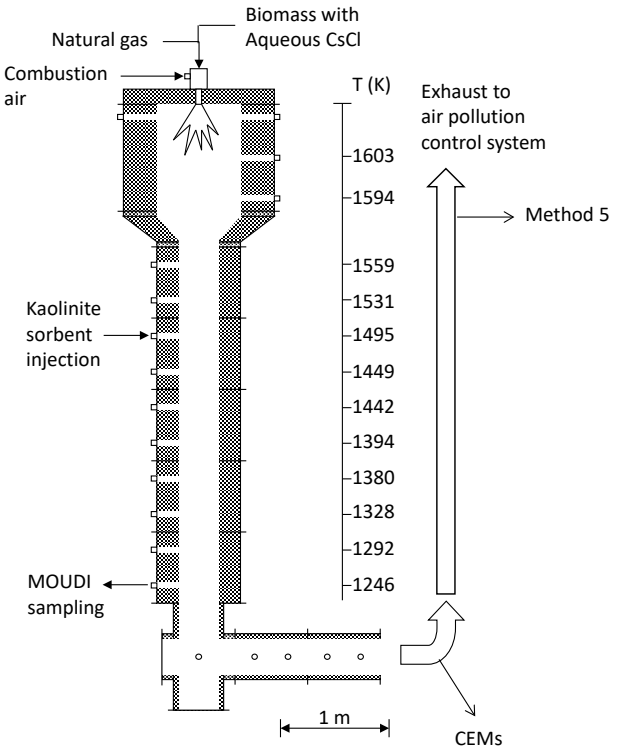

Figure 1. Vertical-Fired Refractory-Lined Laboratory-Scale Furnace

2.1.2 Biomass Description

The furnace was designed to operate on natural gas and liquid fuels but was modified for powdered biomass. Normally, a biomass-fired combustor would burn biomass that had undergone only moderate size reduction. However, since the combustor used for these experiments normally operated on natural gas only, the experiments required the biomass to be very finely ground to minimize the need for major equipment retrofits. For these experiments, approximately 50% of the fuel load (by heating value) was natural gas and 50% of the fuel load was powdered biomass material. The biomass used for the initial set of tests was corncob flour (Mt. Pulaski #100; The Andersons, Inc., Maumee, OH, predominantly < 150 µm in particle diameter), and the biomass used for the second set of tests was pine flour (#70 Pine Wood Flour; Composition Materials Company, Milford, CT, predominantly < 212 µm in particle diameter). The pine flour was evaluated for feedability and combustibility by Galbraith Laboratories (GLI) (Knoxville, TN) and the presence of potentially confounding elements (e.g., Na, K) (Jenkins et al., 1998) via X-ray fluorescence (XRF) in the EPA's X-Ray Laboratory in Research Triangle Park, NC, prior to initiation of the tests. Table 1 lists the properties of the corncob and pine flour used in the experiments. Of particular note is the lower amount of Cl and K in the softwood flour. The material was co-fired into the IFRF burner using a screw-type feeder with a loss-in-mass controller (see Figure 2) (K-Tron Model # KT926; Pitman, NJ) with a nominal feed rate of 4.5 kilograms/hour (kg/h) (10 pounds/hour [lb/h]). The powderized biomass was fed through a custom injection nozzle fabricated from two concentric tubes and installed in the center of the burner. Biomass, transported by air, was blown through the center tube with natural gas supplied through the annulus between the inner and outer tubes.

Table 1. Properties of Biomass Flour Used in Tests (as received)

WD-XRF Analysis	Pine Flour	#100 Corncob Flour
Cellulose	99.815%	98.436%
Hydrogen (H)	6.205%	6.119%
Carbon (C)	44.364%	43.751%
Oxygen (O)	49.246%	48.566%
Sodium (Na)	ND	ND
Magnesium (Mg)	0.017%	0.036%
Aluminum (Al)	ND	0.008%
Silicon (Si)	0.005%	0.101%
Phosphorus (P)	0.001%	0.047%
Sulfur (S)	0.005%	0.030%
Chlorine (Cl)	0.036%	0.363%
Potassium (K)	0.032%	0.950%
Calcium (Ca)	0.077%	0.021%
Iron (Fe)	ND	0.005%
Manganese (Mn)	0.007%	ND
Zinc (Zn)	0.001%	0.001%
Bromine (Br)	ND	0.001%
Strontium (Sr)	0.001%	ND
Barium (Ba)	ND	ND

ND – Not Detected

Figure 2. Biomass Feed System

2.1.3 Sorbent Description

Previous testing (Yoo et al., 2005) used kaolinite sorbent, and the kaolinite was effective at capturing Cs in a solely natural gas-fired system. Kaolinite is also widely available and inexpensive, averaging approximately $160/ton (Statistica.com, 2017). Kaolinite powder (Burgess No. 40; Burgess Pigment, Sandersville, GA; see Table 2) was injected into a port of the furnace using a K-Tron Model KCLKT20 Twin Screw Compact Loss-In-Weight Feeder (Pitman, NJ) with a 12-liter (L) (3.2-gallon) hopper (Figure 3). Sorbent was metered from the hopper by

the rotation of the screws for a given set point. The feeder was equipped with a horizontal agitator and a vertical discharge with a flexible discharge boot. The sorbent metered from the screws entered a conical section where compressed air transported the powdered sorbent through a water-cooled probe into the furnace approximately two meters (m) downstream of the flame.

Table 2. Properties of Kaolinite Powder Sorbent

Typical Physical Properties		**Typical Chemical Properties**	
GE Brightness	85.0 %	Loss on Ignition	13.7-14.1 %
325 Mesh Residue	0.15 %	Silica (SiO_2)	44.8 – 45.3 %
Average Particle Diameter (SediGraph)	**1.3 µm**	Alumina (Al_2O_3)	37.5 – 39.7 %
Free Moisture	1.0 %	Iron Oxide (Fe_2O_3)	Trace
Specific Gravity	2.63	Titanium Dioxide (TiO_2)	1.35 – 2.27 %
Refractive Index	1.56		
pH (20% Solids)	5.3		

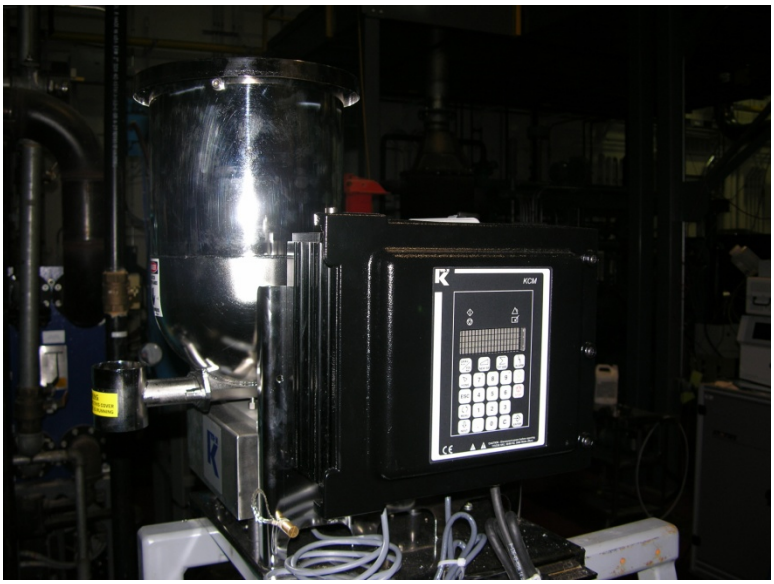

Figure 3. Sorbent Injection System

2.1.4 Instrumentation

The furnace was equipped with instrumentation to monitor combustor operating conditions. Temperature was measured at several locations inside the furnace using ceramic-shielded Type R thermocouples (for detailed temperature profile measurements) or unshielded Type K thermocouples (for routine monitoring of operating conditions). Continuous emission monitors (CEMs) recorded O_2, CO_2 (U.S. EPA, 1989), CO (U.S. EPA, 1996b), and NO_x (U.S. EPA, 1990) levels in the transition duct between the furnace and the facility's Flue Gas Cleaning System (FGCS). Air and gas mass flow meters measured combustion air and natural gas flow rates.

Temperature, air and gas flow rates, and CEM measurements were recorded by the furnace's data acquisition system (DAS). The DAS was comprised of Measurement Computing's (Norton, MA) Personal Daq hardware interfaced with a desktop PC running Measurement Computing's Personal DaqView software. Analog voltage signals from the air and gas mass flow meters, thermocouples, and CEM monitors were digitized by the DAS, displayed to the desktop monitor in real time, and recorded in text format, which was later read into an MS

Excel spreadsheet for post-processing and data analysis.

2.1.5 Experimental Approach

During the tests, the firing rate was determined by the combination of natural gas and biomass feed and was set for a nominal firing rate of 51.1 kW (175,000 Btu/h). For all tests, the furnace was operated with a nominal 20% excess air and a stack O_2 target of 3.5%. The test matrix and samples that were acquired are shown in Table 3.

Table 3. Test Matrix and Samples to be Acquired

Test Condition	Natural Gas	Biomass Feed	Cs Doping	Sorbent Feeding	Gas Species Concentrations	Particle Analysis
1	On	Off*	Off	Off	CEMs	NA
2	On	On	Off	Off	CEMs	MOUDI
3	On	On	On	Off	CEMs	MOUDI
4	On	On	On	On	CEMs	MOUDI

NA – not applicable
* -- natural gas was increased to maintain 51.1 kW firing rate
MOUDI - Micro-Orifice Uniform Deposit Impactor

The effect of sorbent injection on the behavior and transformation of Cs-bound biomass waste was determined by doping the biomass with aqueous cesium chloride prior to feeding the biomass into the furnace operating at a constant load of approximately 51.1 kW (175,000 Btu/h), with a feed rate of corncob flour of 4.4 kg/h (10 lb/h). The natural gas and combustion air feed rates were adjusted to maintain the desired level of excess air and the desired temperature profile. Figure 1 shows the temperature profile of the furnace for these tests.

2.1.6 Doped Biomass and Sorbent Preparation

The concentration of the Cs that was artificially placed onto the biomass was initially based on evaluation of instrument detection limits of XRF and Cs deposition on different impactor stages and sampling times used in the previous work (Yoo et al., 2005). This analysis suggested a minimum Cs target concentration in the combustion gas effluent of 844 ng/L. The biomass was prepared by spraying a small amount of an aqueous solution of CsCl onto the material while it was being agitated in a portable cement mixer. Based on the desired Cs concentration in the flue gases, the target concentration of Cs in the biomass was 55.6 mg Cs per kg of biomass flour (55.6 ppm). The doped biomass flour was prepared by mixing 641 mg of CsCl with 1 L of deionized water and pouring 0.5 L of this solution into 0.45 kg (1 lb) of biomass flour, then adding that mixture to the remaining portion of a 4.5 kg (10 lb) bucket of biomass flour and mixing thoroughly using a cement mixer. The concentration of stable ^{133}Cs used in this study may be significantly higher (perhaps by orders of magnitude) than the contamination level expected in an actual RDD incident. However, the chemical properties of ^{133}Cs are identical to the chemical properties of radioactive $^{134/137}Cs$. Hence, the results from using ^{133}Cs are sufficient to assess the concept of using kaolinite powders as Cs sorbents during biomass incineration. The higher concentrations are necessary to overcome detection limitations associated with using the less sensitive XRF method as opposed to using highly sensitive gamma detectors that could be used to detect radioactive Cs isotopes.

The primary variables of interest were: 1) the molar ratio of kaolinite in the sorbent to the Cs in the biomass; 2) the molar ratio of Cs in the biomass to the other alkali metals and trace constituents (i.e., Na, K, Cl) in the biomass; and 3) the concentration of Cs in the biomass. The sorbent injection temperature was set at the optimal temperature for Cs capture as observed in previous testing on the furnace with Cs (Yoo et al., 2005).

For these initial tests, high kaolinite feed rates exceeding the levels of K in the corncob flour were chosen. To accomplish this high feed rate, 50 g/min of kaolinite was injected into the furnace, which represented a 10:1

molar ratio of kaolinite to K. The large excess of K relative to Cs resulted in a molar ratio of kaolinite to cesium of approximately 6700:1.

2.1.7 Sampling and Analytical Procedures

Metal speciation was determined by XRF analysis of size-segregated PM extracted from the exhaust. Size-segregated samples were taken using a Micro-Orifice Uniform Deposit Impactor (MOUDI) (MSP Corporation, Shoreview, MN)(Applied Physics, 2013). The MOUDI is a cascade impactor designed for high concentration aerosols and provides very sharp cut points, very low bounce response, digital on/off timer controls, and flow meters. Triplicate MOUDI samples were collected for each experimental condition except when otherwise noted.

The furnace is equipped with several sampling ports located along the axis of the combustor for emissions sampling (see Figure 1). All sampling locations are sufficient in length and free of flow disturbances so that PM can be sampled. There was approximately 2 m of distance between the injection port and the sampling port, representing approximately 1.3 seconds (s) of residence time. The flue gas velocity was measured with a pitot tube and a micromanometer (U.S. EPA, 1996a). This flue gas velocity value was used to determine the sample flows required to maintain isokinetic conditions at the end of the probe.

The MOUDI samples were acquired from the main duct using an air-cooled stainless-steel dilution probe. Nitrogen dilution of the sample using a dilution probe was performed to quench aerosol growth and prevent water condensation. The dilution flow was controlled by a mass flow controller, and the total sample flow was measured with a dry gas meter and an orifice plate. The mass flow controller was calibrated by the EPA Metrology Laboratory with a Gilibrator bubble flow meter (Sensidyne, St. Petersburg, FL), and the dry gas meter was calibrated with a wet test meter. All tubing from the probe to the impactor was of minimal length and constructed of conductive silicon tubing to minimize particle loss due to electrostatic deposition.

The MOUDI Model 110 is a 10-stage, 30 L/min (1.06 standard cubic feet per minute [scfm]) inertial cascade impactor capable of measuring PSDs between 0.056 and 10 µm. The impactor is housed inside a cabinet that continuously rotates the impactor nozzle plates relative to the impaction surfaces. The nozzles are staggered in a pattern that produces a uniform layer of particulate when rotated. The uniform deposition allows more particulate to be collected without adversely affecting the critical distance between the nozzles and impaction surface and allows the impactor substrates to be analyzed using XRF.

Substrates used in the MOUDI were 47 mm polycarbonate membrane material. To help deter particle bounce, the substrates were coated with Apiezon Type-L vacuum grease (M&I Materials, Manchester, UK) diluted 20 to 1 with hexane and applied with an airbrush. The airbrush used nitrogen from a cylinder. After coating, the substrates were placed in an 85-degree Centigrade (°C) (185 degrees Fahrenheit (°F)) oven for one hour. After cooling, the substrates were placed in a vacuum desiccator for 24 hours. After collection, the polycarbonate membranes were placed on Petri slides and stored in a desiccator until they were analyzed by XRF for Al, Na, K, Cl, and Cs in the EPA's X-Ray Laboratory in Research Triangle Park, NC.

2.1.8 Test Description

Once the optimal biomass/natural gas combination was determined, the furnace was operated until temperatures stabilized and a temperature profile of the furnace was acquired using a ceramic shielded R-type thermocouple (Omega, Norwalk, CT). A location with temperatures between 1400 and 1500 kelvins (K) (2060 – 2240 °F) was identified to be used later to inject the kaolinite sorbent (see Figure 1).

A background experiment firing only natural gas was performed (Test Condition 1). The particulate sample was taken from the duct with an air-cooled stainless-steel nozzle/tube and was diluted with nitrogen to dilute the

sample and quench aerosol growth. The MOUDI was used to collect size-classified samples and determine particle distributions. All substrates from the MOUDI were analyzed using XRF. Elements of interest included Na, K, and Cs to characterize the alkali metals, Cl to examine possible interference, and Al to track the kaolinite sorbent.

The next set of experiments involved undoped powderized biomass combustion without sorbent injection (Test Condition 2). Using the firing rate that was previously determined, an experiment was performed feeding powderized biomass and natural gas without sorbent injection. The furnace was operated for at least a day on natural gas prior to running these tests.

Test Conditions 1 and 2 were largely designed as baseline conditions to verify operation of the combustor and sampling devices. Comparison of Test Conditions 3 and 4 is the core of the experimental study, where the impact of the sorbent injection on Cs from doped powderized biomass combustion is examined.

Test Condition 3 involved combustion of Cs-doped powderized biomass without sorbent injection, and Test Condition 4 involved combustion of Cs-doped powderized biomass with sorbent injection. Comparison of the PSDs between these two test conditions will illustrate whether the partitioning of Cs between different size fractions can be altered using sorbent injection.

2.2 Pelletized Biomass Tests in Rotary Kiln Incinerator Simulator

2.2.1 Combustor Description

The RKIS is a 73 kW (250,000 Btu/h) primary chamber, 73 kW (250,000 Btu/h) secondary chamber rotary kiln thermal destruction unit that was designed to possess the salient features of full-scale units with thermal ratings 20 to 40 times larger. The RKIS matches the volumetric heat release, gas-phase residence time, and temperature profile of many full-scale units and yet is flexible enough to enable parametric testing. A schematic drawing of the RKIS is presented in Figure 4.

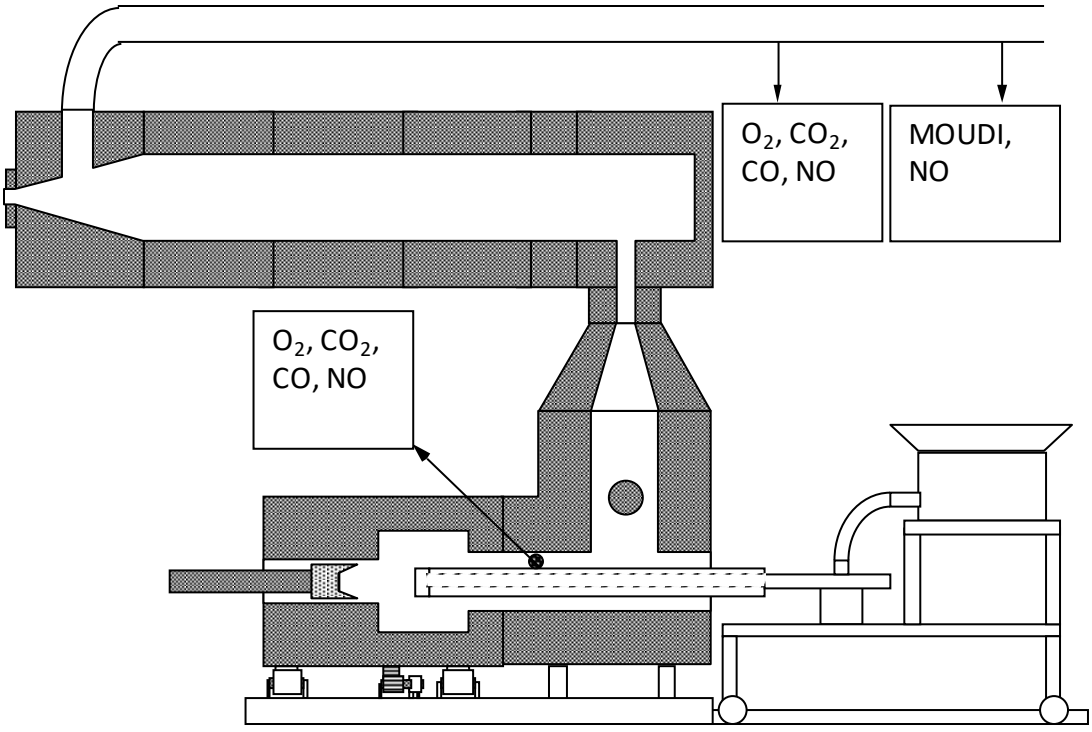

Figure 4. Rotary Kiln Incinerator Simulator

The general dimensions of the RKIS are:

- Inside diameters: 0.762 m in the kiln recess to 0.457 m in the transition and tower sections
- Outside diameters: 1.168-1.219 m
- Internal axial dimensions: 6.096 m from the front burner wall to the solids charging port

The rotating kiln section contains a recess in which solid waste is contained during incineration. The recess area was designed with a length-to-diameter (L/D) ratio of 0.8, which is 20-25 percent of a full-scale system. An Eclipse Model No. 82MVTA burner provides the heat to the primary combustion chamber, and an IFRF variable swirl burner provides heat to the secondary combustion chamber (SCC). The primary fuel for the RKIS is natural gas, but the unit can also fire on fuel oil or liquid wastes. The kiln body rests on two trunnion assemblies and is driven by a motor and variable speed gear drive allowing the drum to rotate at selectable speeds. Rotary leaf spring seals between the kiln and the transition/afterburner section and main burner extension are constructed of Teflon-gasketed rotary leaf springs.

The draft damper affects the system combustion chamber pressure, which can affect in-leakage in areas that are not leak-tight such as the seals around the main burner, charging port, and the rotary leaf spring seals. A pneumatic ram has been installed on the charging port sliding door to minimize in-leakage. Due to drift issues with the pressure transducers displaying the draft settings, 0 to 0.25 inches water Dwyer Instruments Magnehelic pressure gauges (Dwyer, Michigan City, IN) were placed in-line for the PCC, SCC, and exhaust to verify readings and allow for repeatability of firing conditions.

From the kiln, combustion gases enter the transition section. The gases make a 90° bend upwards at that point. Just above the 90° bend, an injection port is positioned where liquid surrogate wastes can be sprayed into the transition section.

Upon leaving the transition section, the combustion gases enter the SCC. The SCC consists of the following regions:

- A 0.610-m diameter mixing chamber,
- A 0.610-m diameter plug flow section, and
- A stack transition section.

2.2.2 Biomass Description

The biomass material used for these experiments was hardwood biomass pellets (Fiber Energy Products, Mountain View, Arkansas), like those used in household smokers. The biomass was analyzed by Galbraith Laboratories (Knoxville, TN) (see Appendix C for laboratory report including the methods used for each analysis) for elements of interest and heat of combustion using a proximate and ultimate analysis.

Table 4. Properties of Biomass Pellets Used in Tests (as received)

Measurement	Value
Carbon	45.95%
Hydrogen	6.18%
Nitrogen	< 0.5%
Oxygen	42.71%
Chlorine	20 ppm
Sulfur	0.042%
Fixed Carbon	12.62%
Loss on Drying	6.00%
Volatile Matter	84.60%
Ash	1.97%
Heat of Combustion	7778 Btu/lb

The Continuous Feed Vibration System (Figure 5) was used to feed hardwood pellets to the kiln. The entire feeding system, including the volumetric feeder (K-Tron 6300 Series, Coperion, Weingarten, Germany), was removed from the kiln and calibrated using a known quantity of hardwood pellets.

The pneumatic vibrators attached to the feeder were unable to prevent the system from plugging during operation, even after maximal tilt of the feeder was achieved. Rubber mallets were used to beat on the base of the feeder at regular intervals while monitoring CEM instruments to avoid large fluctuations in fuel rate (observed by increases/decreases in oxygen levels).

Introduction of biomass to the RKIS was documented in the laboratory notebook, as well as adjustments to the natural gas firing rate at the Main Burner. Biomass pellets were fed by a volumetric feeder through a vertical chute of flexible hose into a water-cooled tube. The water-cooled tube extended into the rotating drum of the kiln section. The duct is at a slight incline from horizontal and is vibrated by a motor to keep the biomass pellets traveling into the drum. The flange provides a seal during testing.

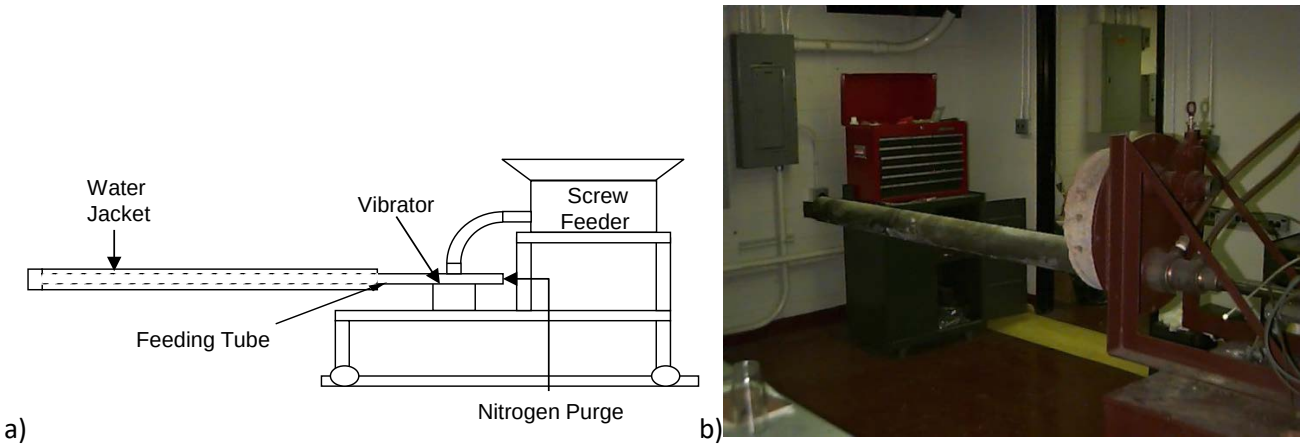

Figure 5. Continuous Feed Vibration System a) Diagram; and b) Photograph

2.2.3 Sorbent Description

The sorbent for these tests was a kaolinite sorbent (Mattex Pro, BASF, Inc, Ludwigshafen, Germany). The sorbent particle size analysis can be found in Appendix D. The sorbent had a mean particle diameter of 2.5 µm. This sorbent had a larger average particle size than the sorbent used in the previous powderized biomass tests,

although chemically it is the same material.

A K-Tron Soder twin screw compact weigh feeder (Model KCL24KT20, Coperion, Weingarten, Germany) was used to feed the sorbent (kaolinite) at a specified location (in the afterburner section) in the SCC based on the temperature profile measurements. Several calibrations were recorded in the laboratory notebook to verify feed rate of sorbent. Difficulties in calibrations were occasionally encountered due to the rapid build-up of moisture from the air in the kaolinite. The feeder had to be cleaned, and the sorbent replaced with a new, dry batch.

2.2.4 Gas Analysis Equipment

2.2.4.1 Continuous Emission Monitors

Several CEM instruments were used to monitor the combustion gases at the exit of the PCC and exhaust, adjacent to the MOUDI sampling location. An additional NO/NO_x instrument was plumbed into the MOUDI sample system to calculate the actual dilution ratio for the impactor. CEM instruments used during operation of the RKIS and MOUDI consisted of the following analyzers:

- California Analytical Instruments (CAI) (Orange, CA) Model ZRE-CBJZ, serial number: A2M7217T CO_2/CO/O_2 Analyzer; Analyzer ranges: CO_2, 0 to 20%; CO, 0-100 ppm; O_2, 0 to 25%.
- Horiba (Kyoto, Japan) model VIA-510 CO analyzer, MFG No. 57814 1023; Analyzer Range: 0 to 1,000 ppm.
- Teledyne (Teledyne Scientific Co., Thousand Oaks, CA) Chemiluminescence Model 200EH NO_x analyzer, serial number 242; Analyzer Range: 0 to 1,000 ppm.
- Teledyne Chemiluminescence Model 200EH (Converted to Model 200EM) NO_x analyzer, serial number 243; Analyzer Range: 0 to 30 ppm.

Calibrations of CEM instruments were recorded in the laboratory notebook as well as electronic data logged by the data acquisition system (Daqview software version 9.1.11). Raw data from Daqview were incorporated into a Microsoft Excel spreadsheet to determine run averages and calculate/display calibrations.

2.2.4.2 MOUDI Impactors

The dilution ratio of nitrogen to flue gas was determined with the intent of remaining close to the isokinetic sampling rate while also ensuring that a large enough concentration of NO was present at the exhaust of the MOUDI to be accurately measured by the NO analyzer (Teledyne 200EM). The calculated target dilution ratio was approximately 14 to 1 to prevent water condensation.

The actual dilution rate for the MOUDI sampling system was monitored and calculated by introducing nitrogen gas through a calibrated mass flow controller (Sierra Instruments [Sierra Instruments, Inc., Monterey, CA], C100L), verifying the total flow of the system using a Dry-Cal gas flow calibrator (Bios International (MesaLab [Mesa Laboratories, Inc., Lakewood, CO]), model: DC-1HC (High Flow Cell)), and by comparing nitric oxide (NO) emissions inside the exhaust duct and at the outlet of the MOUDI.

2.2.5 Experimental Approach

The effect of sorbent injection on the behavior and transformation of Cs-bound biomass waste was determined by doping the biomass with aqueous cesium chloride, prior to feeding into the RKIS operating at a constant load of approximately 175,000 Btu/h. The concentration of Cs artificially placed onto the biomass was based on evaluation of the XRF (Philips, Almelo, The Netherlands, Model PW2404 Spectrometer) instrument detection

limits. The biomass was prepared by spraying a small amount of an aqueous solution of cesium chloride (CsCl) onto the material while it was being agitated in a cement mixer. The mixture was agitated for approximately 1 minute in the cement mixer. Target concentrations of Cs were approximately 31 milligrams of Cs per pound of biomass.

Metal speciation was determined by chemical composition analysis of size-segregated particulate matter extracted from the exhaust. Size-segregated samples were collected using a MOUDI from Applied Physics, Inc. (www.appliedphysicsusa.com/cascade_impactors.html). The MOUDI is a cascade impactor designed for high concentration aerosols and provides very sharp cut points between particle sizes, digital on/off timer controls, and flow meters. Analysis of the MOUDI filters was performed by DHL Analytical (Round Rock, TX) using Inductively-Coupled Plasma-Mass Spectrometry (ICP-MS).

In addition to particulate sampling, operational data recorded on the RKIS included feed rates of the fuel, combustion air flow, and injection rates of sorbents. Temperatures were measured within the combustion chamber and at predetermined critical locations in the duct. The continuous emission monitoring of O_2, CO_2, CO, and NO_X was recorded during all tests.

The primary variables of interest were: 1) the molar ratio of kaolinite in the sorbent to the Cs in the biomass; 2) the molar ratio of Cs in the biomass to the other alkali metals and trace constituents (i.e., sodium, potassium, chlorine) in the biomass; and 3) the concentration of Cs in the biomass. The sorbent injection temperature was set at the optimal temperature (2060 – 2240 °F) for Cs capture as observed in Yoo et al. (2005). The experimental tests were performed in the following order.

2.2.5.1 RKIS background check

Two sets of background runs firing only natural gas were performed, once prior to beginning any of the biomass combustion tests and once just prior to introducing Cs to the system. The sample was taken from the duct with a naked quartz nozzle/tube and was diluted with nitrogen as required to maintain isokinetic sampling. A MOUDI rotating cascade impactor was used to collect filter samples and determine particle distributions. Nitrogen dilution was used with the MOUDI sample probe to attempt to maintain isokinetic conditions at the sample point, although there were difficulties maintaining isokinetic conditions (see Section 5). All filters from the MOUDI were analyzed using ICP-MS. Elements of interest were Na, K, Cl, Al, Si, and Cs.

2.2.5.2 Un-doped Biomass Combustion

The next pair of experiments involved un-doped biomass incineration with and without sorbent injection. An experiment was run feeding biomass nominally at a rate of 8 lb/h without sorbent injection. The experiment was repeated with kaolinite sorbent added at the position in the burner section of the SCC of the RKIS. For both experiments, the MOUDI was used to collect filter samples for analysis.

2.2.5.3 Doped Biomass Combustion

The final experiments involved doped biomass incineration with and without sorbent injection. Using the same firing rate as used previously, an experiment was run feeding biomass without sorbent injection. The experiment was repeated with kaolinite sorbent added at the injection position in the afterburner section of the SCC. For both experiments, the MOUDI was used to collect filter samples for analysis. Table 5 describes the test matrix and samples acquired.

Table 5. Test Matrix

Test Condition #	Cs Conc., mg/lb Biomass	Biomass Feed Rate, lb/h	Sorbent Feed Rate, g/h
1 – Natural Gas Background	NA	NA	NA
2 – Biomass	NA	8	NA
3 – Biomass + Sorbent	NA	8	33.3
4 – Natural Gas Background	NA	NA	NA
5 – Biomass + Cs	31.0	8	NA
6 – Biomass + Cs + Sorbent	31.0	8	33.3

2.2.4.4 Temperature Profile

A temperature profile was measured using a suction pyrometer (a thermocouple with a ceramic shroud on a water-cooled probe that pulls furnace gas samples across the thermocouple, yielding temperature measurements that are accurate despite radiative heat transfer from the walls to the thermocouple). This temperature profile was intended to identify the location in the SCC for the optimal temperature at which to inject the kaolinite sorbent (approximately 1150 °C). Figure 6 shows the results of the temperature profile in graphic and photographic form. Based on desired sorbent injection temperatures, the sorbent was injected at the port in the afterburner chamber (first yellow chamber) of the SCC.

Figure 6. SCC Temperature Profile Results

3.0 Results

3.1 Results from Powderized Biomass Tests in Down-Fired Vertical Tunnel Combustor

Figure 7 depicts the PSDs of Na, Al, Cl, K, and Cs for the Cs-doped biomass flour (corn and pine) with no sorbent injection. Note that the Si data are not presented for clarity of presentation since Si might have been introduced into the system by abrasion from the RKIS refractory walls. Data are reported in terms of normalized XRF counts (dX/dlog Dp) versus particle aerodynamic diameter for each element. This normalization (XRF counts on a given stage divided by the total counts on all stages) is related to species mass and reports the relative distribution of an element across the particle size distribution. Figure 7 indicates that all the biomass alkali metals form a well-established accumulation mode aerosol with a mean diameter of approximately 0.3 µm, indicative of elemental vaporization, nucleation, and growth. Cl is associated with these particles. Particles in this size range exhibit reduced collection efficiencies in common particulate control devices.

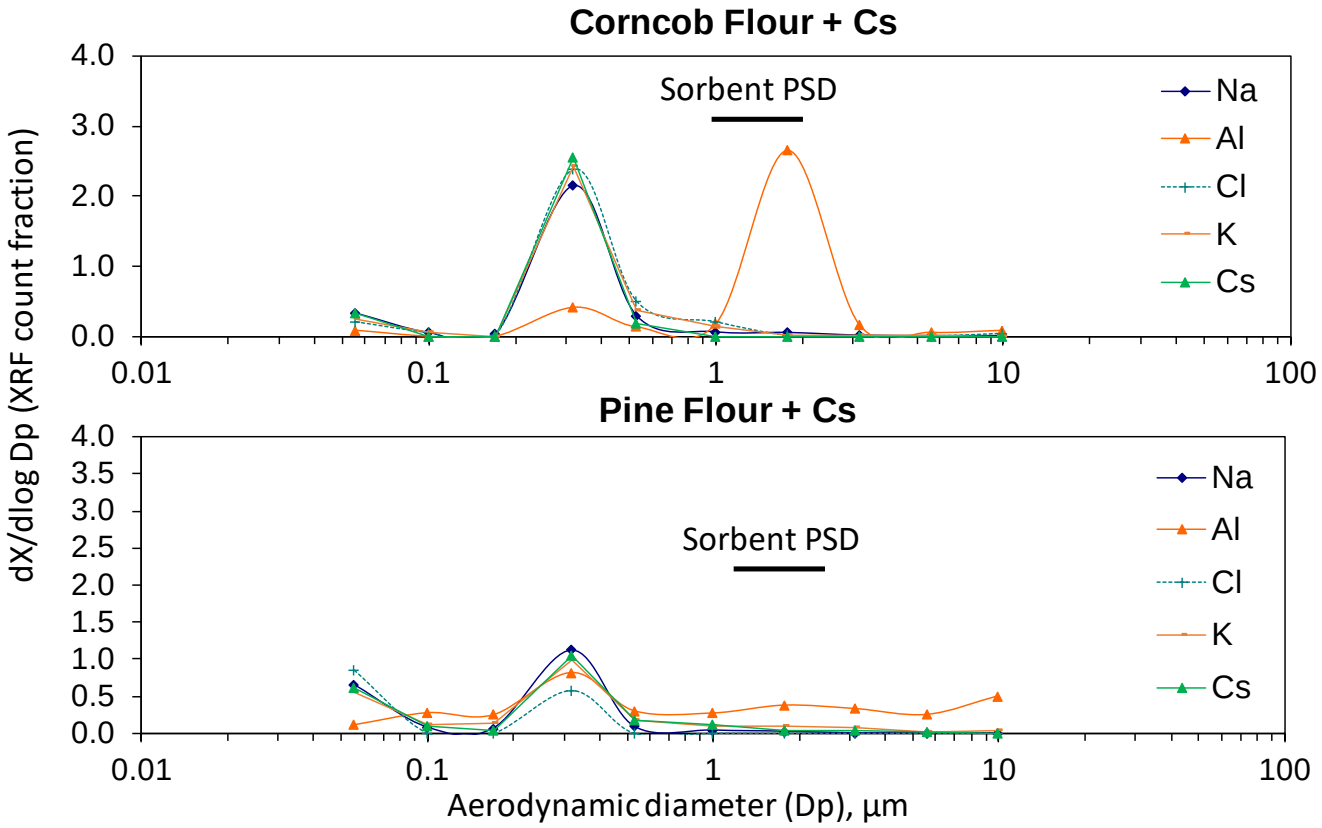

Figure 7. Particle Size Distributions of Cs-Doped Biomass Flour

Figure 8 presents the results from Test Condition #4 (natural gas + powderized biomass + Cs dopant + sorbent). This condition is identical to Test Condition #3 except for added kaolinite sorbent.

Although the sorbent did capture the Cs in the case of both types of biomass, there were some anomalous results with the pine flour. First, the pine flour was somewhat sticky, which made feeding at a constant rate very difficult, since the material agglomerated on the screw feeder parts and then broke off at periodic intervals despite having undergone a drying process. These feeding difficulties may, however, not need to be addressed,

since the next logical step in this research is to test the Cs capture ability of kaolinite sorbent in a system burning chunks of solid biomass fuel, which is a more likely operational scenario than feeding biomass as a finely-ground flour. Second, there was a relatively large Al and Si presence in the furnace under the test conditions where no sorbent was being fed. This presence is potentially due to accumulation of kaolinite sorbent particles in the combustor in places that were difficult to remove as part of the furnace cleanout process. For this reason, there was an approximately 47% capture of Cs in the furnace when no sorbent was being fed. This capture increased to approximately 88% with the addition of sorbent, suggesting that there was an incremental increase in capture by 41% with the addition of the kaolinite sorbent.

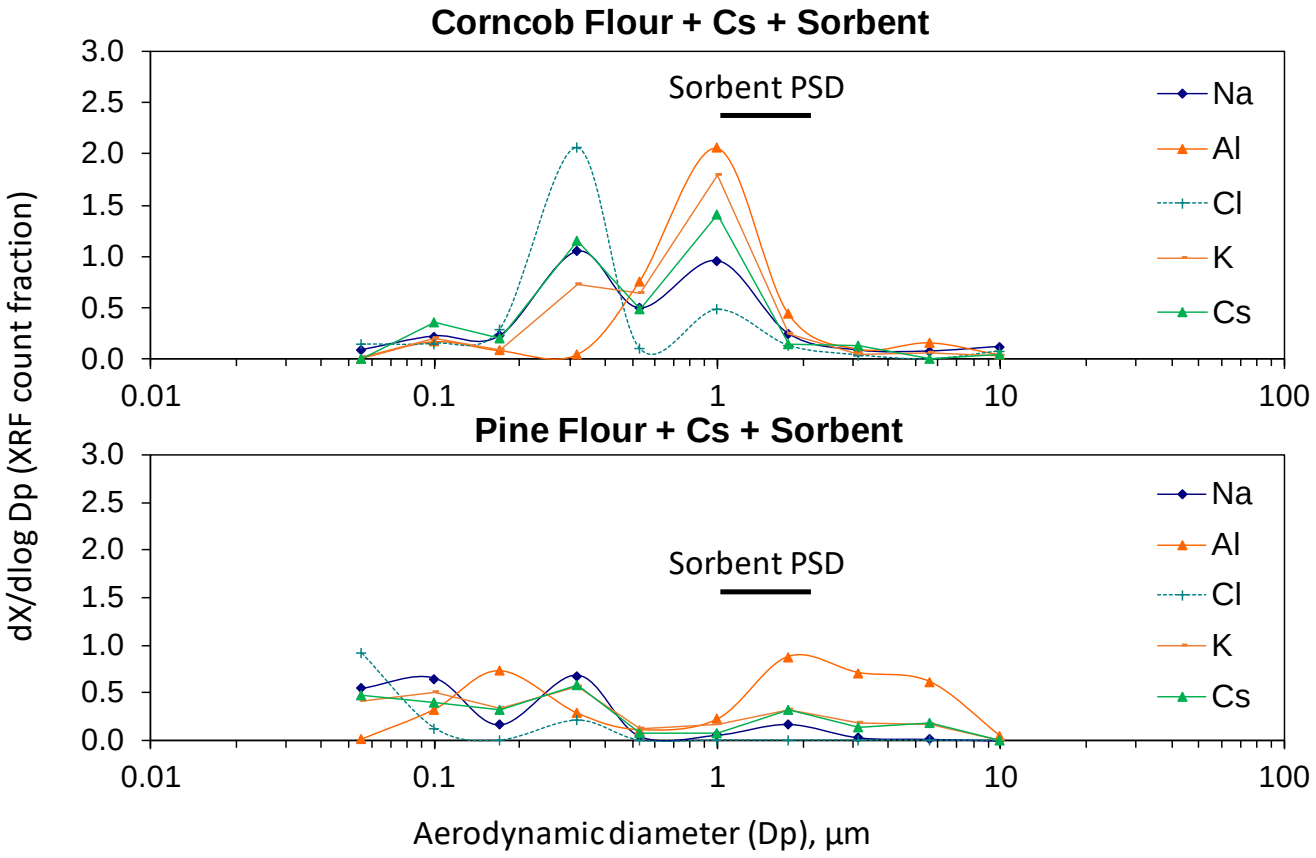

Figure 8. Particle Size Distributions of Cs-Doped Biomass Flour + Sorbent

Figure 9 summarizes the results, showing that the partitioning of the Cs was moved to the supermicron (i.e., aerodynamic diameter > 1 µm) fraction by the addition of the sorbent in the case of both types of biomass. As mentioned previously, it is possible that residual sorbent material had accumulated in the combustor, resulting in the pine flour tests exhibiting approximately a 47% capture of the Cs without any sorbent present, based on a ratio of the mass of Cs found above and below the 1 µm cut.

Even with the experimental difficulties that occurred due to the stickiness of the pine flour, it appears that kaolinite sorbents can capture Cs from combustion systems burning a wide range of biomass types.

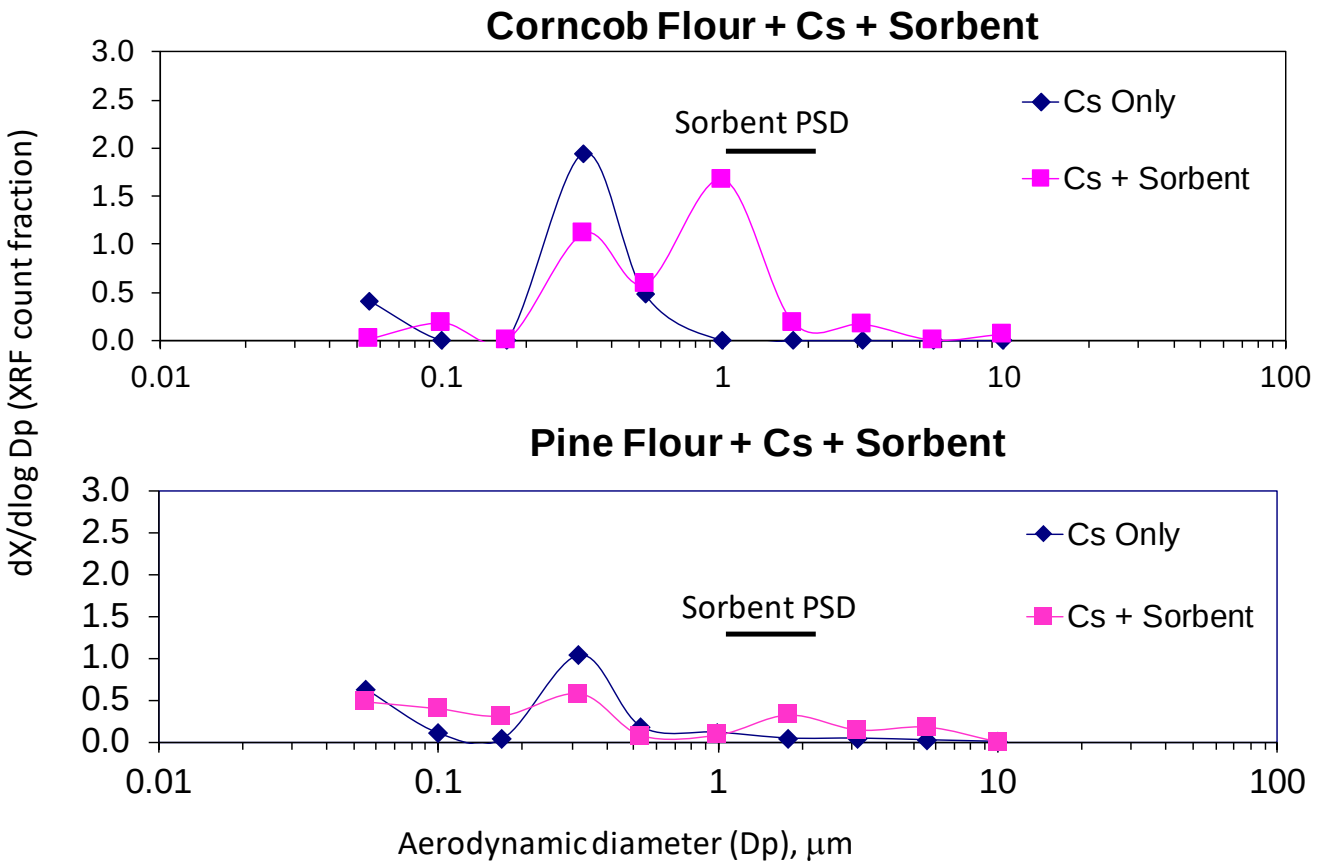

Figure 9. Particle Size Distributions of Cs-Doped Biomass with and without Sorbent

3.2 Results from Pelletized Biomass Tests in Rotary Kiln Incinerator Simulator

The results from the CEMs are presented in Table 6. It should be noted that the variations in the dilution ratio of the MOUDI are somewhat due to the variability in the flow rate within the RKIS exit duct. The static pressure within the rotating chamber of the RKIS needed to be maintained at slightly negative conditions to prevent harmful gases from venting into the laboratory, but the transient changes in air in-leakage due to biomass feed rate fluctuations and the impact of the kiln rotation on the rotary seals resulted in variations in the flue gas flow rate.

The results from the pelletized biomass tests in the EPA RKIS facility are listed in Table 7 in terms of µg Cs/filter. These results were then averaged and normalized to reflect the percentage of Cs on the different MOUDI stages. Table 8 lists the particle size ranges caught by the various MOUDI stages. Note that MOUDI stage 10 is the backing filter that catches all the particulate matter that passed through the other impactor stages uncaptured. These results are graphically presented in Figure 10. None of the Cs was found in the larger particle sizes in the runs when no sorbent was being injected. Approximately 91% of the Cs was captured in the larger particulate fractions with the sorbent injection.

Table 6. CEM Results

Conditions		O_2 %	CO_2 %	CO Low ppm	CO High ppm	NO Low ppm	NO High ppm	Dilution Ratio
NG Bkg1	Run1	3.0	10.2	0.5	0.0	2.8	50.0	17.8 to 1
NG Bkg1	Run2	3.0	10.2	0.2	0.0	3.1	49.9	15.9 to 1
NG Bkg1	Run3	3.0	10.1	0.0	0.0	2.7	50.0	18.5 to 1
NG Bkg1	Avg	3.0	10.2	0.2	0.0	2.9	50.0	17.4 to 1
B	Run2	1.6	11.6	12.4	38.4	3.1	53.5	17.5 to 1
B	Run3	2.5	11.2	6.0	3.3	3.8	59.6	15.9 to 1
B	Run4	2.8	11.0	0.9	0.0	3.9	60.4	15.5 to 1
B	Avg	2.3	11.3	6.4	13.9	3.6	57.8	16.3 to 1
B+S	Run1	4.1	10.2	0.0	0.0	5.8	71.3	12.2 to 1
B+S	Run2	4.4	9.9	0.0	0.0	4.7	70.7	15.2 to 1
B+S	Run3	4.4	9.9	0.0	0.0	4.3	70.4	16.4 to 1
B+S	Avg	4.3	10.0	0.0	0.0	4.9	70.8	14.6 to 1
NG Bkg2	Run1	3.3	9.9	2.6	0.0	3.7	59.0	15.8 to 1
NG Bkg2	Run2	3.3	10.1	1.9	0.0	6.1	59.4	9.7 to 1
NG Bkg2	Run3	3.2	10.2	1.5	0.0	6.0	59.3	9.9 to 1
NG Bkg2	Avg	3.3	10.1	2.0	0.0	5.3	59.3	11.8 to 1
B+Cs	Run2	3.5	10.4	-1.3	-3.0	7.0	72.0	10.3 to 1
B+Cs	Run3	3.1	10.8	-1.7	-3.0	7.0	68.4	9.8 to 1
B+Cs	Run4	3.2	10.7	-2.1	-2.8	7.7	67.9	8.8 to 1
B+Cs	Avg	3.3	10.6	-1.7	-3.0	7.3	69.4	9.6 to 1
B+Cs+S	Run1	3.3	10.5	1.1	-3.2	4.7	65.3	14.0 to 1
B+Cs+S	Run2	3.1	10.8	-0.3	-3.2	6.2	63.2	10.2 to 1
B+Cs+S	Run3	3.2	10.7	-1.2	-3.2	6.8	64.2	9.4 to 1
B+Cs+S	Avg	3.2	10.7	-0.1	-3.2	5.9	64.2	11.2 to 1

The first run of the experiments with cesium-doped biomass and sorbent did not have cesium present in any stage of the impactor. It is unknown why this occurred. Potential explanations include the possibility that the Cs-dosed hardwood pellets may not have had enough time to achieve steady-state incineration conditions in the kiln and flow through the SCC and exhaust duct to the MOUDI sampling point. There were residual coarse particles in the bottom of the rotating chamber of the RKIS, which possibly might have caused some capture. Cesium was present in subsequent runs. Cs was present in all three runs when feeding Cs-doped biomass without sorbent. The residence time of the biomass was longer during these experiments since the first run had to be discarded due to issues with the feeder. This anomalous run is included in Table 7 although it is not included in the averaging and subsequent reporting.

Table 7. ICP-MS Analysis Results from Pelletized Biomass/Sorbent Tests in RKIS

MOUDI Stage	Biomass Only (µg Cs/filter)				Biomass + Cs (µg Cs/filter)				Biomass + Sorbent (µg Cs/filter)				Biomass + Cs + Sorbent (µg Cs/filter)			
	Run 1	Run 2	Run 3	Avg	Run 1	Run 2	Run 3	Avg	Run 1	Run 2	Run 3	Avg	Run 1*	Run 2	Run 3	Avg
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07	0.07
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.10	0.11
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.11	0.12
10	0.00	0.00	0.00	0.00	0.27	0.29	0.39	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.03

* Run 1 with sorbent and Cs did not result in any Cs in the sampling train. It was unknown why this happened, therefore this run is not included in the averaging although the data are presented.

Table 8. Particle Size Fractions Caught on MOUDI Stages

Stage	Dp Min (µm)	Dp Max (µm)
10 (after-filter)	0.01	0.18
8	0.18	0.32
7	0.32	0.56
6	0.56	1
5	1	1.8
4	1.8	3.2
3	3.2	5.6
2	5.6	10
1	10	15.7
0 (Inlet)	15.7	>15.7

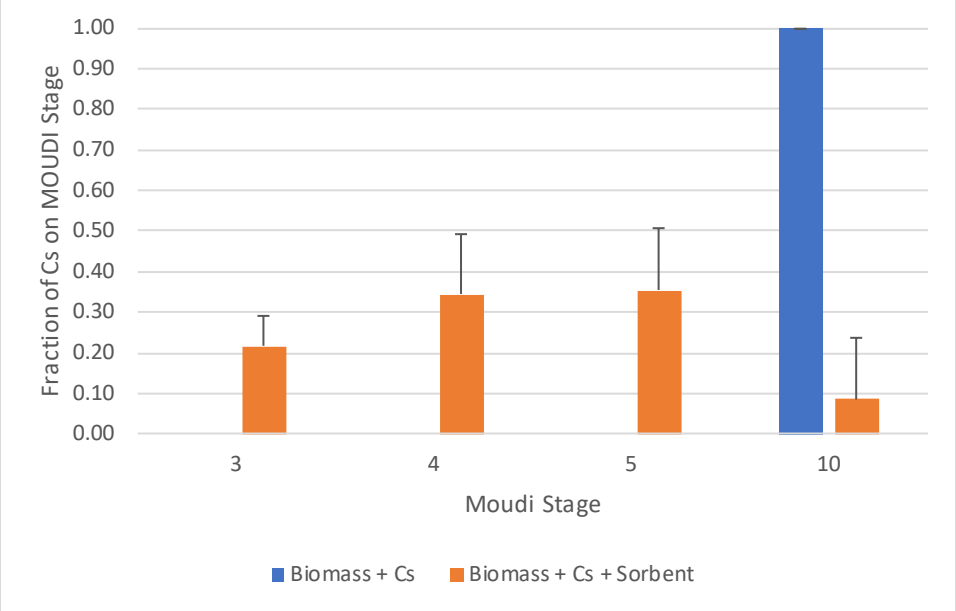

Figure 10. Cesium Particle Partitioning with and without Sorbent Injection

4.0 Discussion

A series of experiments was performed on a laboratory-scale vertically-fired furnace, using various combinations of corncob flour and pine flour (as idealized biomass materials), a cesium chloride dopant (to simulate Cs contamination on the biomass), and in-furnace injection of kaolinite sorbent, in a temperature regime that had previously been shown to successfully capture Cs in a natural gas-only combustion environment. Without sorbent injection, Cs was almost totally associated with the particle size fraction around 200 nm. With sorbent addition, the Cs was successfully shifted into supermicron particle sizes associated with the sorbent, resulting in 65% capture of the Cs onto the sorbent while combusting corncob flour and from 47 to 88% capture while combusting pine flour, suggesting that kaolinite sorbent injection may be a useful combustion modification that could be used in practical-scale combustion systems while burning Cs-contaminated biomass. By shifting the particle sizes associated with the Cs emissions to supermicron-sized particles, the ease of capturing Cs in particulate control devices is greatly enhanced. Previous work (Yoo et al., 2005) showed that, in a natural gas-only system, up to 85% capture was achieved. It may be possible to optimize this process further to achieve greater degrees of capture. The apparent stickiness of the pine flour made it difficult to feed at a constant rate, unlike the corncob flour could be fed reproducibly at a constant rate.

Given the success at capturing Cs from a natural gas-fired system (Yoo et al., 2005) and from a combustion system burning finely pulverized biomass (Lemieux et al., 2013), follow-on work was performed using a combustion system more representative of the type of biomass waste that would be generated from a radiological contamination incident, in a pilot-scale rotary kiln incinerator simulator with an experimental secondary combustion chamber. The sorbent injection was performed in the secondary combustion chamber at a similar temperature that showed successful Cs capture in the natural gas-fired system and the powderized biomass system.

Approximately 91% capture of the Cs was achieved in the pilot-scale RKIS experiments. The capture percentage that was achieved was equal to or greater than the capture achieved in the previous experiments.

Data gaps still exist regarding the effect of the presence of Cl, Na, and K on Cs capture, on the Cs solubility and leachability once captured on the sorbent, and to optimize the amount of sorbent that is injected into the furnace, but this appears to be a viable technique for minimizing Cs emissions from combustion of radionuclide-contaminated biomass.

5.0 Quality Control Report

The Quality Control (QC) evaluation report presented here reflects only the most recent tests that were performed at the RKIS facility since the previously published results all had their own QC writeups associated with them.

All test activities were documented in laboratory notebooks, data sheets, and digital photographs. The documentation included, but was not limited to, records for calibration of equipment, operating conditions of RKIS, and calculation spreadsheets to determine feed/injection rates, Cs concentrations, and dilution ratios of the MOUDI sampler.

In general, the critical data elements all fell within targeted data quality indicator goals. Any deviations are mentioned in this section. The QC deviations were mostly related to Si being present in the field blanks (possibly due to Si contamination present in the RKIS system prior to initiation of any testing) and fluctuations in the flue gas flow rate due to system transients related to having to operate the rotating part of the RKIS at static pressure conditions just barely on the negative side (for safety reasons), and the impact that those transients in the rotating section had on air in-leakage volumes throughout the system.

The following sections discuss the criteria for the quality control (QC), calibrations, and quality assurance (QA) assessments and corrective action taken.

5.1 Quality Control

Field blanks were conducted during each day of testing. Nitrogen and air were drawn through the MOUDI sampling system with the probe disconnected for 20 minutes. House air was run across the probe sheathe (did not come in contact with the flue gas) to maintain the temperature of the flue gas entering the MOUDI. This was done to detect and quantify any residual contamination that might be present in the testing vessel. All the field blanks had silicon concentrations around 100 µg/filter in the after filter of the MOUDI (<0.18 µm aerodynamic diameter). These were consistent with the concentrations of Si found in the after filter during each test condition. This could be from residual Si in the RKIS (refractory, Kaowool, etc.), or could indicate contamination of the MOUDI sampling system; possibly the anti-static tubing running from the probe to the MOUDI inlet. The last field blank taken on the same date as the test runs burning cesium-doped biomass while injecting sorbent also had Si present at approximately 40 µg/filter in the 0.18 to 0.32 µm (#8).

Spike samples and spike duplicates were prepared at the end of testing in various concentrations to verify that a known amount of cesium chloride (CsCl) could be extracted from the filters with accuracy. Analysis of the spike and spike duplicates determined the analytical results were all within 3.5% of the expected value.

5.2 Calibrations

Instruments calibrated included the mass air flow controller used to monitor the nitrogen used as the diluent for the MOUDI sampling system, thermocouples used on the RKIS (brand new thermocouples were not calibrated), the balance used to weigh sorbent and biomass, and the Dry-Cal meter used by the Metrology Laboratory to verify the total flow of the MOUDI sampling system. Calibration criteria are listed in Table 9.

Calibration of the Continuous Feed Vibration System was done by feeding wood pellets through the entire system into a 5-gallon bucket for 15 minutes. The contents of the bucket were weighed to calculate a feed rate. This experiment was done in triplicate to verify that the targeted feed rate could be achieved (8 lb/h). The sorbent injection feeder (K-Tron) was calibrated in a similar fashion to verify a feed rate of approximately 33.3 grams/min.

The required flow rate (30 liters per minute [LPM]) through the MOUDI sampling system was verified by the EPA/NRMRL/AEMD Metrology Laboratory using a Dry-Cal gas flow calibrator.

Daily calibrations were performed on the CEM instruments monitoring combustion gases in the RKIS exhaust and MOUDI dilution ratio. A direct calibration to each analyzer was recorded at the beginning of each test day using a zero and span gas. This calibration was followed by a system bias check, where calibration gas was introduced into the measurement system at the probe, upstream of the filter and all sample condition components. A two-point calibration drift check was made daily (through the measurement system) at the end of each day using the same gases. A system bias could not be performed on the NO analyzer sampling from the outlet of the MOUDI. All gas cylinders used for calibration were certified by the suppliers (AirGas, Durham, NC) that they are traceable to National Institute of Standards and Technology (NIST) standards. Calibrations were recorded in a laboratory notebook as well as on the Daqview software.

Table 9. CEM Calibration Criteria

Parameter	Measurement	QA/QC Check	Frequency	Acceptance Criteria
CEMs	O_2, CO_2, CO, NO	2-point direct calibration	Pre-test	± 5% of calibration span
CEMs	O_2, CO_2, CO, NO	2-point system calibration	Pre- and post-test	± 10% of calibration span
CEMs	O_2, CO_2, CO, NO	2-point drift check	Pre- and post-test	± 5% of full scale

5.3 QA Assessments and Corrective Action

5.3.1 Elemental Analysis of MOUDI substrates

Elemental analysis of MOUDI substrates was performed by DHL Analytical in Round Rock, Texas. No traces of potassium or sodium were found on any of the substrates, although the elemental analysis of the hardwood pellets done by Galbraith Laboratories showed occurrences of both. A majority of the potassium and sodium may have remained in the ash at the bottom of the kiln. Any traces in the flue gas may have been below the minimum detection limits for the ICP-MS analysis, especially the sodium which is present in the biomass at very small concentrations.

Silicon was detected on nearly every stage on the first run of the second set of natural gas background experiments (NG Bkg2-R1). Detection of silicon could potentially be from residual kaolinite left in the MOUDI sampling system, although silicon was also present in stages that did not have any detects when kaolinite was injected. The silicon did not appear in subsequent runs, aside from the after filter. Si could also be present due to entrainment of refractory material that got abraded off the walls of the rotating section of the kiln. For this reason, Si was not included in the presented results.

The first run of the experiments with cesium-doped biomass and sorbent did not have cesium present in any stage of the impactor. It is unknown why this occurred. Potential explanations include the possibility that the Cs-dosed hardwood pellets may not have had enough time to achieve steady-state incineration conditions in the kiln and flow through the SCC and exhaust duct to the MOUDI sampling point. There were residual coarse particles in the bottom of the rotating chamber of the RKIS, which possibly might have caused some capture. Cesium was present in subsequent runs. Cs was present in all three runs when feeding Cs-doped biomass without sorbent. The residence time of the biomass was longer during these experiments since the first run had to be discarded due to issues with the feeder.

Silicon was present in the after filter of every field blank as well as the 0.18 to 0.32 µm stage for the field blank associated with the Cs-doped biomass and sorbent run (B+Cs+S). Si was not presented in the results due to these anomalies.

5.3.2 CEM Calibrations

All CEM values were corrected for bias according to equation 12-6 from EPA Method 7E (Instrumental Analyzer Procedure) (U.S. EPA, 1990).

Discrepancies between the analyzer readout on the Teledyne 200EM NO analyzer and data recorded in DaqView were observed during testing of biomass (no Cs and no sorbent) and biomass and sorbent (no Cs). The value on the analyzer was within scope for the direct calibration criteria, however, values recorded by the data acquisition system were outside the acceptance criteria. Since we were unable to perform an initial and final system bias, these NO readings were corrected using the direct calibration value instead of initial and final system bias. The issue was determined to be a faulty connection in the data acquisition module, which was repaired prior to subsequent runs.

The low CO analyzer (CAI ZRE) failed the final bias and drift check for the second set of natural gas background tests, biomass and Cs (no sorbent) runs, and Cs-doped biomass with sorbent runs. After correcting these values, the CO remained between -2.09 and 2.57 parts per million (ppm). These measurements were consistent with absence of CO in previous runs under similar firing conditions.

5.3.3 Rotary Kiln Incinerator Simulator

Due to drift issues with the pressure transducers displaying the draft settings, 0 to 0.25 inches water Dwyer Instruments Magnehelic pressure gauges were placed in-line for the Main Burner, After Burner, and exhaust to verify readings and allow for repeatability of firing conditions.

5.3.3 Biomass Feeder

The Continuous Feed Vibration System was used to feed hardwood pellets to the kiln. The entire feeding system, including the volumetric feeder (K-Tron 6300 Series), was removed from the kiln and calibrated using a known quantity of hardwood pellets.

The pneumatic vibrators attached to the feeder were unable to prevent the system from plugging during operation, even after maximal tilt of the feeder was achieved. Rubber mallets were used to beat on the base of the feeder at regular intervals while monitoring Continuous Emissions Monitoring (CEM) instruments to avoid large fluctuations in fuel rate (observed by increases/decreases in oxygen levels).

Introduction of biomass to the RKIS was documented in the laboratory notebook, as well as adjustments to the natural gas firing rate at the Main Burner.

5.3.4 Sorbent Injection

Several calibrations were recorded in the laboratory notebook to verify feed rate of sorbent. Difficulties in calibrations were encountered due to the rapid build-up of moisture in the kaolinite. The feeder had to be cleaned, and the sorbent replaced with a new, dry batch.

6.0 Conclusions

A series of experiments was performed to investigate how well the use of in-furnace kaolinite sorbent injection captured cesium emissions from combustors, a process that worked very effectively in a natural-gas combustion system and worked in a biomass combustion system. The experiments were performed initially on a vertically-fired combustor firing two types of powderized biomass, then subsequently on a rotary kiln incinerator simulator firing pelletized biomass fed into the rotating drum section of the combustor. In both cases, the biomass material was doped with non-radioactive cesium in the form of aqueous cesium chloride. A MOUDI impactor was used as the primary sampling device, where success of capture was assessed by whether the cesium predominated in the lower particle size impactor stages or whether the cesium was caught on the impactor stages corresponding to the sorbent particle size, an indication that the cesium was associated with the sorbent particles.

Without sorbent injection, Cs was almost totally associated with the particle size fraction around 200 nm. With injection of the sorbent, approximately 91% of the Cs was captured in the supermicron particle size fraction in the pilot-scale RKIS experiments. The capture percentage that was achieved was equal to or greater than the capture achieved in the previous experiments and was similar in capture efficiency to the initial natural-gas-only experiments.

Data gaps still exist regarding the effect of the presence of Cl, Na, and K on Cs capture, on the Cs solubility and leachability once captured on the sorbent, and to optimize the amount of sorbent that is injected into the furnace, but this appears to be a viable technique for minimizing Cs emissions from combustion of radionuclide-contaminated biomass.

7.0 References

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Appendix A: Analysis of Corncob Flour

Laboratory Report

Report prepared for:
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Arcadis
4915-F Prospectus Dr
Durham, NC 27713
Phone: 919-544-4535
Fax: 919-544-5690
Email: bsharpe@arcadis-us.com

Report prepared by:
Pat B Delozier

Purchase Order:
RB66612

For further assistance, contact:
Pat B Delozier
Report Coordinator
PO Box 51610
Knoxville, TN 37950-1610
(865) 546-1335
patdelozier@galbraith.com

Sample: Granville Milling 1/8" corn cob bedding material
Lab ID: 2010-K-0716 **Received:** 2010-02-09

Analysis	Method	Result	Basis	Amount	Date (Time)
114: Heat of Combustion (BTU)					
	ASTM D5865-07 (mod.)	7688 BTU/lb	As Received	0.57366 g	2010-02-17
Al : Aluminum					
	GLI Procedure ME-70	< 0.03 %	As Received	110.58 mg	2010-02-19
Cs : Cesium					
	GLI Procedure ME-71	< 0.04 %	As Received	142.36 mg	2010-02-16
K : Potassium					
	GLI Procedure ME-70	0.543 %	As Received	110.58 mg	2010-02-19
Na : Sodium					
	GLI Procedure ME-70	517 ppm	As Received	110.58 mg	2010-02-19
Si : Silicon					
	GLI Procedure ME-70	0.136 %	As Received	110.58 mg	2010-02-19
X3T: Total Halogens as Cl					
	GLI Procedure ME-13	0.15 %	As Received	11.03 mg	2010-02-16

Signatures:
Published By: pat.b.delozier 2010-02-22T20:23:27.947-05:00

Laboratory Report

Report prepared for:
Chris Winterrowd
Arcadis US Inc
Suite F
4915 Prospectus Dr
Durham, NC 27713
Phone: 919-541-1847
Fax: 919-541-0082
Email: chris.winterrowd@arcadis-us.com

Report prepared by:
Pat B Delozier

Purchase Order:
RB68311

For further assistance, contact:
Pat B Delozier
Report Production Coordinator
PO Box 51610
Knoxville, TN 37950-1610
(865) 546-1335
patdelozier@galbraith.com

Sample: Corncob Flour #100
Lab ID: 2011-M-9842 **Received:** 2011-01-06

Analysis	Method	Result	Basis	Amount	Date (Time)
114: Heat of Combustion (BTU)					
	ASTM D5865-10a (mod.)	7670 BTU/lb	As Received	0.59537 g	2011-01-07
	Calculation	8499 BTU/lb	Dried	Calculation	2011-01-24
115: Ash					
	ASTM D3174-04	1.44 %	Dried	1192.73 mg	2011-01-18
	Calculation	1.30 %	As Received	Calculation	2011-01-24
302: Loss on Drying (LOD)					
	ASTM D3173-03	9.75 %	As Received	1488.33 mg	2011-01-17
810: Volatile Matter					
	ASTM D3175-07	81.19 %	Dried	1192.73 mg	2011-01-18
	Calculation	73.27 %	As Received	Calculation	2011-01-24
811: Fixed Carbon (Calculated)					
	Calculation	15.68 %	As Received	Calculation	2011-01-24
	Calculation	17.37 %	Dried	Calculation	2011-01-24
C : Carbon					
	GLI Procedure ME-3	45.58 %	As Received	1.844 mg	2011-01-13
	Calculation	50.50 %	Dried	Calculation	2011-01-24
Cl : Chlorine					
	GLI Procedure ME-4A	0.17 %	As Received	507.41 mg	2011-01-14
	Calculation	0.188 %	Dried	Calculation	2011-01-24
d08: Oxygen by difference					
	Calculation	46.88 %	As Received	Calculation	2011-01-24
	Calculation	42.35 %	Dried	Calculation	2011-01-24
H : Hydrogen					
	GLI Procedure ME-3	6.07 %	As Received	1.844 mg	2011-01-13
	Calculation	5.52 %	Dried	Calculation	2011-01-24
N : Nitrogen					
	GLI Procedure ME-3	< 0.5 %	As Received	1.844 mg	2011-01-13
	Calculation	< 0.5 %	Dried	Calculation	2011-01-24
S : Sulfur					
	GLI Procedure E16-2	< 0.5 %	As Received	43.81 mg	2011-01-19
	Calculation	< 0.5 %	Dried	Calculation	2011-01-24

Signatures:

Published By: pat.b.delozier 2011-01-24T17:40:07.677-05:00

Appendix B. Analysis of Pine Flour

Laboratory Report

Report prepared for:
Chris Winterrowd
Jacobs Technology Inc
Mail Drop H137-04
U S EPA
RTP, NC 27711
Phone: 919-541-1847
Email: winterrowd.chris@epa.gov

Report prepared by:
Debbie S Robertson

Purchase Order:
Visa,Medley,9/11/15

For further assistance, contact:
Debbie S Robertson
Report Production Coordinator
PO Box 51610
Knoxville, TN 37950 -1610
(865) 546-1335
debbierobertson@galbraith.com

Sample: #70 Pine Wood Flour
Lab ID: 2015-A-0709 **Received:** 2015-09-11

Analysis	Method	Result	Basis	Sample Amount Used	Date (Time)
114: Heat of Combustion (BTU)					
	GLI Procedure S-231	8640 BTU/lb	As Received	0.45124 g	2015-09-16
	Calculation	9191 BTU/lb	Dried	Calculation	2015-09-30
115: Ash					
	ASTM D3174-12	0.800 %	As Received	1006.59 mg	2015-09-24
	Calculation	0.85 %	Dried	Calculation	2015-09-30
302: Loss on Drying (LOD)					
	GLI Procedure S-200	6.00 %	As Received	1024.35 mg	2015-09-29
810: Volatile Matter					
	ASTM D3175-11	87.78 %	As Received	1006.59 mg	2015-09-23
	Calculation	93.38 %	Dried	Calculation	2015-09-30
811: Fixed Carbon (Calculated)					
	Calculation	5.77 %	Dried	Calculation	2015-09-30
	Calculation	5.42 %	As Received	Calculation	2015-09-30
C : Carbon					
	GLI Procedure ME-14	48.28 %	As Received	2.086 mg	2015-09-21
	Calculation	51.36 %	Dried	Calculation	2015-09-30
Cl : Chlorine					
	GLI Procedure ME-4A	11 ppm	As Received	481.40 mg	2015-09-18
	Calculation	12 ppm	Dried	Calculation	2015-09-30
d08: Oxygen by difference					
	Calculation	44.51 %	As Received	Calculation	2015-09-30
	Calculation	41.68 %	Dried	Calculation	2015-09-30
H : Hydrogen					
	GLI Procedure ME-14	6.39 %	As Received	2.086 mg	2015-09-21
	Calculation	6.08 %	Dried	Calculation	2015-09-30
N : Nitrogen					
	GLI Procedure ME-14	< 0.50 %	As Received	2.086 mg	2015-09-21
	Calculation	< 0.50 %	Dried	Calculation	2015-09-30
S : Sulfur					
	GLI Procedure E16-2	0.0185 %	As Received	167.844 mg	2015-09-15

	Calculation	0.020 %	Dried	Calculation	2015-09-30

Signatures:

Published By:	Debbie.S.Robertson	2015-09-30T18:46:50.053-04:00
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Appendix C. Analysis of Biomass Pellets

Laboratory Report

Report prepared for:
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Jacobs Technology Inc
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Report prepared by:
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Purchase Order:
EPATP-0000001844

For further assistance, contact:
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Report Production Coordinator
PO Box 51610
Knoxville, TN 37950 -1610
(865) 546-1335
debbierobertson@galbraith.com

Sample: Wood Pellets
Lab ID: 2017-E-2300 **Received:** 2017-05-16

Analysis	Method	Result	Basis	Sample Amount Used	Date (Time)
114: Heat of Combustion (BTU)					
	ASTM D5865	7778 BTU/lb	As Received	0.94603 g	2017-05-19
	Calculation	8274 BTU/lb	Dried	Calculation	2017-05-31
115: Ash					
	ASTM D3174	1.97 %	Dried and Ground	948.62 mg	2017-05-30
	Calculation	1.85 %	As Received	Calculation	2017-05-31
302: Loss on Drying (LOD)					
	ASTM D3173	6.00 %	Ground	1015.10 mg	2017-05-18
810: Volatile Matter					
	ASTM D3175	84.60 %	Dried and Ground	948.62 mg	2017-05-30
	Calculation	79.52 %	As Received	Calculation	2017-05-31
811: Fixed Carbon (Calculated)					
	Calculation	12.62 %	As Received	Calculation	2017-05-31
	Calculation	13.43 %	Dried	Calculation	2017-05-31
C : Carbon					
	GLI Procedure ME-14	45.95 %	Ground	3.179 mg	2017-05-24
	Calculation	48.88 %	Dried	Calculation	2017-05-31
Cl : Chlorine					
	GLI Procedure ME-4A	20 ppm	Ground	605.54 mg	2017-05-26
	Calculation	21 ppm	Dried	Calculation	2017-05-31
d08: Oxygen by difference					
	Calculation	42.71 %	Dried	Calculation	2017-05-31
	Calculation	45.47 %	As Received	Calculation	2017-05-31
Grn: Grind					
	GLI Procedure G-8	Completed	As Received	Direct	2017-05-17
H : Hydrogen					
	GLI Procedure ME-14	6.18 %	Ground	3.179 mg	2017-05-24
	Calculation	5.86 %	Dried	Calculation	2017-05-31
N : Nitrogen					

	GLI Procedure ME-14	< 0.5 %	Ground	3.179 mg	2017-05-24
	Calculation	< 0.53 %	Dried	Calculation	2017-05-31
S : Sulfur					
	GLI Procedure E16-3	0.042 %	Ground	30.639 mg	2017-05-18
	Calculation	0.044 %	Dried	Calculation	2017-05-31

Signatures:

Published By:	Debbie.S.Robertson	2017-05-31T18:01:49.453-04:00
Created By:	Debbie.S.Robertson	2017-05-31T18:00:44.293-04:00

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Appendix D. Particle Size Analysis of Sorbent for Rotary Kiln Tests

BASF Corporation

SediGraph III V1.07 | Unit 1 | Serial Number: 1045 | Page 1

Sample: # 2 SAMPLE
Operator:
Submitter:
File: C:\5120\DATA\001-796.SMP
Material/Liquid: Kaolin / Water
Measurement Principle: X-Ray monitored gravity sedimentation
Calculation Method: Stokes sedimentation and Beer's law of extinction

Test Number: 1
Analyzed: 4/27/2017 12:54:37PM
Reported: 4/27/2017 1:33:00PM
Liquid Visc: 0.7296 mPa·s
Analysis Temp: 35.0 °C
Full Scale Mass: 100.0 %

Analysis Type: Standard
Run Time: 0:33 hrs:min
Sample Density: 2.730 g/cm³
Liquid Density: 0.9943 g/cm³
Base/Full Scale: 140 / 99 kCnts/s
Reynolds Number: 0.22

Combined Report

Report by Size Table

Low Diameter (µm)	Cumulative Mass Finer (Percent)	Low Diameter (µm)	Cumulative Mass Finer (Percent)	Low Diameter (µm)	Cumulative Mass Finer (Percent)	Low Diameter (µm)	Cumulative Mass Finer (Percent)
10.00	82.2	2.000	44.2	0.500	3.4	0.300	-0.7
5.000	66.6	1.000	19.7	0.400	1.3	0.200	-0.7

Report by Mass Percent

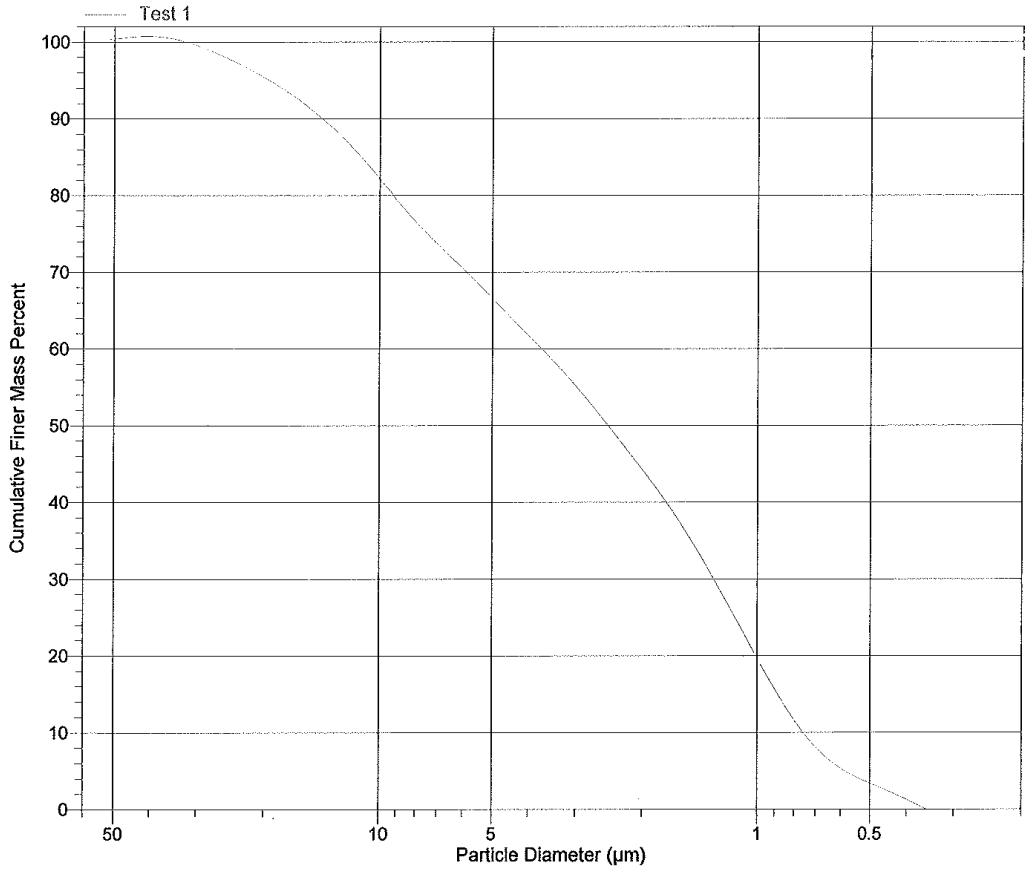
Low Diameter (µm)	Cumulative Mass Finer (Percent)
2.467	50.0

Sample: # 2 SAMPLE
Operator:
Submitter:
File: C:\5120\DATA\001-796.SMP
Material/Liquid: Kaolin / Water
Measurement Principle: X-Ray monitored gravity sedimentation
Calculation Method: Stokes sedimentation and Beer's law of extinction

Test Number: 1
Analyzed: 4/27/2017 12:54:37PM
Reported: 4/27/2017 1:33:00PM
Liquid Visc: 0.7296 mPa·s
Analysis Temp: 35.0 °C
Full Scale Mass: 100.0 %

Analysis Type: Standard
Run Time: 0:33 hrs:min
Sample Density: 2.730 g/cm³
Liquid Density: 0.9943 g/cm³
Base/Full Scale: 140 / 99 kCnts/s
Reynolds Number: 0.22

Cumulative Finer Mass Percent vs. Diameter



Appendix E: ICP-MS Results for MOUDI Filters

March 19, 2018

Paul Lemieux
US EPA
4930 Old Page Rd Rm E311G
Durham, NC 27703
TEL: (919) 541-0962
FAX

Order No.: 1802197

RE: Thermal Destruction of CBR Contaminants

Dear Paul Lemieux:

DHL Analytical, Inc. received 60 sample(s) on 2/26/2018 for the analyses presented in the following report.

There were no problems with the analyses and all data met requirements of NELAC except where noted in the Case Narrative. All non-NELAC methods will be identified accordingly in the case narrative and all estimated uncertainties of test results are within method or EPA specifications.

If you have any questions regarding these tests results, please feel free to call. Thank you for using DHL Analytical.

Sincerely,

John DuPont
General Manager

This report was performed under the accreditation of the State of Texas Laboratory Certification Number: T104704211-17-19

Table of Contents

JACOBS

109 T.W. Alexander Drive
RTP, NC 27709

Report to:	Bill to: Not Applicable

W.O. # 1802197

Page 1

Chain of Custody Record

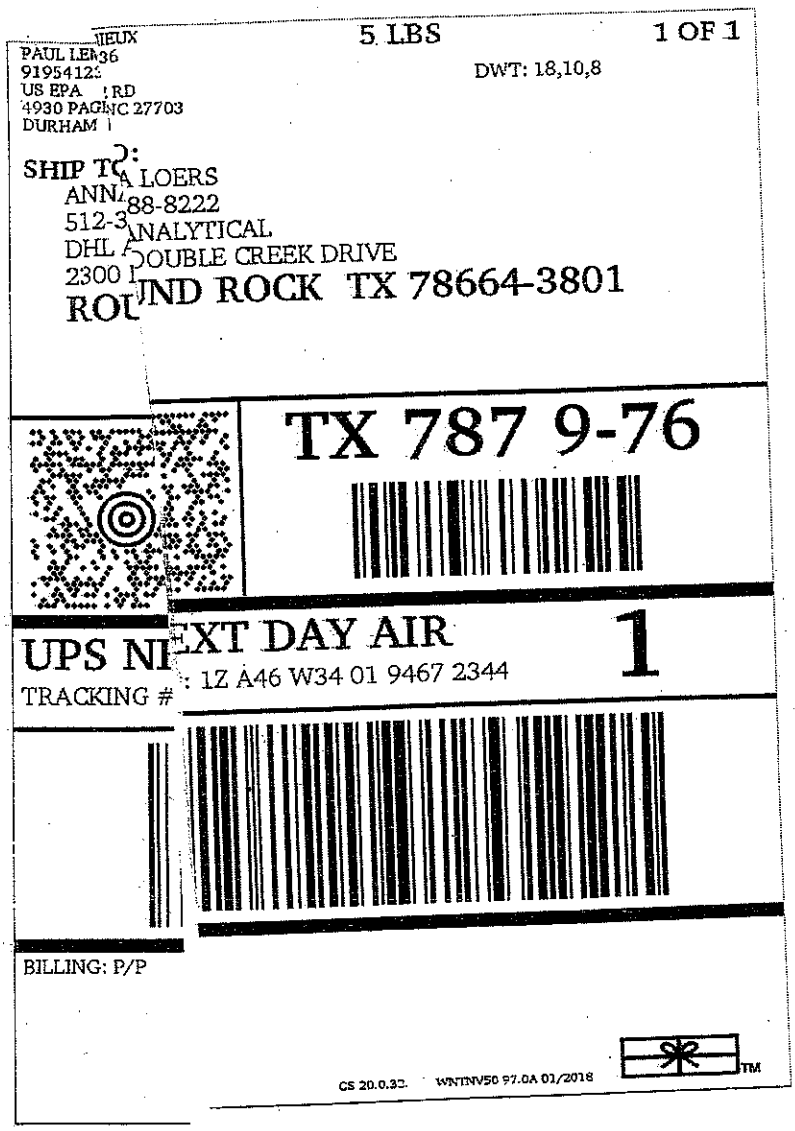
PROJECT NUMBER WA-2-068	PO# Not Applicable			No. of Containers	Analysis Required	LABORATORY: H106, E-485	
PROJECT NAME Thermal Destruction of CBR Contaminants						LAB ADDRESS EPA / RTP NC	
COLLECTED BY *(SIGNATURE)*						REPORT FORMAT *(CIRCLE ALL REQUIRED)* ELECTRONIC/VERBAL/FAX/HARDCOPY	
FIELD SAMPLE ID	RUSH FACTOR	SAMPLE Matrix	DATE/ TIME			REMARKS	LAB ID NO. (for lab use only)
1. Sample Substrates	ASAP	Polycarbon	01/23/2018	162	ICP-MS		
2. Sample Substrates	"	Quartz	01/23/2018	18	"		
3. Field Blanks	"	Polycarbon	01/23/2018	45	"		
4. Field Blanks	"	Quartz	01/23/2018	5	"		
5. Spiked Samples	"	Polycarbon	02/13/2018	10	"		

REMARKS 240 total substrates (217 polycarbon substrates; 23 quartz filters) Temp: 21.5 no cust. seal Therm: 78						RELINQUISHED BY: Larry Vintaranta	DATE 2/27/18	TIME 14:22
RECEIVED BY: UPS	DATE 2/23/18	TIME 6:46	RELINQUISHED BY: UPS	DATE 2/26/18	TIME 10:10	RECEIVED BY:	DATE 2/26/18	TIME 10:10

Please sign here.

W.O. # 1802197

					DHL #
121	184	B + Ce	R2	0	01
122	185	B + Ce	R2	1	02
123	186	B + Ce	R2	2	03
124	187	B + Ce	R2	3	04
125	188	B + Ce	R2	4	05
126	189	B + Ce	R2	5	06
127	190	B + Ce	R2	6	07
128	191	B + Ce	R2	7	08
129	192	B + Ce	R2	8	09
130	NA	B + Ce	R2	10	10
131	193	B + Ce	R3	0	11
132	194	B + Ce	R3	1	12
133	195	B + Ce	R3	2	13
134	196	B + Ce	R3	3	14
135	197	B + Ce	R3	4	15
136	198	B + Ce	R3	5	16
137	199	B + Ce	R3	6	17
138	200	B + Ce	R3	7	18
139	201	B + Ce	R3	8	19
140	NA	B + Ce	R3	10	20
141	229	B + Ce	R4	0	21
142	230	B + Ce	R4	1	22
143	231	B + Ce	R4	2	23
144	232	B + Ce	R4	3	24
145	234	B + Ce	R4	4	25
146	235	B + Ce	R4	5	26
147	236	B + Ce	R4	6	27
148	237	B + Ce	R4	7	28
149	238	B + Ce	R4	8	29
150	NA	B + Ce	R4	10	30
151	202	B + Ce + S	R1	0	31
152	203	B + Ce + S	R1	1	32
153	204	B + Ce + S	R1	2	33
154	205	B + Ce + S	R1	3	34
155	206	B + Ce + S	R1	4	35
156	207	B + Ce + S	R1	5	36
157	208	B + Ce + S	R1	6	37
158	209	B + Ce + S	R1	7	38
159	210	B + Ce + S	R1	8	39
160	NA	B + Ce + S	R1	10	40
161	211	B + Ce + S	R2	0	41
162	212	B + Ce + S	R2	1	42
163	213	B + Ce + S	R2	2	43
164	214	B + Ce + S	R2	3	44
165	215	B + Ce + S	R2	4	45
166	216	B + Ce + S	R2	5	46
167	217	B + Ce + S	R2	6	47
168	218	B + Ce + S	R2	7	48
169	219	B + Ce + S	R2	8	49
170	NA	B + Ce + S	R2	10	50
171	220	B + Ce + S	R3	0	51
172	221	B + Ce + S	R3	1	52
173	222	B + Ce + S	R3	2	53
174	223	B + Ce + S	R3	3	54
175	224	B + Ce + S	R3	4	55
176	225	B + Ce + S	R3	5	56
177	226	B + Ce + S	R3	6	57
178	227	B + Ce + S	R3	7	58
179	228	B + Ce + S	R3	8	59
180	NA	B + Ce + S	R3	10	60



5 LBS 1 OF 1

DWT: 18,10,8

PAUL LE[illegible]IEUX
9195412[illegible]
US EPA [illegible]RD
4930 PAG[illegible]NC 27703
DURHAM

SHIP TO:
ANN[illegible]A LOERS
512-3[illegible]88-8222
DHL [illegible]ANALYTICAL
2300 [illegible]OUBLE CREEK DRIVE
ROU[illegible]ND ROCK TX 78664-3801

TX 787 9-76

UPS NI[illegible]EXT DAY AIR 1

TRACKING #: 1Z A46 W34 01 9467 2344

BILLING: P/P

GS 20.0.32 WNTINV50 97.0A 01/2018

TM

UPS CampusShip

[illegible] CREEK DR
[illegible]8664

S: BLUE4 1:804 Pag
1004 X
2344 1030
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DHL Analytical, Inc.

Sample Receipt Checklist

Client Name US EPA | Date Received: 2/28/2018

Work Order Number 1802197 | Received by EL

Checklist completed by: _____ 2/28/2018 (Signature / Date) | Reviewed by: DL 2/28/2018 (Initials / Date)

Carrier name UPS Blue

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shippping container/cooler?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☐	No ☑	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐	21.5 °C
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH<2 acceptable upon receipt?	Yes ☐	No ☐	NA ☑ LOT #
	Adjusted? _____		Checked by _____
Water - ph>9 (S) or ph>10 (CN) acceptable upon receipt?	Yes ☐	No ☐	NA ☑ LOT #
	Adjusted? _____		Checked by _____

Any No response must be detailed in the comments section below.

Client contacted _____ Date contacted: _____ Person contacted _____

Contacted by: _____ Regarding: _____

Comments: CoC received w/o client signature

Corrective Action Client e-mailed signed CoC on 2/27/18.

Laboratory Name: DHL Analytical, Inc.

Laboratory Review Checklist: Reportable Data

Project Name: Thermal Destruction of CBR Contaminants	**LRC Date:** 3/19/18
Reviewer Name: Carlos Castro	**Laboratory Work Order:** 1802197
Prep Batch Number(s): See Prep Dates Report	**Run Batch:** See Analytical Dates Report

#[1]	A[2]	Description	Yes	No	NA[3]	NR[4]	ER#[5]
		Chain-of-Custody (C-O-C)					
R1	OI	**1)** Did samples meet the laboratory's standard conditions of sample acceptability upon receipt?	**X**				**R1-01**
		2) Were all departures from standard conditions described in an exception report?			**X**		
R2	OI	**Sample and Quality Control (QC) Identification**					
		1) Are all field sample ID numbers cross-referenced to the laboratory ID numbers?	**X**				
		2) Are all laboratory ID numbers cross-referenced to the corresponding QC data?	**X**				
R3	OI	**Test Reports**					
		1) Were all samples prepared and analyzed within holding times?	**X**				
		2) Other than those results < MQL, were all other raw values bracketed by calibration standards?	**X**				
		3) Were calculations checked by a peer or supervisor?	**X**				
		4) Were all analyte identifications checked by a peer or supervisor?	**X**				
		5) Were sample detection limits reported for all analytes not detected?	**X**				
		6) Were all results for soil and sediment samples reported on a dry weight basis?			**X**		
		7) Were % moisture (or solids) reported for all soil and sediment samples?			**X**		
		8) Were bulk soils/solids samples for volatile analysis extracted with methanol per EPA Method 5035?			**X**		
		9) If required for the project, TICs reported?			**X**		
R4	O	**Surrogate Recovery Data**					
		1) Were surrogates added prior to extraction?			**X**		
		2) Were surrogate percent recoveries in all samples within the laboratory QC limits?			**X**		
R5	OI	**Test Reports/Summary Forms for Blank Samples**					
		1) Were appropriate type(s) of blanks analyzed?	**X**				
		2) Were blanks analyzed at the appropriate frequency?	**X**				
		3) Where method blanks taken through the entire analytical process, including preparation and, if applicable, cleanup procedures?	**X**				
		4) Were blank concentrations < MDL?	**X**				
		5) For analyte(s) detected in a blank sample, was the concentration, unadjusted for sample specific factors, in all associated field samples, **greater** than 10 times the concentration in the blank sample?	**X**				
R6	OI	**Laboratory Control Samples (LCS):**					
		1) Were all COCs included in the LCS?	**X**				
		2) Was each LCS taken through the entire analytical procedure, including prep and cleanup steps?	**X**				
		3) Were LCSs analyzed at the required frequency?	**X**				
		4) Were LCS (and LCSD, if applicable) %Rs within the laboratory QC limits?	**X**				
		5) Does the detectability data document the laboratory's capability to detect the COCs at the MDL used to calculate the SDLs?	**X**				
		6) Was the LCSD RPD within QC limits (if applicable)?	**X**				
R7	OI	**Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Data**					
		1) Were the project/method specified analytes included in the MS and MSD?			**X**		
		2) Were MS/MSD analyzed at the appropriate frequency?			**X**		
		3) Were MS (and MSD, if applicable) %Rs within the laboratory QC limits?			**X**		
		4) Were MS/MSD RPDs within laboratory QC limits?			**X**		
R8	OI	**Analytical Duplicate Data**					
		1) Were appropriate analytical duplicates analyzed for each matrix?			**X**		
		2) Were analytical duplicates analyzed at the appropriate frequency?			**X**		
		3) Were RPDs or relative standard deviations within the laboratory QC limits?			**X**		
R9	OI	**Method Quantitation Limits (MQLs):**					
		1) Are the MQLs for each method analyte included in the laboratory data package?	**X**				
		2) Do the MQLs correspond to the concentration of the lowest non-zero calibration standard?	**X**				
		3) Are unadjusted MQLs and DCSs included in the laboratory data package?	**X**				
R10	OI	**Other Problems/Anomalies**					
		1) Are all known problems/anomalies/special conditions noted in this LRC and ER?	**X**				
		2) Was applicable and available technology used to lower the SDL to minimize the matrix interference affects on the sample results?	**X**				
		3) Is the laboratory NELAC-accredited under the Texas Laboratory Accreditation Program for the analytes, matrices and methods associated with this laboratory data package?	**X**				

Laboratory Name: DHL Analytical, Inc.

Laboratory Review Checklist (continued): Supporting Data

Project Name: Thermal Destruction of CBR Contaminants	**LRC Date:** 3/19/18
Reviewer Name: Carlos Castro	**Laboratory Work Order:** 1802197
Prep Batch Number(s): See Prep Dates Report	**Run Batch:** See Analytical Dates Report

#[1]	A[2]	Description	Yes	No	NA[3]	NR[4]	ER#[5]
S1	OI	**Initial Calibration (ICAL)**					
		1) Were response factors and/or relative response factors for each analyte within QC limits?	**X**				
		2) Were percent RSDs or correlation coefficient criteria met?	**X**				
		3) Was the number of standards recommended in the method used for all analytes?	**X**				
		4) Were all points generated between the lowest and highest standard used to calculate the curve?	**X**				
		5) Are ICAL data available for all instruments used?	**X**				
		6) Has the initial calibration curve been verified using an appropriate second source standard?	**X**				
S2	OI	**Initial and Continuing calibration Verification (ICCV and CCV) and Continuing Calibration blank (CCB):**					
		1) Was the CCV analyzed at the method-required frequency?	**X**				
		2) Were percent differences for each analyte within the method-required QC limits?	**X**				
		3) Was the ICAL curve verified for each analyte?	**X**				
		4) Was the absolute value of the analyte concentration in the inorganic CCB < MDL?	**X**				
S3	O	**Mass Spectral Tuning:**					
		1) Was the appropriate compound for the method used for tuning?	**X**				
		2) Were ion abundance data within the method-required QC limits?	**X**				
S4	O	**Internal Standards (IS):**					
		1) Were IS area counts and retention times within the method-required QC limits?	**X**				
S5	OI	**Raw Data (NELAC Section 5.5.10)**					
		1) Were the raw data (for example, chromatograms, spectral data) reviewed by an analyst?	**X**				
		2) Were data associated with manual integrations flagged on the raw data?	**X**				
S6	O	**Dual Column Confirmation**					
		1) Did dual column confirmation results meet the method-required QC?			**X**		
S7	O	**Tentatively Identified Compounds (TICs):**					
		1) If TICs were requested, were the mass spectra and TIC data subject to appropriate checks?			**X**		
S8	I	**Interference Check Sample (ICS) Results:**					
		1) Were percent recoveries within method QC limits?	**X**				
S9	I	**Serial Dilutions, Post Digestion Spikes, and Method of Standard Additions**					
		1) Were percent differences, recoveries, and the linearity within the QC limits specified in the method?		**X**			**S9-01**
S10	OI	**Method Detection Limit (MDL) Studies**					
		1) Was a MDL study performed for each reported analyte?	**X**				
		2) Is the MDL either adjusted or supported by the analysis of DCSs?			**X**		
S11	OI	**Proficiency Test Reports:**					
		1) Was the lab's performance acceptable on the applicable proficiency tests or evaluation studies?	**X**				
S12	OI	**Standards Documentation**					
		1) Are all standards used in the analyses NIST-traceable or obtained from other appropriate sources?	**X**				
S13	OI	**Compound/Analyte Identification Procedures**					
		1) Are the procedures for compound/analyte identification documented?	**X**				
S14	OI	**Demonstration of Analyst Competency (DOC)**					
		1) Was DOC conducted consistent with NELAC Chapter 5 – Appendix C?	**X**				
		2) Is documentation of the analyst's competency up-to-date and on file?	**X**				
S15	OI	**Verification/Validation Documentation for Methods** (NELAC Chapter 5)					
		1) Are all the methods used to generate the data documented, verified, and validated, where applicable?	**X**				
S16	OI	**Laboratory Standard Operating Procedures (SOPs):**					
		1) Are laboratory SOPs current and on file for each method performed?	**X**				

1 Items identified by the letter "R" should be included in the laboratory data package submitted to the TCEQ in the TRRP-required report(s). Items identified by the letter "S" should be retained and made available upon request for the appropriate retention period.
2 O = organic analyses; I = inorganic analyses (and general chemistry, when applicable).
3 NA = Not applicable.
4 NR = Not Reviewed.
5 ER# = Exception Report identification number (an Exception Report should be completed for an item if "NR" or "No" is checked).

Laboratory Data Package Signature Page – RG-366/TRRP-13

This data package consists of:

This signature page, the laboratory review checklist, and the following reportable data:

R1 Field chain-of-custody documentation;
R2 Sample identification cross-reference;
R3 Test reports (analytical data sheets) for each environmental sample that includes:
  a) Items consistent with NELAC Chapter 5,
  b) dilution factors,
  c) preparation methods,
  d) cleanup methods, and
  e) if required for the project, tentatively identified compounds (TICs).
R4 Surrogate recovery data including:
  a) Calculated recovery (%R), and
  b) The laboratory's surrogate QC limits.
R5 Test reports/summary forms for blank samples;
R6 Test reports/summary forms for laboratory control samples (LCSs) including:
  a) LCS spiking amounts,
  b) Calculated %R for each analyte, and
  c) The laboratory's LCS QC limits.
R7 Test reports for project matrix spike/matrix spike duplicates (MS/MSDs) including:
  a) Samples associated with the MS/MSD clearly identified,
  b) MS/MSD spiking amounts,
  c) Concentration of each MS/MSD analyte measured in the parent and spiked samples,
  d) Calculated %Rs and relative percent differences (RPDs), and
  e) The laboratory's MS/MSD QC limits
R8 Laboratory analytical duplicate (if applicable) recovery and precision:
  a) The amount of analyte measured in the duplicate,
  b) The calculated RPD, and
  c) The laboratory's QC limits for analytical duplicates.
R9 List of method quantitation limits (MQLs) and detectability check sample results for each analyte for each method and matrix;
R10 Other problems or anomalies.

The Exception Report for each "No" or "Not Reviewed (NR)" item in the Laboratory Review Checklist and for each analyte, matrix, and method for which the laboratory is not accredited under the Texas Laboratory Accreditation Program.

Release Statement: I am responsible for the release of this laboratory data package. This laboratory is accredited under the Texas Laboratory Accreditation Program for all the methods, analytes, and matrices reported in this data package except as noted in the Exception Reports. The data have been reviewed and are technically compliant with the requirements of the methods used, except where noted by the laboratory in the Exception Reports. By my signature below, I affirm to the best of my knowledge that all problems/anomalies observed by the laboratory have been identified in the Laboratory Review Checklist, and no information or data affecting the quality of the data has been knowingly withheld.

This laboratory was last inspected by TCEQ on March 27, 2017. Any findings affecting the data in this laboratory data package are noted in the Exception Reports herein. The official signing the cover page of the report in which these data are used is responsible for releasing this data package and is by signature affirming the above release statement is true.

Name: John DuPont
Official Title: General Manager

Signature

03/19/18

Date

Name: Dr. Derhsing Luu
Official Title: Technical Director

Samples were analyzed using the methods outlined in the following references:

Method SW6020A - Metals Analysis (The analytes Cesium and Silicon are not NELAC Certified)

PROJECT SPECIFICATIONS

As per the project Statement of Work, DHL Analytical performed the analyses of the Moudi filter samples for Aluminum, Potassium, Sodium, Silicon and Cesium according to the published EPA Method 6020a, prepared according to EPA Method 3050C and reported in accordance with relevant National Environmental Laboratory Accreditation Program (NELAP). All incidental exceptions to NELAP requirements are noted in the report narrative. DHL Analytical is NELAP accredited by Texas Commission on Environmental Quality (TCEQ) and this agency does not offer accreditation for Cesium or Silicon by Method 6020A. Results for this project are reported in units of µg/filter.

All 240 samples received were filter samples and they were prepared according to EPA Method 3050C and in accordance with DHL Analytical's SOP. The filters were transferred from the plastic planchet holder to the digestion vessel by using tweezers to fold the filter once, then transferring the filter into the digestion vessel, and then rinsing the interior of the planchet with a small volume of DI water; the water was then transferred to the digestion vessel. Acid digestion of the samples plus batch QC (Method Blank, LCS and LCSD) then followed DHL Analytical's SOP and as per the SOP, each batch contains a maximum of 20 samples. After digestion was completed, each sample was analyzed to achieve the lowest possible reporting limit within the constraints of DHL Analytical's SOP for Method 6020A. For Cesium the method detection limit (MDL) was determined via EPA protocol to be 0.05 µg/filter and for all other target analytes the MDL is 12.5 µg/filter. All analyses were performed in accordance with established laboratory standard operating procedures (SOPs) that incorporate QA/QC procedures described in the method.

Exception Report R1-01

The samples were received and log-in performed on 2/26/2018. A total of 240 samples were received and 60 samples were logged in under this work order and analyzed. The Chain-of-Custody (COC) was not signed by the client upon arrival at DHL Analytical. The client sent a signed COC and sample ID summary to DHL Analytical via email on 2/27/2018. The samples arrived in good condition and were properly packaged.

Exception Report S9-01

For Metals analysis performed on 3/14/18 (batch 84655) the RPD for the serial dilution was above control limits for Silicon. This is flagged accordingly in the QC summary report. The PDS was within

control limits for this analyte. No further corrective actions were taken.

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT: US EPA
Project: Thermal Destruction of CBR Contaminants
Lab Order: 1802197

Work Order Sample Summary

Lab Smp ID	Client Sample ID	Tag Number	Date Collected	Date Recved
1802197-01	B+Ce - R2 - 0	184	01/23/18	2/26/2018
1802197-02	B+Ce - R2 - 1	185	01/23/18	2/26/2018
1802197-03	B+Ce - R2 - 2	186	01/23/18	2/26/2018
1802197-04	B+Ce - R2 - 3	187	01/23/18	2/26/2018
1802197-05	B+Ce - R2 - 4	188	01/23/18	2/26/2018
1802197-06	B+Ce - R2 - 5	189	01/23/18	2/26/2018
1802197-07	B+Ce - R2 - 6	190	01/23/18	2/26/2018
1802197-08	B+Ce - R2 - 7	191	01/23/18	2/26/2018
1802197-09	B+Ce - R2 - 8	192	01/23/18	2/26/2018
1802197-10	B+Ce - R2 - 10	NA	01/23/18	2/26/2018
1802197-11	B+Ce - R3 - 0	193	01/23/18	2/26/2018
1802197-12	B+Ce - R3 - 1	194	01/23/18	2/26/2018
1802197-13	B+Ce - R3 - 2	195	01/23/18	2/26/2018
1802197-14	B+Ce - R3 - 3	196	01/23/18	2/26/2018
1802197-15	B+Ce - R3 - 4	197	01/23/18	2/26/2018
1802197-16	B+Ce - R3 - 5	198	01/23/18	2/26/2018
1802197-17	B+Ce - R3 - 6	199	01/23/18	2/26/2018
1802197-18	B+Ce - R3 - 7	200	01/23/18	2/26/2018
1802197-19	B+Ce - R3 - 8	201	01/23/18	2/26/2018
1802197-20	B+Ce - R3 - 10	NA	01/23/18	2/26/2018
1802197-21	B+Ce - R4 - 0	229	01/23/18	2/26/2018
1802197-22	B+Ce - R4 - 1	230	01/23/18	2/26/2018
1802197-23	B+Ce - R4 - 2	231	01/23/18	2/26/2018
1802197-24	B+Ce - R4 - 3	232	01/23/18	2/26/2018
1802197-25	B+Ce - R4 - 4	234	01/23/18	2/26/2018
1802197-26	B+Ce - R4 - 5	235	01/23/18	2/26/2018
1802197-27	B+Ce - R4 - 6	236	01/23/18	2/26/2018
1802197-28	B+Ce - R4 - 7	237	01/23/18	2/26/2018
1802197-29	B+Ce - R4 - 8	238	01/23/18	2/26/2018
1802197-30	B+Ce - R4 - 10	NA	01/23/18	2/26/2018
1802197-31	B+Ce+S - R1 - 0	202	01/23/18	2/26/2018
1802197-32	B+Ce+S - R1 - 1	203	01/23/18	2/26/2018
1802197-33	B+Ce+S - R1 - 2	204	01/23/18	2/26/2018
1802197-34	B+Ce+S - R1 - 3	205	01/23/18	2/26/2018
1802197-35	B+Ce+S - R1 - 4	206	01/23/18	2/26/2018
1802197-36	B+Ce+S - R1 - 5	207	01/23/18	2/26/2018
1802197-37	B+Ce+S - R1 - 6	208	01/23/18	2/26/2018
1802197-38	B+Ce+S - R1 - 7	209	01/23/18	2/26/2018

CLIENT: US EPA
Project: Thermal Destruction of CBR Contaminants
Lab Order: 1802197

Work Order Sample Summary

Lab Smp ID	Client Sample ID	Tag Number	Date Collected	Date Recved
1802197-39	B+Ce+S - R1 - 8	210	01/23/18	2/26/2018
1802197-40	B+Ce+S - R1 - 10	NA	01/23/18	2/26/2018
1802197-41	B+Ce+S - R2 - 0	211	01/23/18	2/26/2018
1802197-42	B+Ce+S - R2 - 1	212	01/23/18	2/26/2018
1802197-43	B+Ce+S - R2 - 2	213	01/23/18	2/26/2018
1802197-44	B+Ce+S - R2 - 3	214	01/23/18	2/26/2018
1802197-45	B+Ce+S - R2 - 4	215	01/23/18	2/26/2018
1802197-46	B+Ce+S - R2 - 5	216	01/23/18	2/26/2018
1802197-47	B+Ce+S - R2 - 6	217	01/23/18	2/26/2018
1802197-48	B+Ce+S - R2 - 7	218	01/23/18	2/26/2018
1802197-49	B+Ce+S - R2 - 8	219	01/23/18	2/26/2018
1802197-50	B+Ce+S - R2 - 10	NA	01/23/18	2/26/2018
1802197-51	B+Ce+S - R3 - 0	220	01/23/18	2/26/2018
1802197-52	B+Ce+S - R3 - 1	221	01/23/18	2/26/2018
1802197-53	B+Ce+S - R3 - 2	222	01/23/18	2/26/2018
1802197-54	B+Ce+S - R3 - 3	223	01/23/18	2/26/2018
1802197-55	B+Ce+S - R3 - 4	224	01/23/18	2/26/2018
1802197-56	B+Ce+S - R3 - 5	225	01/23/18	2/26/2018
1802197-57	B+Ce+S - R3 - 6	226	01/23/18	2/26/2018
1802197-58	B+Ce+S - R3 - 7	227	01/23/18	2/26/2018
1802197-59	B+Ce+S - R3 - 8	228	01/23/18	2/26/2018
1802197-60	B+Ce+S - R3 - 10	NA	01/23/18	2/26/2018

Lab Order: 1802197
Client: US EPA
Project: Thermal Destruction of CBR Cont

PREP DATES REPORT

Sample ID	Client Sample ID	Collection Date	Matrix	Test Number	Test Name	Prep Date	Batch ID
1802197-01A	B+Ce - R2 - 0	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-02A	B+Ce - R2 - 1	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-03A	B+Ce - R2 - 2	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-04A	B+Ce - R2 - 3	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-05A	B+Ce - R2 - 4	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-06A	B+Ce - R2 - 5	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-07A	B+Ce - R2 - 6	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-08A	B+Ce - R2 - 7	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-09A	B+Ce - R2 - 8	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-10A	B+Ce - R2 - 10	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-11A	B+Ce - R3 - 0	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-12A	B+Ce - R3 - 1	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-13A	B+Ce - R3 - 2	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-14A	B+Ce - R3 - 3	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-15A	B+Ce - R3 - 4	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-16A	B+Ce - R3 - 5	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-17A	B+Ce - R3 - 6	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-18A	B+Ce - R3 - 7	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-19A	B+Ce - R3 - 8	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-20A	B+Ce - R3 - 10	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/12/18 08:11 AM	84655
1802197-21A	B+Ce - R4 - 0	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-22A	B+Ce - R4 - 1	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-23A	B+Ce - R4 - 2	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-24A	B+Ce - R4 - 3	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-25A	B+Ce - R4 - 4	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-26A	B+Ce - R4 - 5	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-27A	B+Ce - R4 - 6	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-28A	B+Ce - R4 - 7	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699

Lab Order: 1802197
Client: US EPA
Project: Thermal Destruction of CBR Cont

PREP DATES REPORT

Sample ID	Client Sample ID	Collection Date	Matrix	Test Number	Test Name	Prep Date	Batch ID
1802197-29A	B+Ce - R4 - 8	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-30A	B+Ce - R4 - 10	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-31A	B+Ce+S - R1 - 0	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-32A	B+Ce+S - R1 - 1	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-33A	B+Ce+S - R1 - 2	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-34A	B+Ce+S - R1 - 3	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-35A	B+Ce+S - R1 - 4	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-36A	B+Ce+S - R1 - 5	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-37A	B+Ce+S - R1 - 6	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-38A	B+Ce+S - R1 - 7	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-39A	B+Ce+S - R1 - 8	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-40A	B+Ce+S - R1 - 10	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:23 AM	84699
1802197-41A	B+Ce+S - R2 - 0	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-42A	B+Ce+S - R2 - 1	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-43A	B+Ce+S - R2 - 2	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-44A	B+Ce+S - R2 - 3	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-45A	B+Ce+S - R2 - 4	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-46A	B+Ce+S - R2 - 5	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-47A	B+Ce+S - R2 - 6	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-48A	B+Ce+S - R2 - 7	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-49A	B+Ce+S - R2 - 8	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-50A	B+Ce+S - R2 - 10	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-51A	B+Ce+S - R3 - 0	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-52A	B+Ce+S - R3 - 1	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-53A	B+Ce+S - R3 - 2	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-54A	B+Ce+S - R3 - 3	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-55A	B+Ce+S - R3 - 4	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-56A	B+Ce+S - R3 - 5	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700

Lab Order: 1802197
Client: US EPA
Project: Thermal Destruction of CBR Cont

PREP DATES REPORT

Sample ID	Client Sample ID	Collection Date	Matrix	Test Number	Test Name	Prep Date	Batch ID
1802197-57A	B+Ce+S - R3 - 6	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-58A	B+Ce+S - R3 - 7	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-59A	B+Ce+S - R3 - 8	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700
1802197-60A	B+Ce+S - R3 - 10	01/23/18	Filter	SW3050B	Soil Prep Total Metals: ICP-MS	03/14/18 09:25 AM	84700

Lab Order: 1802197
Client: US EPA
Project: Thermal Destruction of CBR Cont

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1802197-01A	B+Ce - R2 - 0	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 04:37 PM	ICP-MS4_180314B
1802197-02A	B+Ce - R2 - 1	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 04:39 PM	ICP-MS4_180314B
1802197-03A	B+Ce - R2 - 2	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 04:41 PM	ICP-MS4_180314B
1802197-04A	B+Ce - R2 - 3	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 04:43 PM	ICP-MS4_180314B
1802197-05A	B+Ce - R2 - 4	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 04:45 PM	ICP-MS4_180314B
1802197-06A	B+Ce - R2 - 5	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 04:47 PM	ICP-MS4_180314B
1802197-07A	B+Ce - R2 - 6	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 04:49 PM	ICP-MS4_180314B
1802197-08A	B+Ce - R2 - 7	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 04:51 PM	ICP-MS4_180314B
1802197-09A	B+Ce - R2 - 8	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 04:53 PM	ICP-MS4_180314B
1802197-10A	B+Ce - R2 - 10	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 04:33 PM	ICP-MS4_180314B
1802197-11A	B+Ce - R3 - 0	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 05:07 PM	ICP-MS4_180314B
1802197-12A	B+Ce - R3 - 1	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 05:09 PM	ICP-MS4_180314B
1802197-13A	B+Ce - R3 - 2	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 05:11 PM	ICP-MS4_180314B
1802197-14A	B+Ce - R3 - 3	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 05:13 PM	ICP-MS4_180314B
1802197-15A	B+Ce - R3 - 4	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 05:15 PM	ICP-MS4_180314B
1802197-16A	B+Ce - R3 - 5	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 05:17 PM	ICP-MS4_180314B
1802197-17A	B+Ce - R3 - 6	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 05:19 PM	ICP-MS4_180314B
1802197-18A	B+Ce - R3 - 7	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 05:21 PM	ICP-MS4_180314B
1802197-19A	B+Ce - R3 - 8	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 05:23 PM	ICP-MS4_180314B
1802197-20A	B+Ce - R3 - 10	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84655	5	03/14/18 05:25 PM	ICP-MS4_180314B
1802197-21A	B+Ce - R4 - 0	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 12:46 PM	ICP-MS4_180315A
1802197-22A	B+Ce - R4 - 1	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 12:48 PM	ICP-MS4_180315A
1802197-23A	B+Ce - R4 - 2	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 12:50 PM	ICP-MS4_180315A
1802197-24A	B+Ce - R4 - 3	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 12:52 PM	ICP-MS4_180315A
1802197-25A	B+Ce - R4 - 4	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 12:54 PM	ICP-MS4_180315A
1802197-26A	B+Ce - R4 - 5	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 12:56 PM	ICP-MS4_180315A
1802197-27A	B+Ce - R4 - 6	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 12:42 PM	ICP-MS4_180315A
1802197-28A	B+Ce - R4 - 7	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 12:58 PM	ICP-MS4_180315A

Lab Order: 1802197
Client: US EPA
Project: Thermal Destruction of CBR Cont

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1802197-29A	B+Ce - R4 - 8	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 01:00 PM	ICP-MS4_180315A
1802197-30A	B+Ce - R4 - 10	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 01:02 PM	ICP-MS4_180315A
1802197-31A	B+Ce+S - R1 - 0	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 01:15 PM	ICP-MS4_180315A
1802197-32A	B+Ce+S - R1 - 1	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 01:17 PM	ICP-MS4_180315A
1802197-33A	B+Ce+S - R1 - 2	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 01:19 PM	ICP-MS4_180315A
1802197-34A	B+Ce+S - R1 - 3	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 01:21 PM	ICP-MS4_180315A
1802197-35A	B+Ce+S - R1 - 4	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 01:23 PM	ICP-MS4_180315A
1802197-36A	B+Ce+S - R1 - 5	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 01:25 PM	ICP-MS4_180315A
1802197-37A	B+Ce+S - R1 - 6	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 01:27 PM	ICP-MS4_180315A
1802197-38A	B+Ce+S - R1 - 7	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 01:29 PM	ICP-MS4_180315A
1802197-39A	B+Ce+S - R1 - 8	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 01:31 PM	ICP-MS4_180315A
1802197-40A	B+Ce+S - R1 - 10	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84699	5	03/15/18 01:34 PM	ICP-MS4_180315A
1802197-41A	B+Ce+S - R2 - 0	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 01:54 PM	ICP-MS4_180315A
1802197-42A	B+Ce+S - R2 - 1	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 01:58 PM	ICP-MS4_180315A
1802197-43A	B+Ce+S - R2 - 2	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:00 PM	ICP-MS4_180315A
1802197-44A	B+Ce+S - R2 - 3	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:02 PM	ICP-MS4_180315A
1802197-45A	B+Ce+S - R2 - 4	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:04 PM	ICP-MS4_180315A
1802197-46A	B+Ce+S - R2 - 5	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:06 PM	ICP-MS4_180315A
1802197-47A	B+Ce+S - R2 - 6	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:08 PM	ICP-MS4_180315A
1802197-48A	B+Ce+S - R2 - 7	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:10 PM	ICP-MS4_180315A
1802197-49A	B+Ce+S - R2 - 8	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:13 PM	ICP-MS4_180315A
1802197-50A	B+Ce+S - R2 - 10	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:15 PM	ICP-MS4_180315A
1802197-51A	B+Ce+S - R3 - 0	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:29 PM	ICP-MS4_180315A
1802197-52A	B+Ce+S - R3 - 1	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:31 PM	ICP-MS4_180315A
1802197-53A	B+Ce+S - R3 - 2	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:33 PM	ICP-MS4_180315A
1802197-54A	B+Ce+S - R3 - 3	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:35 PM	ICP-MS4_180315A
1802197-55A	B+Ce+S - R3 - 4	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:37 PM	ICP-MS4_180315A
1802197-56A	B+Ce+S - R3 - 5	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:39 PM	ICP-MS4_180315A

Lab Order: 1802197
Client: US EPA
Project: Thermal Destruction of CBR Cont

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1802197-57A	B+Ce+S - R3 - 6	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:41 PM	ICP-MS4_180315A
1802197-58A	B+Ce+S - R3 - 7	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:43 PM	ICP-MS4_180315A
1802197-59A	B+Ce+S - R3 - 8	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:45 PM	ICP-MS4_180315A
1802197-60A	B+Ce+S - R3 - 10	Filter	SW6020A	Trace Metals: ICP-MS - Moudi Filter	84700	5	03/15/18 02:47 PM	ICP-MS4_180315A

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R2 - 0
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-01
Project No:	PR-ORD-17-02372	**Alternate ID:**	184
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:37 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 04:37 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:37 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 04:37 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:37 PM
IS: Indium	98.4	0	70-200		%REC	5	03/14/18 04:37 PM
IS: Scandium(1)	96.2	0	70-200		%REC	5	03/14/18 04:37 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R2 - 1
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-02
Project No:	PR-ORD-17-02372	**Alternate ID:**	185
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:39 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 04:39 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:39 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 04:39 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:39 PM
IS: Indium	98.9	0	70-200		%REC	5	03/14/18 04:39 PM
IS: Scandium(1)	94.5	0	70-200		%REC	5	03/14/18 04:39 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R2 - 2
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-03
Project No:	PR-ORD-17-02372	**Alternate ID:**	186
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:41 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 04:41 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:41 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 04:41 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:41 PM
IS: Indium	99.6	0	70-200		%REC	5	03/14/18 04:41 PM
IS: Scandium(1)	96.0	0	70-200		%REC	5	03/14/18 04:41 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R2 - 3
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-04
Project No:	PR-ORD-17-02372	**Alternate ID:**	187
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:43 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 04:43 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:43 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 04:43 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:43 PM
IS: Indium	98.7	0	70-200		%REC	5	03/14/18 04:43 PM
IS: Scandium(1)	95.0	0	70-200		%REC	5	03/14/18 04:43 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R2 - 4
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-05
Project No:	PR-ORD-17-02372	**Alternate ID:**	188
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:45 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 04:45 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:45 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 04:45 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:45 PM
IS: Indium	97.1	0	70-200		%REC	5	03/14/18 04:45 PM
IS: Scandium(1)	93.8	0	70-200		%REC	5	03/14/18 04:45 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R2 - 5
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-06
Project No:	PR-ORD-17-02372	**Alternate ID:**	189
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:47 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 04:47 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:47 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 04:47 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:47 PM
IS: Indium	97.6	0	70-200		%REC	5	03/14/18 04:47 PM
IS: Scandium(1)	94.0	0	70-200		%REC	5	03/14/18 04:47 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R2 - 6
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-07
Project No:	PR-ORD-17-02372	**Alternate ID:**	190
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:49 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 04:49 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:49 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 04:49 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:49 PM
IS: Indium	99.4	0	70-200		%REC	5	03/14/18 04:49 PM
IS: Scandium(1)	96.0	0	70-200		%REC	5	03/14/18 04:49 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R2 - 7
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-08
Project No:	PR-ORD-17-02372	**Alternate ID:**	191
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:51 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 04:51 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:51 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 04:51 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:51 PM
IS: Indium	98.9	0	70-200		%REC	5	03/14/18 04:51 PM
IS: Scandium(1)	96.2	0	70-200		%REC	5	03/14/18 04:51 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R2 - 8
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-09
Project No:	PR-ORD-17-02372	**Alternate ID:**	192
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:53 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 04:53 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:53 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 04:53 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:53 PM
IS: Indium	99.6	0	70-200		%REC	5	03/14/18 04:53 PM
IS: Scandium(1)	96.4	0	70-200		%REC	5	03/14/18 04:53 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R2 - 10
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-10
Project No:	PR-ORD-17-02372	**Alternate ID:**	NA
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:33 PM
Cesium	0.274	0.0500	2.00	JN	µg/Filter	5	03/14/18 04:33 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:33 PM
Silicon	89.4	12.5	37.5	N	µg/Filter	5	03/14/18 04:33 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 04:33 PM
IS: Indium	98.2	0	70-200		%REC	5	03/14/18 04:33 PM
IS: Scandium(1)	95.7	0	70-200		%REC	5	03/14/18 04:33 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R3 - 0
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-11
Project No:	PR-ORD-17-02372	**Alternate ID:**	193
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:07 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 05:07 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:07 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 05:07 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:07 PM
IS: Indium	98.0	0	70-200		%REC	5	03/14/18 05:07 PM
IS: Scandium(1)	94.8	0	70-200		%REC	5	03/14/18 05:07 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R3 - 1
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-12
Project No:	PR-ORD-17-02372	**Alternate ID:**	194
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:09 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 05:09 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:09 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 05:09 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:09 PM
IS: Indium	98.9	0	70-200		%REC	5	03/14/18 05:09 PM
IS: Scandium(1)	95.3	0	70-200		%REC	5	03/14/18 05:09 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R3 - 2
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-13
Project No:	PR-ORD-17-02372	**Alternate ID:**	195
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:11 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 05:11 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:11 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 05:11 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:11 PM
IS: Indium	98.2	0	70-200		%REC	5	03/14/18 05:11 PM
IS: Scandium(1)	95.8	0	70-200		%REC	5	03/14/18 05:11 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R3 - 3
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-14
Project No:	PR-ORD-17-02372	**Alternate ID:**	196
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:13 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 05:13 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:13 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 05:13 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:13 PM
IS: Indium	98.6	0	70-200		%REC	5	03/14/18 05:13 PM
IS: Scandium(1)	95.4	0	70-200		%REC	5	03/14/18 05:13 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R3 - 4
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-15
Project No:	PR-ORD-17-02372	**Alternate ID:**	197
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:15 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 05:15 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:15 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 05:15 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:15 PM
IS: Indium	99.1	0	70-200		%REC	5	03/14/18 05:15 PM
IS: Scandium(1)	94.3	0	70-200		%REC	5	03/14/18 05:15 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R3 - 5
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-16
Project No:	PR-ORD-17-02372	**Alternate ID:**	198
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:17 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 05:17 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:17 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 05:17 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:17 PM
IS: Indium	97.4	0	70-200		%REC	5	03/14/18 05:17 PM
IS: Scandium(1)	98.1	0	70-200		%REC	5	03/14/18 05:17 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R3 - 6
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-17
Project No:	PR-ORD-17-02372	**Alternate ID:**	199
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:19 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 05:19 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:19 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 05:19 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:19 PM
IS: Indium	98.5	0	70-200		%REC	5	03/14/18 05:19 PM
IS: Scandium(1)	95.7	0	70-200		%REC	5	03/14/18 05:19 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R3 - 7
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-18
Project No:	PR-ORD-17-02372	**Alternate ID:**	200
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:21 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 05:21 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:21 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 05:21 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:21 PM
IS: Indium	99.2	0	70-200		%REC	5	03/14/18 05:21 PM
IS: Scandium(1)	94.5	0	70-200		%REC	5	03/14/18 05:21 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R3 - 8
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-19
Project No:	PR-ORD-17-02372	**Alternate ID:**	201
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:23 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/14/18 05:23 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:23 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/14/18 05:23 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:23 PM
IS: Indium	99.5	0	70-200		%REC	5	03/14/18 05:23 PM
IS: Scandium(1)	96.2	0	70-200		%REC	5	03/14/18 05:23 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R3 - 10
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-20
Project No:	PR-ORD-17-02372	**Alternate ID:**	NA
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:25 PM
Cesium	0.290	0.0500	2.00	JN	µg/Filter	5	03/14/18 05:25 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:25 PM
Silicon	87.0	12.5	37.5	N	µg/Filter	5	03/14/18 05:25 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/14/18 05:25 PM
IS: Indium	98.7	0	70-200		%REC	5	03/14/18 05:25 PM
IS: Scandium(1)	93.3	0	70-200		%REC	5	03/14/18 05:25 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R4 - 0
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-21
Project No:	PR-ORD-17-02372	**Alternate ID:**	229
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:46 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 12:46 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:46 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 12:46 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:46 PM
IS: Indium	104	0	70-200		%REC	5	03/15/18 12:46 PM
IS: Scandium(1)	99.6	0	70-200		%REC	5	03/15/18 12:46 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R4 - 1
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-22
Project No:	PR-ORD-17-02372	**Alternate ID:**	230
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:48 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 12:48 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:48 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 12:48 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:48 PM
IS: Indium	103	0	70-200		%REC	5	03/15/18 12:48 PM
IS: Scandium(1)	100	0	70-200		%REC	5	03/15/18 12:48 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R4 - 2
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-23
Project No:	PR-ORD-17-02372	**Alternate ID:**	231
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:50 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 12:50 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:50 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 12:50 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:50 PM
IS: Indium	104	0	70-200		%REC	5	03/15/18 12:50 PM
IS: Scandium(1)	100	0	70-200		%REC	5	03/15/18 12:50 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R4 - 3
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-24
Project No:	PR-ORD-17-02372	**Alternate ID:**	232
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:52 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 12:52 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:52 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 12:52 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:52 PM
IS: Indium	102	0	70-200		%REC	5	03/15/18 12:52 PM
IS: Scandium(1)	99.8	0	70-200		%REC	5	03/15/18 12:52 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R4 - 4
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-25
Project No:	PR-ORD-17-02372	**Alternate ID:**	234
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:54 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 12:54 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:54 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 12:54 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:54 PM
IS: Indium	104	0	70-200		%REC	5	03/15/18 12:54 PM
IS: Scandium(1)	100	0	70-200		%REC	5	03/15/18 12:54 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R4 - 5
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-26
Project No:	PR-ORD-17-02372	**Alternate ID:**	235
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:56 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 12:56 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:56 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 12:56 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:56 PM
IS: Indium	103	0	70-200		%REC	5	03/15/18 12:56 PM
IS: Scandium(1)	99.5	0	70-200		%REC	5	03/15/18 12:56 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R4 - 6
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-27
Project No:	PR-ORD-17-02372	**Alternate ID:**	236
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:42 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 12:42 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:42 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 12:42 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:42 PM
IS: Indium	103	0	70-200		%REC	5	03/15/18 12:42 PM
IS: Scandium(1)	100	0	70-200		%REC	5	03/15/18 12:42 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R4 - 7
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-28
Project No:	PR-ORD-17-02372	**Alternate ID:**	237
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:58 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 12:58 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:58 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 12:58 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 12:58 PM
IS: Indium	102	0	70-200		%REC	5	03/15/18 12:58 PM
IS: Scandium(1)	100	0	70-200		%REC	5	03/15/18 12:58 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R4 - 8
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-29
Project No:	PR-ORD-17-02372	**Alternate ID:**	238
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:00 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 01:00 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:00 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 01:00 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:00 PM
IS: Indium	103	0	70-200		%REC	5	03/15/18 01:00 PM
IS: Scandium(1)	100	0	70-200		%REC	5	03/15/18 01:00 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce - R4 - 10
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-30
Project No:	PR-ORD-17-02372	**Alternate ID:**	NA
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:02 PM
Cesium	0.394	0.0500	2.00	JN	µg/Filter	5	03/15/18 01:02 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:02 PM
Silicon	123	12.5	37.5	N	µg/Filter	5	03/15/18 01:02 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:02 PM
IS: Indium	103	0	70-200		%REC	5	03/15/18 01:02 PM
IS: Scandium(1)	97.5	0	70-200		%REC	5	03/15/18 01:02 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R1 - 0
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-31
Project No:	PR-ORD-17-02372	**Alternate ID:**	202
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:15 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 01:15 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:15 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 01:15 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:15 PM
IS: Indium	103	0	70-200		%REC	5	03/15/18 01:15 PM
IS: Scandium(1)	97.7	0	70-200		%REC	5	03/15/18 01:15 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R1 - 1
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-32
Project No:	PR-ORD-17-02372	**Alternate ID:**	203
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:17 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 01:17 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:17 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 01:17 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:17 PM
IS: Indium	102	0	70-200		%REC	5	03/15/18 01:17 PM
IS: Scandium(1)	97.5	0	70-200		%REC	5	03/15/18 01:17 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R1 - 2
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-33
Project No:	PR-ORD-17-02372	**Alternate ID:**	204
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:19 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 01:19 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:19 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 01:19 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:19 PM
IS: Indium	102	0	70-200		%REC	5	03/15/18 01:19 PM
IS: Scandium(1)	98.2	0	70-200		%REC	5	03/15/18 01:19 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R1 - 3
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-34
Project No:	PR-ORD-17-02372	**Alternate ID:**	205
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	22.5	12.5	37.5	J	µg/Filter	5	03/15/18 01:21 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 01:21 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:21 PM
Silicon	24.0	12.5	37.5	JN	µg/Filter	5	03/15/18 01:21 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:21 PM
IS: Indium	102	0	70-200		%REC	5	03/15/18 01:21 PM
IS: Scandium(1)	99.3	0	70-200		%REC	5	03/15/18 01:21 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R1 - 4
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-35
Project No:	PR-ORD-17-02372	**Alternate ID:**	206
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	28.6	12.5	37.5	J	µg/Filter	5	03/15/18 01:23 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 01:23 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:23 PM
Silicon	35.9	12.5	37.5	JN	µg/Filter	5	03/15/18 01:23 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:23 PM
IS: Indium	103	0	70-200		%REC	5	03/15/18 01:23 PM
IS: Scandium(1)	98.7	0	70-200		%REC	5	03/15/18 01:23 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R1 - 5
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-36
Project No:	PR-ORD-17-02372	**Alternate ID:**	207
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	30.5	12.5	37.5	J	µg/Filter	5	03/15/18 01:25 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 01:25 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:25 PM
Silicon	41.3	12.5	37.5	N	µg/Filter	5	03/15/18 01:25 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:25 PM
IS: Indium	102	0	70-200		%REC	5	03/15/18 01:25 PM
IS: Scandium(1)	98.4	0	70-200		%REC	5	03/15/18 01:25 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R1 - 6
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-37
Project No:	PR-ORD-17-02372	**Alternate ID:**	208
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:27 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 01:27 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:27 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 01:27 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:27 PM
IS: Indium	102	0	70-200		%REC	5	03/15/18 01:27 PM
IS: Scandium(1)	99.8	0	70-200		%REC	5	03/15/18 01:27 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R1 - 7
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-38
Project No:	PR-ORD-17-02372	**Alternate ID:**	209
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:29 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 01:29 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:29 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 01:29 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:29 PM
IS: Indium	102	0	70-200		%REC	5	03/15/18 01:29 PM
IS: Scandium(1)	98.2	0	70-200		%REC	5	03/15/18 01:29 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R1 - 8
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-39
Project No:	PR-ORD-17-02372	**Alternate ID:**	210
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:31 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 01:31 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:31 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 01:31 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:31 PM
IS: Indium	102	0	70-200		%REC	5	03/15/18 01:31 PM
IS: Scandium(1)	98.7	0	70-200		%REC	5	03/15/18 01:31 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R1 - 10
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-40
Project No:	PR-ORD-17-02372	**Alternate ID:**	NA
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	29.2	12.5	37.5	J	µg/Filter	5	03/15/18 01:34 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 01:34 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:34 PM
Silicon	116	12.5	37.5	N	µg/Filter	5	03/15/18 01:34 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:34 PM
IS: Indium	102	0	70-200		%REC	5	03/15/18 01:34 PM
IS: Scandium(1)	97.1	0	70-200		%REC	5	03/15/18 01:34 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R2 - 0
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-41
Project No:	PR-ORD-17-02372	**Alternate ID:**	211
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:54 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 01:54 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:54 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 01:54 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:54 PM
IS: Indium	102	0	70-200		%REC	5	03/15/18 01:54 PM
IS: Scandium(1)	97.7	0	70-200		%REC	5	03/15/18 01:54 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R2 - 1
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-42
Project No:	PR-ORD-17-02372	**Alternate ID:**	212
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:58 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 01:58 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:58 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 01:58 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 01:58 PM
IS: Indium	101	0	70-200		%REC	5	03/15/18 01:58 PM
IS: Scandium(1)	96.5	0	70-200		%REC	5	03/15/18 01:58 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R2 - 2
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-43
Project No:	PR-ORD-17-02372	**Alternate ID:**	213
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:00 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 02:00 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:00 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 02:00 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:00 PM
IS: Indium	102	0	70-200		%REC	5	03/15/18 02:00 PM
IS: Scandium(1)	95.6	0	70-200		%REC	5	03/15/18 02:00 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R2 - 3
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-44
Project No:	PR-ORD-17-02372	**Alternate ID:**	214
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	28.7	12.5	37.5	J	µg/Filter	5	03/15/18 02:02 PM
Cesium	0.0695	0.0500	2.00	JN	µg/Filter	5	03/15/18 02:02 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:02 PM
Silicon	36.5	12.5	37.5	JN	µg/Filter	5	03/15/18 02:02 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:02 PM
IS: Indium	102	0	70-200		%REC	5	03/15/18 02:02 PM
IS: Scandium(1)	96.2	0	70-200		%REC	5	03/15/18 02:02 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R2 - 4
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-45
Project No:	PR-ORD-17-02372	**Alternate ID:**	215
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	46.5	12.5	37.5		µg/Filter	5	03/15/18 02:04 PM
Cesium	0.120	0.0500	2.00	JN	µg/Filter	5	03/15/18 02:04 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:04 PM
Silicon	56.9	12.5	37.5	N	µg/Filter	5	03/15/18 02:04 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:04 PM
IS: Indium	101	0	70-200		%REC	5	03/15/18 02:04 PM
IS: Scandium(1)	96.9	0	70-200		%REC	5	03/15/18 02:04 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R2 - 5
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-46
Project No:	PR-ORD-17-02372	**Alternate ID:**	216
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	42.3	12.5	37.5		µg/Filter	5	03/15/18 02:06 PM
Cesium	0.124	0.0500	2.00	JN	µg/Filter	5	03/15/18 02:06 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:06 PM
Silicon	47.1	12.5	37.5	N	µg/Filter	5	03/15/18 02:06 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:06 PM
IS: Indium	101	0	70-200		%REC	5	03/15/18 02:06 PM
IS: Scandium(1)	97.0	0	70-200		%REC	5	03/15/18 02:06 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R2 - 6
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-47
Project No:	PR-ORD-17-02372	**Alternate ID:**	217
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:08 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 02:08 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:08 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 02:08 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:08 PM
IS: Indium	101	0	70-200		%REC	5	03/15/18 02:08 PM
IS: Scandium(1)	97.0	0	70-200		%REC	5	03/15/18 02:08 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R2 - 7
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-48
Project No:	PR-ORD-17-02372	**Alternate ID:**	218
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:10 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 02:10 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:10 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 02:10 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:10 PM
IS: Indium	101	0	70-200		%REC	5	03/15/18 02:10 PM
IS: Scandium(1)	98.9	0	70-200		%REC	5	03/15/18 02:10 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R2 - 8
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-49
Project No:	PR-ORD-17-02372	**Alternate ID:**	219
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:13 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 02:13 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:13 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 02:13 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:13 PM
IS: Indium	102	0	70-200		%REC	5	03/15/18 02:13 PM
IS: Scandium(1)	97.4	0	70-200		%REC	5	03/15/18 02:13 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R2 - 10
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-50
Project No:	PR-ORD-17-02372	**Alternate ID:**	NA
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	20.2	12.5	37.5	J	µg/Filter	5	03/15/18 02:15 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 02:15 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:15 PM
Silicon	124	12.5	37.5	N	µg/Filter	5	03/15/18 02:15 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:15 PM
IS: Indium	101	0	70-200		%REC	5	03/15/18 02:15 PM
IS: Scandium(1)	95.9	0	70-200		%REC	5	03/15/18 02:15 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R3 - 0
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-51
Project No:	PR-ORD-17-02372	**Alternate ID:**	220
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:29 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 02:29 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:29 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 02:29 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:29 PM
IS: Indium	99.8	0	70-200		%REC	5	03/15/18 02:29 PM
IS: Scandium(1)	94.8	0	70-200		%REC	5	03/15/18 02:29 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R3 - 1
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-52
Project No:	PR-ORD-17-02372	**Alternate ID:**	221
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:31 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 02:31 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:31 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 02:31 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:31 PM
IS: Indium	101	0	70-200		%REC	5	03/15/18 02:31 PM
IS: Scandium(1)	96.3	0	70-200		%REC	5	03/15/18 02:31 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R3 - 2
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-53
Project No:	PR-ORD-17-02372	**Alternate ID:**	222
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:33 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 02:33 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:33 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 02:33 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:33 PM
IS: Indium	100	0	70-200		%REC	5	03/15/18 02:33 PM
IS: Scandium(1)	95.1	0	70-200		%REC	5	03/15/18 02:33 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R3 - 3
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-54
Project No:	PR-ORD-17-02372	**Alternate ID:**	223
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	33.1	12.5	37.5	J	µg/Filter	5	03/15/18 02:35 PM
Cesium	0.0710	0.0500	2.00	JN	µg/Filter	5	03/15/18 02:35 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:35 PM
Silicon	32.9	12.5	37.5	JN	µg/Filter	5	03/15/18 02:35 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:35 PM
IS: Indium	101	0	70-200		%REC	5	03/15/18 02:35 PM
IS: Scandium(1)	94.9	0	70-200		%REC	5	03/15/18 02:35 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R3 - 4
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-55
Project No:	PR-ORD-17-02372	**Alternate ID:**	224
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	41.6	12.5	37.5		µg/Filter	5	03/15/18 02:37 PM
Cesium	0.104	0.0500	2.00	JN	µg/Filter	5	03/15/18 02:37 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:37 PM
Silicon	43.0	12.5	37.5	N	µg/Filter	5	03/15/18 02:37 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:37 PM
IS: Indium	101	0	70-200		%REC	5	03/15/18 02:37 PM
IS: Scandium(1)	96.0	0	70-200		%REC	5	03/15/18 02:37 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R3 - 5
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-56
Project No:	PR-ORD-17-02372	**Alternate ID:**	225
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	42.8	12.5	37.5		µg/Filter	5	03/15/18 02:39 PM
Cesium	0.107	0.0500	2.00	JN	µg/Filter	5	03/15/18 02:39 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:39 PM
Silicon	43.8	12.5	37.5	N	µg/Filter	5	03/15/18 02:39 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:39 PM
IS: Indium	100	0	70-200		%REC	5	03/15/18 02:39 PM
IS: Scandium(1)	95.8	0	70-200		%REC	5	03/15/18 02:39 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R3 - 6
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-57
Project No:	PR-ORD-17-02372	**Alternate ID:**	226
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:41 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 02:41 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:41 PM
Silicon	14.1	12.5	37.5	JN	µg/Filter	5	03/15/18 02:41 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:41 PM
IS: Indium	99.7	0	70-200		%REC	5	03/15/18 02:41 PM
IS: Scandium(1)	94.4	0	70-200		%REC	5	03/15/18 02:41 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R3 - 7
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-58
Project No:	PR-ORD-17-02372	**Alternate ID:**	227
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:43 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 02:43 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:43 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 02:43 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:43 PM
IS: Indium	99.3	0	70-200		%REC	5	03/15/18 02:43 PM
IS: Scandium(1)	98.1	0	70-200		%REC	5	03/15/18 02:43 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R3 - 8
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-59
Project No:	PR-ORD-17-02372	**Alternate ID:**	228
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:45 PM
Cesium	<2.00	0.0500	2.00	N	µg/Filter	5	03/15/18 02:45 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:45 PM
Silicon	<37.5	12.5	37.5	N	µg/Filter	5	03/15/18 02:45 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:45 PM
IS: Indium	99.7	0	70-200		%REC	5	03/15/18 02:45 PM
IS: Scandium(1)	96.7	0	70-200		%REC	5	03/15/18 02:45 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT:	US EPA	**Client Sample ID:**	B+Ce+S - R3 - 10
Project:	Thermal Destruction of CBR Contaminants	**Lab ID:**	1802197-60
Project No:	PR-ORD-17-02372	**Alternate ID:**	NA
Lab Order:	1802197	**Collection Date:**	01/23/18
		Matrix:	FILTER

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - MOUDI FILTER		**SW6020A**					Analyst: **SP**
Aluminum	20.9	12.5	37.5	J	µg/Filter	5	03/15/18 02:47 PM
Cesium	0.0560	0.0500	2.00	JN	µg/Filter	5	03/15/18 02:47 PM
Potassium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:47 PM
Silicon	150	12.5	37.5	N	µg/Filter	5	03/15/18 02:47 PM
Sodium	<37.5	12.5	37.5		µg/Filter	5	03/15/18 02:47 PM
IS: Indium	101	0	70-200		%REC	5	03/15/18 02:47 PM
IS: Scandium(1)	94.9	0	70-200		%REC	5	03/15/18 02:47 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	B	Analyte detected in the associated Method Blank
C	Sample Result or QC discussed in the Case Narrative	DF	Dilution Factor
E	TPH pattern not Gas or Diesel Range Pattern	J	Analyte detected between MDL and RL
MDL	Method Detection Limit	ND	Not Detected at the Method Detection Limit
RL	Reporting Limit	S	Spike Recovery outside control limits

CLIENT: US EPA
Work Order: 1802197
Project: Thermal Destruction of CBR Contaminants

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_180314B

The QC data in batch 84655 applies to the following samples: 1802197-01A, 1802197-02A, 1802197-03A, 1802197-04A, 1802197-05A, 1802197-06A, 1802197-07A, 1802197-08A, 1802197-09A, 1802197-10A, 1802197-11A, 1802197-12A, 1802197-13A, 1802197-14A, 1802197-15A, 1802197-16A, 1802197-17A, 1802197-18A, 1802197-19A, 1802197-20A

Sample ID **MB-84655** Batch ID: **84655** TestNo: **SW6020A** Units: **µg/Filter**
SampType: **MBLK** Run ID: **ICP-MS4_180314B** Analysis Date: **3/14/2018 4:24:00 PM** Prep Date: **3/12/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	<37.5	37.5								
Cesium	<2.00	2.00								N
Potassium	<37.5	37.5								
Silicon	<37.5	37.5								N
Sodium	<37.5	37.5								
IS: Indium	50.0		200.0		100	70	200			
IS: Scandium(1)	50.0		200.0		95.3	70	200			

Sample ID **LCS-84655** Batch ID: **84655** TestNo: **SW6020A** Units: **µg/Filter**
SampType: **LCS** Run ID: **ICP-MS4_180314B** Analysis Date: **3/14/2018 4:27:00 PM** Prep Date: **3/12/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	251	37.5	250.0	0	100	80	120			
Cesium	50.5	2.00	50.00	0	101	80	120			N
Potassium	1290	37.5	1250	0	103	80	120			
Silicon	251	37.5	250.0	0	100	80	120			N
Sodium	1290	37.5	1250	0	103	80	120			
IS: Indium	50.0		200.0		96.9	70	200			
IS: Scandium(1)	50.0		200.0		94.4	70	200			

Sample ID **LCSD-84655** Batch ID: **84655** TestNo: **SW6020A** Units: **µg/Filter**
SampType: **LCSD** Run ID: **ICP-MS4_180314B** Analysis Date: **3/14/2018 4:29:00 PM** Prep Date: **3/12/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	253	37.5	250.0	0	101	80	120	0.841	25	
Cesium	50.2	2.00	50.00	0	100	80	120	0.591	25	N
Potassium	1310	37.5	1250	0	105	80	120	1.25	25	
Silicon	253	37.5	250.0	0	101	80	120	0.943	25	N
Sodium	1290	37.5	1250	0	103	80	120	0.016	25	
IS: Indium	50.0		200.0		96.5	70	200	0	0	
IS: Scandium(1)	50.0		200.0		93.1	70	200	0	0	

Sample ID **1802197-10A SD** Batch ID: **84655** TestNo: **SW6020A** Units: **µg/Filter**
SampType: **SD** Run ID: **ICP-MS4_180314B** Analysis Date: **3/14/2018 4:35:00 PM** Prep Date: **3/12/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	<188	188	0	0				0	10	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAC certified

CLIENT: US EPA
Work Order: 1802197
Project: Thermal Destruction of CBR Contaminants

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS4_180314B**

Sample ID **1802197-10A SD**	Batch ID: **84655**	TestNo: **SW6020A**	Units: **µg/Filter**
SampType: **SD**	Run ID: **ICP-MS4_180314B**	Analysis Date: **3/14/2018 4:35:00 PM**	Prep Date: **3/12/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cesium	0.266	10.0	0	0.2735				2.69	10	N
Potassium	<188	188	0	0				0	10	
Silicon	72.8	188	0	89.41				20.5	10	RN
Sodium	<188	188	0	0				0	10	
IS: Indium	250		200.0		98.3	70	200	0	0	
IS: Scandium(1)	250		200.0		95.2	70	200	0	0	

Sample ID **1802197-10A PDS**	Batch ID: **84655**	TestNo: **SW6020A**	Units: **µg/Filter**
SampType: **PDS**	Run ID: **ICP-MS4_180314B**	Analysis Date: **3/14/2018 4:55:00 PM**	Prep Date: **3/12/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	1220	37.5	1250	0	97.6	80	120			
Cesium	50.1	2.00	50.00	0.2735	99.6	80	120			N
Potassium	1270	37.5	1250	0	102	80	120			
Silicon	1360	37.5	1250	89.41	101	80	120			N
Sodium	1280	37.5	1250	0	103	80	120			
IS: Indium	50.0		1000		95.5	70	200			
IS: Scandium(1)	50.0		1000		92.4	70	200			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAC certified

CLIENT: US EPA
Work Order: 1802197
Project: Thermal Destruction of CBR Contaminants

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_180314B

Sample ID	ICV-180314	Batch ID:	R96908	TestNo:	SW6020A	Units:	mg/L
SampType:	ICV	Run ID:	ICP-MS4_180314B	Analysis Date:	3/14/2018 11:57:00 AM	Prep Date:	

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	2.36	0.0300	2.50	0	94.4	90	110			
Cesium	0.0992	0.00500	0.100	0	99.2	90	110			N
Potassium	2.54	0.300	2.50	0	102	90	110			
Silicon	2.45	0.100	2.50	0	98.0	90	110			N
Sodium	2.58	0.300	2.50	0	103	90	110			
IS: Indium	0.200		0.200		99.0	70	200			
IS: Scandium(1)	0.200		0.200		96.1	70	200			

Sample ID	LCVL-180314	Batch ID:	R96908	TestNo:	SW6020A	Units:	mg/L
SampType:	LCVL	Run ID:	ICP-MS4_180314B	Analysis Date:	3/14/2018 12:04:00 PM	Prep Date:	

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.0937	0.0300	0.100	0	93.7	70	130			
Cesium	0.00189	0.00500	0.00200	0	94.4	70	130			N
Potassium	0.100	0.300	0.100	0	100	70	130			
Silicon	0.0936	0.100	0.100	0	93.6	70	130			N
Sodium	0.105	0.300	0.100	0	105	70	130			
IS: Indium	0.200		0.200		102	70	200			
IS: Scandium(1)	0.200		0.200		98.6	70	200			

Sample ID	CCV7-180314	Batch ID:	R96908	TestNo:	SW6020A	Units:	mg/L
SampType:	CCV	Run ID:	ICP-MS4_180314B	Analysis Date:	3/14/2018 4:15:00 PM	Prep Date:	

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	5.05	0.0300	5.00	0	101	90	110			
Cesium	0.205	0.00500	0.200	0	102	90	110			N
Potassium	5.25	0.300	5.00	0	105	90	110			
Silicon	5.13	0.100	5.00	0	103	90	110			N
Sodium	5.24	0.300	5.00	0	105	90	110			
IS: Indium	0.200		0.200		94.2	70	200			
IS: Scandium(1)	0.200		0.200		91.2	70	200			

Sample ID	LCVL7-180314	Batch ID:	R96908	TestNo:	SW6020A	Units:	mg/L
SampType:	LCVL	Run ID:	ICP-MS4_180314B	Analysis Date:	3/14/2018 4:20:00 PM	Prep Date:	

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.0926	0.0300	0.100	0	92.6	70	130			
Cesium	0.00194	0.00500	0.00200	0	97.2	70	130			N
Potassium	0.105	0.300	0.100	0	105	70	130			
Silicon	0.0889	0.100	0.100	0	88.9	70	130			N
Sodium	0.104	0.300	0.100	0	104	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAC certified

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_180314B

Sample ID **LCVL7-180314**	Batch ID: **R96908**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS4_180314B**	Analysis Date: **3/14/2018 4:20:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
IS: Indium	0.200		0.200		98.0	70	200			
IS: Scandium(1)	0.200		0.200		94.9	70	200			

Sample ID **CCV8-180314**	Batch ID: **R96908**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **CCV**	Run ID: **ICP-MS4_180314B**	Analysis Date: **3/14/2018 4:57:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	5.09	0.0300	5.00	0	102	90	110			
Cesium	0.203	0.00500	0.200	0	102	90	110			N
Potassium	5.27	0.300	5.00	0	105	90	110			
Silicon	5.18	0.100	5.00	0	104	90	110			N
Sodium	5.26	0.300	5.00	0	105	90	110			
IS: Indium	0.200		0.200		94.4	70	200			
IS: Scandium(1)	0.200		0.200		90.2	70	200			

Sample ID **LCVL8-180314**	Batch ID: **R96908**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS4_180314B**	Analysis Date: **3/14/2018 5:02:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.0953	0.0300	0.100	0	95.3	70	130			
Cesium	0.00192	0.00500	0.00200	0	96.2	70	130			N
Potassium	0.102	0.300	0.100	0	102	70	130			
Silicon	0.0919	0.100	0.100	0	91.9	70	130			N
Sodium	0.101	0.300	0.100	0	101	70	130			
IS: Indium	0.200		0.200		97.7	70	200			
IS: Scandium(1)	0.200		0.200		95.2	70	200			

Sample ID **CCV9-180314**	Batch ID: **R96908**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **CCV**	Run ID: **ICP-MS4_180314B**	Analysis Date: **3/14/2018 5:27:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	5.03	0.0300	5.00	0	101	90	110			
Cesium	0.206	0.00500	0.200	0	103	90	110			N
Potassium	5.26	0.300	5.00	0	105	90	110			
Silicon	5.14	0.100	5.00	0	103	90	110			N
Sodium	5.24	0.300	5.00	0	105	90	110			
IS: Indium	0.200		0.200		92.9	70	200			
IS: Scandium(1)	0.200		0.200		89.9	70	200			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAC certified

CLIENT: US EPA
Work Order: 1802197
Project: Thermal Destruction of CBR Contaminants

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_180314B

Sample ID **LCVL9-180314** Batch ID: **R96908** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCVL** Run ID: **ICP-MS4_180314B** Analysis Date: **3/14/2018 5:31:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.0948	0.0300	0.100	0	94.8	70	130			
Cesium	0.00196	0.00500	0.00200	0	97.8	70	130			N
Potassium	0.102	0.300	0.100	0	102	70	130			
Silicon	0.0888	0.100	0.100	0	88.8	70	130			N
Sodium	0.104	0.300	0.100	0	104	70	130			
IS: Indium	0.200		0.200		95.3	70	200			
IS: Scandium(1)	0.200		0.200		92.2	70	200			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAC certified

CLIENT: US EPA
Work Order: 1802197
Project: Thermal Destruction of CBR Contaminants

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_180315A

The QC data in batch 84699 applies to the following samples: 1802197-21A, 1802197-22A, 1802197-23A, 1802197-24A, 1802197-25A, 1802197-26A, 1802197-27A, 1802197-28A, 1802197-29A, 1802197-30A, 1802197-31A, 1802197-32A, 1802197-33A, 1802197-34A, 1802197-35A, 1802197-36A, 1802197-37A, 1802197-38A, 1802197-39A, 1802197-40A

Sample ID **MB-84699** Batch ID: **84699** TestNo: **SW6020A** Units: **µg/Filter**
SampType: **MBLK** Run ID: **ICP-MS4_180315A** Analysis Date: **3/15/2018 12:33:00 PM** Prep Date: **3/14/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	<37.5	37.5								
Cesium	<2.00	2.00								N
Potassium	<37.5	37.5								
Silicon	<37.5	37.5								N
Sodium	<37.5	37.5								
IS: Indium	50.0		200.0		102	70	200			
IS: Scandium(1)	50.0		200.0		98.8	70	200			

Sample ID **LCS-84699** Batch ID: **84699** TestNo: **SW6020A** Units: **µg/Filter**
SampType: **LCS** Run ID: **ICP-MS4_180315A** Analysis Date: **3/15/2018 12:36:00 PM** Prep Date: **3/14/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	252	37.5	250.0	0	101	80	120			
Cesium	50.2	2.00	50.00	0	100	80	120			N
Potassium	1290	37.5	1250	0	103	80	120			
Silicon	251	37.5	250.0	0	101	80	120			N
Sodium	1300	37.5	1250	0	104	80	120			
IS: Indium	50.0		200.0		100	70	200			
IS: Scandium(1)	50.0		200.0		97.4	70	200			

Sample ID **LCSD-84699** Batch ID: **84699** TestNo: **SW6020A** Units: **µg/Filter**
SampType: **LCSD** Run ID: **ICP-MS4_180315A** Analysis Date: **3/15/2018 12:38:00 PM** Prep Date: **3/14/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	257	37.5	250.0	0	103	80	120	2.26	25	
Cesium	50.2	2.00	50.00	0	100	80	120	0.005	25	N
Potassium	1330	37.5	1250	0	106	80	120	2.56	25	
Silicon	258	37.5	250.0	0	103	80	120	2.46	25	N
Sodium	1320	37.5	1250	0	105	80	120	1.44	25	
IS: Indium	50.0		200.0		101	70	200	0	0	
IS: Scandium(1)	50.0		200.0		97.2	70	200	0	0	

Sample ID **1802197-27A SD** Batch ID: **84699** TestNo: **SW6020A** Units: **µg/Filter**
SampType: **SD** Run ID: **ICP-MS4_180315A** Analysis Date: **3/15/2018 12:44:00 PM** Prep Date: **3/14/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	<188	188	0	0				0	10	
Cesium	<10.0	10.0	0	0				0	10	N
Potassium	<188	188	0	0				0	10	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAC certified

CLIENT: US EPA
Work Order: 1802197
Project: Thermal Destruction of CBR Contaminants

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_180315A

Sample ID **1802197-27A SD**	Batch ID: **84699**	TestNo: **SW6020A**	Units: **µg/Filter**
SampType: **SD**	Run ID: **ICP-MS4_180315A**	Analysis Date: **3/15/2018 12:44:00 PM**	Prep Date: **3/14/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Silicon	<188	188	0	0				0	10	N
Sodium	<188	188	0	0				0	10	
IS: Indium	250		200.0		103	70	200	0	0	
IS: Scandium(1)	250		200.0		100	70	200	0	0	

Sample ID **1802197-27A PDS**	Batch ID: **84699**	TestNo: **SW6020A**	Units: **µg/Filter**
SampType: **PDS**	Run ID: **ICP-MS4_180315A**	Analysis Date: **3/15/2018 1:04:00 PM**	Prep Date: **3/14/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	1220	37.5	1250	0	97.4	80	120			
Cesium	49.1	2.00	50.00	0	98.1	80	120			N
Potassium	1260	37.5	1250	0	101	80	120			
Silicon	1250	37.5	1250	0	99.8	80	120			N
Sodium	1280	37.5	1250	0	103	80	120			
IS: Indium	50.0		1000		98.9	70	200			
IS: Scandium(1)	50.0		1000		96.8	70	200			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAC certified

CLIENT: US EPA
Work Order: 1802197
Project: Thermal Destruction of CBR Contaminants

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_180315A

The QC data in batch 84700 applies to the following samples: 1802197-41A, 1802197-42A, 1802197-43A, 1802197-44A, 1802197-45A, 1802197-46A, 1802197-47A, 1802197-48A, 1802197-49A, 1802197-50A, 1802197-51A, 1802197-52A, 1802197-53A, 1802197-54A, 1802197-55A, 1802197-56A, 1802197-57A, 1802197-58A, 1802197-59A, 1802197-60A

Sample ID **MB-84700** Batch ID: **84700** TestNo: **SW6020A** Units: **µg/Filter**
SampType: **MBLK** Run ID: **ICP-MS4_180315A** Analysis Date: **3/15/2018 1:46:00 PM** Prep Date: **3/14/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	<37.5	37.5								
Cesium	<2.00	2.00								N
Potassium	<37.5	37.5								
Silicon	<37.5	37.5								N
Sodium	<37.5	37.5								
IS: Indium	50.0		200.0		99.9	70	200			
IS: Scandium(1)	50.0		200.0		96.1	70	200			

Sample ID **LCS-84700** Batch ID: **84700** TestNo: **SW6020A** Units: **µg/Filter**
SampType: **LCS** Run ID: **ICP-MS4_180315A** Analysis Date: **3/15/2018 1:48:00 PM** Prep Date: **3/14/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	255	37.5	250.0	0	102	80	120			
Cesium	48.7	2.00	50.00	0	97.5	80	120			N
Potassium	1290	37.5	1250	0	103	80	120			
Silicon	251	37.5	250.0	0	100	80	120			N
Sodium	1290	37.5	1250	0	103	80	120			
IS: Indium	50.0		200.0		98.9	70	200			
IS: Scandium(1)	50.0		200.0		95.6	70	200			

Sample ID **LCSD-84700** Batch ID: **84700** TestNo: **SW6020A** Units: **µg/Filter**
SampType: **LCSD** Run ID: **ICP-MS4_180315A** Analysis Date: **3/15/2018 1:50:00 PM** Prep Date: **3/14/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	262	37.5	250.0	0	105	80	120	2.89	25	
Cesium	50.3	2.00	50.00	0	101	80	120	3.18	25	N
Potassium	1320	37.5	1250	0	105	80	120	1.85	25	
Silicon	256	37.5	250.0	0	102	80	120	2.04	25	N
Sodium	1320	37.5	1250	0	106	80	120	2.01	25	
IS: Indium	50.0		200.0		98.5	70	200	0	0	
IS: Scandium(1)	50.0		200.0		95.7	70	200	0	0	

Sample ID **1802197-41A SD** Batch ID: **84700** TestNo: **SW6020A** Units: **µg/Filter**
SampType: **SD** Run ID: **ICP-MS4_180315A** Analysis Date: **3/15/2018 1:56:00 PM** Prep Date: **3/14/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	<188	188	0	0				0	10	
Cesium	<10.0	10.0	0	0				0	10	N
Potassium	<188	188	0	0				0	10	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAC certified

CLIENT: US EPA
Work Order: 1802197
Project: Thermal Destruction of CBR Contaminants

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_180315A

Sample ID **1802197-41A SD**	Batch ID: **84700**	TestNo: **SW6020A**	Units: **µg/Filter**
SampType: **SD**	Run ID: **ICP-MS4_180315A**	Analysis Date: **3/15/2018 1:56:00 PM**	Prep Date: **3/14/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Silicon	<188	188	0	0				0	10	N
Sodium	<188	188	0	0				0	10	
IS: Indium	250		200.0		101	70	200	0	0	
IS: Scandium(1)	250		200.0		97.1	70	200	0	0	

Sample ID **1802197-41A PDS**	Batch ID: **84700**	TestNo: **SW6020A**	Units: **µg/Filter**
SampType: **PDS**	Run ID: **ICP-MS4_180315A**	Analysis Date: **3/15/2018 2:17:00 PM**	Prep Date: **3/14/2018**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	1220	37.5	1250	0	97.7	80	120			
Cesium	48.0	2.00	50.00	0	95.9	80	120			N
Potassium	1240	37.5	1250	0	99.5	80	120			
Silicon	1240	37.5	1250	0	99.2	80	120			N
Sodium	1270	37.5	1250	0	102	80	120			
IS: Indium	50.0		1000		97.6	70	200			
IS: Scandium(1)	50.0		1000		94.2	70	200			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAC certified

CLIENT: US EPA
Work Order: 1802197
Project: Thermal Destruction of CBR Contaminants

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_180315A

Sample ID	ICV-180315	Batch ID:	R96921	TestNo:	SW6020A	Units:	mg/L
SampType:	ICV	Run ID:	ICP-MS4_180315A	Analysis Date:	3/15/2018 12:23:00 PM	Prep Date:	

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	2.42	0.0300	2.50	0	96.6	90	110			
Cesium	0.0982	0.00500	0.100	0	98.2	90	110			N
Potassium	2.53	0.300	2.50	0	101	90	110			
Silicon	2.49	0.100	2.50	0	99.7	90	110			N
Sodium	2.62	0.300	2.50	0	105	90	110			
IS: Indium	0.200		0.200		99.1	70	200			
IS: Scandium(1)	0.200		0.200		95.4	70	200			

Sample ID	LCVL-180315	Batch ID:	R96921	TestNo:	SW6020A	Units:	mg/L
SampType:	LCVL	Run ID:	ICP-MS4_180315A	Analysis Date:	3/15/2018 12:27:00 PM	Prep Date:	

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.0952	0.0300	0.100	0	95.2	70	130			
Cesium	0.00192	0.00500	0.00200	0	96.2	70	130			N
Potassium	0.0991	0.300	0.100	0	99.1	70	130			
Silicon	0.0973	0.100	0.100	0	97.3	70	130			N
Sodium	0.108	0.300	0.100	0	108	70	130			
IS: Indium	0.200		0.200		99.9	70	200			
IS: Scandium(1)	0.200		0.200		96.8	70	200			

Sample ID	CCV1-180315	Batch ID:	R96921	TestNo:	SW6020A	Units:	mg/L
SampType:	CCV	Run ID:	ICP-MS4_180315A	Analysis Date:	3/15/2018 1:06:00 PM	Prep Date:	

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	4.92	0.0300	5.00	0	98.5	90	110			
Cesium	0.197	0.00500	0.200	0	98.5	90	110			N
Potassium	5.16	0.300	5.00	0	103	90	110			
Silicon	4.99	0.100	5.00	0	99.8	90	110			N
Sodium	5.21	0.300	5.00	0	104	90	110			
IS: Indium	0.200		0.200		97.4	70	200			
IS: Scandium(1)	0.200		0.200		94.6	70	200			

Sample ID	LCVL1-180315	Batch ID:	R96921	TestNo:	SW6020A	Units:	mg/L
SampType:	LCVL	Run ID:	ICP-MS4_180315A	Analysis Date:	3/15/2018 1:10:00 PM	Prep Date:	

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.0999	0.0300	0.100	0	99.9	70	130			
Cesium	0.00195	0.00500	0.00200	0	97.3	70	130			N
Potassium	0.104	0.300	0.100	0	104	70	130			
Silicon	0.104	0.100	0.100	0	104	70	130			N
Sodium	0.105	0.300	0.100	0	105	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAC certified

CLIENT: US EPA
Work Order: 1802197
Project: Thermal Destruction of CBR Contaminants

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_180315A

Sample ID **LCVL1-180315**	Batch ID: **R96921**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS4_180315A**	Analysis Date: **3/15/2018 1:10:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
IS: Indium	0.200		0.200		102	70	200			
IS: Scandium(1)	0.200		0.200		96.5	70	200			

Sample ID **CCV2-180315**	Batch ID: **R96921**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **CCV**	Run ID: **ICP-MS4_180315A**	Analysis Date: **3/15/2018 1:36:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	4.95	0.0300	5.00	0	99.1	90	110			
Cesium	0.195	0.00500	0.200	0	97.7	90	110			N
Potassium	5.06	0.300	5.00	0	101	90	110			
Silicon	5.02	0.100	5.00	0	100	90	110			N
Sodium	5.18	0.300	5.00	0	104	90	110			
IS: Indium	0.200		0.200		97.3	70	200			
IS: Scandium(1)	0.200		0.200		94.7	70	200			

Sample ID **LCVL2-180315**	Batch ID: **R96921**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS4_180315A**	Analysis Date: **3/15/2018 1:41:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.0966	0.0300	0.100	0	96.6	70	130			
Cesium	0.00190	0.00500	0.00200	0	94.8	70	130			N
Potassium	0.103	0.300	0.100	0	103	70	130			
Silicon	0.0963	0.100	0.100	0	96.3	70	130			N
Sodium	0.104	0.300	0.100	0	104	70	130			
IS: Indium	0.200		0.200		102	70	200			
IS: Scandium(1)	0.200		0.200		96.5	70	200			

Sample ID **CCV3-180315**	Batch ID: **R96921**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **CCV**	Run ID: **ICP-MS4_180315A**	Analysis Date: **3/15/2018 2:19:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	4.98	0.0300	5.00	0	99.6	90	110			
Cesium	0.195	0.00500	0.200	0	97.3	90	110			N
Potassium	5.18	0.300	5.00	0	104	90	110			
Silicon	5.01	0.100	5.00	0	100	90	110			N
Sodium	5.25	0.300	5.00	0	105	90	110			
IS: Indium	0.200		0.200		96.6	70	200			
IS: Scandium(1)	0.200		0.200		92.1	70	200			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAC certified

CLIENT: US EPA
Work Order: 1802197
Project: Thermal Destruction of CBR Contaminants

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_180315A

Sample ID **LCVL3-180315**	Batch ID: **R96921**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS4_180315A**	Analysis Date: **3/15/2018 2:24:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.121	0.0300	0.100	0	121	70	130			
Cesium	0.00194	0.00500	0.00200	0	97.2	70	130			N
Potassium	0.103	0.300	0.100	0	103	70	130			
Silicon	0.0989	0.100	0.100	0	98.9	70	130			N
Sodium	0.103	0.300	0.100	0	103	70	130			
IS: Indium	0.200		0.200		98.3	70	200			
IS: Scandium(1)	0.200		0.200		94.7	70	200			

Sample ID **CCV4-180315**	Batch ID: **R96921**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **CCV**	Run ID: **ICP-MS4_180315A**	Analysis Date: **3/15/2018 2:49:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	5.02	0.0300	5.00	0	100	90	110			
Cesium	0.198	0.00500	0.200	0	98.8	90	110			N
Potassium	5.10	0.300	5.00	0	102	90	110			
Silicon	5.02	0.100	5.00	0	100	90	110			N
Sodium	5.18	0.300	5.00	0	104	90	110			
IS: Indium	0.200		0.200		95.2	70	200			
IS: Scandium(1)	0.200		0.200		92.7	70	200			

Sample ID **LCVL4-180315**	Batch ID: **R96921**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS4_180315A**	Analysis Date: **3/15/2018 2:54:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.123	0.0300	0.100	0	123	70	130			
Cesium	0.00189	0.00500	0.00200	0	94.7	70	130			N
Potassium	0.104	0.300	0.100	0	104	70	130			
Silicon	0.0998	0.100	0.100	0	99.8	70	130			N
Sodium	0.104	0.300	0.100	0	104	70	130			
IS: Indium	0.200		0.200		98.6	70	200			
IS: Scandium(1)	0.200		0.200		94.6	70	200			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAC certified

DHL Analytical, Inc.

Date: *19-Mar-18*

CLIENT: US EPA
Work Order: 1802197
Project: Thermal Destruction of CBR Contaminants

MQL SUMMARY REPORT

TestNo: SW6020A	MDL	MQL
Analyte	**µg/Filter**	**µg/Filter**
Aluminum	12.5	37.5
Cesium	0.0500	2.00
Potassium	12.5	37.5
Silicon	12.5	37.5
Sodium	12.5	37.5

Qualifiers: MQL -Method Quantitation Limit as defined by TRRP
MDL -Method Detection Limit as defined by TRRP

Appendix F: MOUDI Data Sheets

Dilution impactor operation data sheet - MOUDI

Operator: L. Virtaranta
Condition: Natural Gas 1
Run Number: R1
Date: ~~9-26-2017~~ ~~9-27-2017~~ (PLV 12-1-17 EE) 9-26-17
Start time: 1314
Stop time: 1334

Time	N2 Flow (L/min)	MOUDI T_s (°F)	Duct T (°C)	Probe T_F (°F)	~~MOUDI T (°F)~~	Pump T_P (°F)	Magnahelic (in. WC)	Flow Meter *	Nox MOUDI (ppm)	Nox Stack (ppm)
0	27	89	559	89		113	>25/10	1.44		
5	22	91	559	94		135	>25/10	1.47	1.65	54
10	27	92	559	101		144	>25/~~10~~ 8	1.49	3.31	54
15	27	93	559	99		154	>25/5	1.46	3.01	54
20	27	94	559	98		162	>25/5	1.45	3.00	53

Dilution impactor operation data sheet - MOUDI

Operator: L. Victoranle

Condition: Natural Gas 1

Run Number: R2

Date: 9-~~27~~ 26-2012 (PV 12-11-12)

Start time: 1403 -

Stop time: 1423

Time	N2 Flow (L/min)	MOUDI T (°F)	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Magnahelic (in. WC)	Flow Meter *	Nox MOUDI (ppm)	Nox Stack (ppm)
0	27	83	558	91		124	>25/5	1.46	–	53
5	27	90	559	97		148	>25/5	1.46	3.26	54
10	22	92	559	99		158	>25/5	1.46	2.62	53
15	27	93	559	100		166	>25/5	1.45	3.50	53
20	27	94	559	99		171	>25/5	1.45	2.99	53

Dilution impactor operation data sheet - MOUDI

Operator: L. Virtaranta
Condition: Natural Gas 1
Run Number: R3
Date: 9-~~27~~ 26-2017 (PLV 12-11-17)
Start time: 1440
Stop time: 1500

Time	N2 Flow (L/min)	MOUDI T (°F)	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Magnahelic (in. WC)	Flow Meter *	Nox MOUDI (ppm)	Nox Stack (ppm)
0	27	88	559	93		147	>25/5	1.46		53
5	27	90	559	97		157	>25/5	1.45	3.71	55
10	27	92	559	99		164	>25/5	1.45	3.36	53
15	27	94	559	98		172	>25/5	1.45	3.08	54
20	27	94	559	97		176	>25/5	1.45	2.87	48

Dilution impactor operation data sheet - MOUDI

Operator L. Victaramte
Condition Field Blank 1
Run Number FB-1
Date ~~2-26-2017~~ PW 12-1-17 9-26-17
Start time 1534
Stop time 1554

Time	N2 Flow (L/min)	MOUDI T (°F)	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Magnahelic (in. WC)	Flow Meter *	Nox MOUDI (ppm)	Nox Stack (ppm)
0	27	87		87		132	>25/5	1.46		
5	27	89		87		152	>25/5	1.46		
10	27	91		87		162	>25/5	1.46		
15	27	91		87		168	>25/5	1.46		
20	27	91		87		172	>25/5	1.46		

Dilution impactor operation data sheet - MOUDI

Operator L. Virtaranta
Condition Ni + Biomass
Run Number R1
Date 9-27-2017
Start time 1048
Stop time 1108

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	25.3	1.46	558	96	94	96	>25	5	—	53
5	25.3	1.46	559	106	95	95	>25	5	5.6	51
10	25.3	1.46	559	112	96	95	>25	5	5.85	53
15	25.3	1.45	559	112	97	95	>25	5	6.35	55
20	25.3	1.44	559	113	95	95	>25	5	5.83	54

Dilution impactor operation data sheet - MOUDI

Operator: L. Virtamanta
Condition: Biomass
Run Number: ~~R4~~ 82 (PW 10-10-12 [illegible])
Date: 9-29-12
Start time: 8:40
Stop time: 9:00

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	~~26~~1.45	559	91	89	93	>25	5	-	48
5	↓	1.45	557	93	90	93	>25	5	3.40	44
10		1.45	559	96	91	93	>25	5	3.04	60
15		1.45	561	99	92	93	>25	5	3.91	57
20		1.46	561	100	93	93	>25	5	4.17	59

Dilution impactor operation data sheet - MOUDI

Operator L. Vinterman
Condition Burner 3
Run Number R3
Date 9-29-17
Start time 914
Stop time 934

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.45	561	98	89	94	>25	5	-	54
5	↓	1.46	561	102	92	94	>25	5	4.94	66
10	↓	1.44	562	102	93	93	>25	5	4.86	65
15	↓	1.44	562	102	94	93	>25	5	5.18	64
20	↓	1.44	561	102	94	93	>25	5	5.08	58

Dilution impactor operation data sheet - MOUDI

Operator L. Vitercnik
Condition Biomass
Run Number R4
Date 9-29-2017
Start time 944
Stop time 1004

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.44	560	99	91	94	>25	5	-	65
5	↓	1.44	560	102	92	93	>25	5	5.57	62
10		1.43	561	103	94	93	>25	5	5.02	61
15		1.43	561	103	94	93	>25	5	5.59	65
20	↓	1.43	560	103	95	94	>25	5	5.59	65

Dilution impactor operation data sheet - MOUDI

Operator	L. Virtaranta
Condition	Field Blank 2
Run Number	FB-2
Date	9-29-2012
Start time	1015
Stop time	1035

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.44	NA	78	72	74	>25	5	NA	NA
5	26.3	1.45	↓	78	74	74	>25	5	↓	↓
10	26.3	1.45	↓	78	74	74	>25	5	↓	↓
15	26.3	1.45	↓	78	75	74	>25	5	↓	↓
20	26.5	1.44	↓	78	75	74	>25	5	↓	↓

Dilution impactor operation data sheet - MOUDI

Operator L. Virtaranta
Condition Biomass + Sorbent
Run Number R1
Date 10.3.17
Start time 1354
Stop time 1414

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.44	560	92	91	71	>25	5	-	73
5	↓	1.44	560	97	92	71	>25	5	5.21	74
10		1.44	561	100	93	91	>25	5	5.73	72
15		1.44	562	101	93	91	>25	5	5.84	75
20		1.44	564	102	94	91	>25	5	5.69	71

Dilution impactor operation data sheet - MOUDI

Operator L. Virtaranta
Condition Biomass + Sorbent
Run Number R2
Date 10-3-2017
Start time 1431
Stop time 1451

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.44	566	97	89	93	>25	5	-	69
5	↓	1.44	565	103	91	93	>25	5	7.76	73
10		1.43	566	104	93	92	>25	5	6.71	74
15		1.42	567	103	94	93	>25	5	6.68	75
20		1.42	567	103	94	91	>25	5	6.00	74

Dilution impactor operation data sheet - MOUDI

Operator	L. Victorino
Condition	Biomass + Sorbent
Run Number	R3
Date	10-3-2017
Start time	1504
Stop time	1524

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.42	568	97	90	94	>25	5	–	73
5	↓	1.41	569	101	93	92	>25	5	7.45	75
10		1.41	569	101	92	94	>25	5	5.63	74
15		1.41	569	101	95	92	>25	5	5.43	72
20		1.40	569	102	96	92	>25	5	5.19	70

Dilution impactor operation data sheet - MOUDI

Operator	L. Virtaranta
Condition	Field Blank 3
Run Number	FB-3
Date	10-3-17
Start time	1540
Stop time	1600

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.44	NA	78	76	75	>25	5	NA	NA
5	↓	1.44	↓	78	76	75	>25	5	↓	↓
10		1.44		79	76	76	>25	5		
15		1.44		79	77	76	>25	5		
20		1.44		79	77	76	>25	5		

Dilution impactor operation data sheet - MOUDI

Operator: L. Vitaranta
Condition: Natural Gas 2
Run Number: R1
Date: 12-7-2017
Start time: 9:40
Stop time: 10:00

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.43	559	90	86	91	>25	5	—	61
5	26.3	1.44	559	94	88	90	>25	5	4.10	60
10	26.3	1.44	559	97	90	91	>25	5	4.57	6.1
15	26.3	1.43	558	97	91	91	>25	5	4.34	61
20	26.3	1.44	558	100	92	91	>25	5	5.12	61

Dilution impactor operation data sheet - MOUDI

Operator L. Victorsen
Condition Natural Gas 2
Run Number R2
Date 12-7-17
Start time 10:11
Stop time 10:31

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.44	558	96	88	91	>25	5	–	61
5	26.3	1.45	559	107	90	91	>25	5	7.62	60
10	26.3	1.45	558	107	92	91	>25	5	7.48	62
15	26.3	1.44	559	107	93	91	>25	5	6.53	62
20	26.3	1.44	559	108	94	91	>25	5	6.73	62

Dilution impactor operation data sheet - MOUDI

Operator	L. Virtuoso
Condition	Natural Gas 2
Run Number	R3
Date	12-7-17
Start time	1041
Stop time	1101

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.44	558	101	89	92	>25	5	-	61
5	26.3	1.46	559	107	92	92	>25	5	7.77	62
10	26.3	1.45	559	107	93	92	>25	5	6.52	57
15	26.3	1.44	559	107	94	92	>25	5	6.85	61
20	26.3	1.44	559	107	95	92	>25	5	6.74	67

Dilution impactor operation data sheet - MOUDI

Operator: L. Victoranta
Condition: Biomass + Cesium
Run Number: R1
Date: 12-7-17
Start time: 1232
Stop time: 1252

X

wrong ratio of spiked & un-spiked pellets

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.44	559	91	85	94	>25	5	–	71
5	26.3	1.45	559	98	88	94	>25	5	5.18	70
10	26.3	1.44	560	101	91	93	>25	5	5.78	73
15	26.3	1.44	560	102	92	93	>25	5	6.15	72
20										

Dilution impactor operation data sheet - MOUDI

Operator L. Virbaralis
Condition Biomass + Cesium
Run Number R2
Date 12-7-17
Start time 1314
Stop time 1334

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.44	560	97	70	94	>25	5	-	72
5	26.3	1.45	560	101	92	94	>25	~~74~~ 5	8.84	74
10	26.3	1.46	560	109	94	94	>25	5	8.61	75
15	26.3	1.45	561	106	95	93	>25	5	7.10	72
20	26.3	1.44	560	107	96	94	>25	5	7.70	71

Dilution impactor operation data sheet - MOUDI

Operator	L. Virtaranta
Condition	Biomass + Cesium
Run Number	R3
Date	12-7-17
Start time	1550
Stop time	1910

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.45	560	98	88	94	>25	5	-	69
5	26.3	1.45	561	102	91	94	>25	5	8.16	63
10	26.3	1.45	561	109	94	94	>25	5	8.20	67
15	26.3	1.45	560	110	95	94	>25	5	8.63	72
20	26.3	1.45	560	110	96	94	>25	5	8.34	68

Dilution impactor operation data sheet - MOUDI

Operator: L. Victaranta
Condition: Biomass + Cesium
Run Number: R4
Date: 12-7-2017
Start time: 1427
Stop time: 1447

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.45	561	101	89	92	>25	5	–	67
5	26.3	1.45	561	109	92	93	>25	5	9.16	70
10	26.3	1.46	561	113	95	94 (PW 66)	>25	5	8.64	70
15	26.3	1.46	561	113	95	~~95~~ 94	>25	5	9.11	69
20	26.3	1.46	561	112	96	~~96~~ 94	>25	5	9.10	72

Dilution impactor operation data sheet - MOUDI

Operator	L. Virtaranta
Condition	Field Blank 4
Run Number	FB - 4
Date	12 - 7 - 17
Start time	1500
Stop time	1520

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.44	NA	78	75	75	>25	5	NA	NA
5	↓	1.44	↓	78	75	75	>25	5	↓	↓
10		1.44		78	76	75	>25	5		
15		1.44		79	76	75	>25	5		
20		1.44		79	76	76	>25	5		

Dilution impactor operation data sheet - MOUDI

Operator: L. Virtarante
Condition: Biomass + Cs + Sorbent
Run Number: R1
Date: 12-8-17
Start time: 1022
Stop time: 1042

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.44	560	90	80	90	>25	5	–	67
5	26.3	1.44	560	95	83	90	>25	5	5.09	68
10	26.3	1.45	561	99	87	90	>25	5	5.15	64
15	26.3	1.45	562	100	90	90	>25	5	5.98	67
20	26.3	1.44	563	101	91	90	>25	5	5.72	68

Dilution impactor operation data sheet - MOUDI

Operator: L. Vitarana
Condition: Biomass + Cs + Sorbent
Run Number: R2
Date: 12-8-17
Start time: 1058
Stop time: 1118

N_2 Dewar started running low w/ ~3 min left in the run (~24 LPM)

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.45	563	87	86	92	>25	5	-	71
5	26.3	1.45	564	101	90	92	>25	5	6.86	65
10	26.3	1.45	566	104	92	92	>25	5	6.20	64
15	26.3	1.45	566	112	94	92	>25	5	6.18	66
20	24	~~1.45~~ 1.44 (pw 12-8-17)	567	126	96	92	>25	5	11.17	67

Dilution impactor operation data sheet - MOUDI

Operator L. Verkamp
Condition Biomass + CO_2 + Sorbent
Run Number R3
Date 12-8-17
Start time 1129
Stop time 1149

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.45	567	97	90	92	> 25	5	<	68
5	26.3	1.46	562	111	94	93	>25	5	8.32	65
10	26.3	1.46	568	109	94	93	>25	5	7.50	68
15	26.3	1.46	568	109	95	93	>25	5	7.27	67
20	26.3	1.46	569	109	96	93	>25	5	6.94	69

Dilution impactor operation data sheet - MOUDI

Operator: L. Victorianis
Condition: Field Blank - 5
Run Number: FB-5
Date: 12-8-17
Start time: 1200
Stop time: 1220

Time	N2 Flow (L/min)	Flow Meter *	Duct T (°C)	Probe T (°F)	MOUDI T (°F)	Pump T (°F)	Top Mag (in. WC)	Bottom Mag (in. WC)	NO MOUDI (ppm)	NO Stack (ppm)
0	26.3	1.44	NA	80	77	76	>25	5	NA	NA
5	↓	1.44	↓	80	78	76	>25	5	↓	↓
10		1.44		80	78	72	>25	5		
15		1.44		81	78	72	>25	5		
20	↓	1.44	↓	81	77	72	>25	5	↓	↓

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