APPENDIX A

Summary of SVE System Operation, Maintenance, Repair, and Hydrocarbon Recovery Calculations
January – March 2011

A-1. SVE and Treatment System Maintenance Repair and Downtime Summary

A-2. SVE and Treatment System Hydrocarbon Recovery Calculations

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ACRONYMS AND ABBREVIATIONS

C	vapor concentration
CO	carbon monoxide
CO_2	carbon dioxide
K	Kelvin
KAFB	Kirtland Air Force Base
kg	kilogram
kg/m^3	kilograms per cubic meter
m^3/hr	cubic meters per hour
O_2	oxygen
ppmv	parts per million by volume
SVE	soil-vapor extraction

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A-1. SVE and Treatment System Maintenance Repair and Downtime Summary

The primary maintenance interval for the soil-vapor extraction (SVE) and treatment systems is every 360 hours (approximately 2 weeks), as recommended by the system manufacturer. Routine biweekly maintenance includes checking and changing the oil, filters, spark plugs and spark plug wires; checking the coolant level and adding coolant as needed; cleaning the air filter; and checking all belts, hose connections, battery connections and emergency contact switches. Monthly maintenance includes all bi-weekly maintenance, and includes replacing distributer caps, rotors, polyvinyl chloride valves and cleaning the radiators. All bi-weekly and monthly maintenance requires each unit being serviced, to be shut down for approximately 4 hours.

During the reporting period, biweekly maintenance was performed on the SVE and treatment systems on the following dates:

- January 10, 2011
- January 11, 2011
- January 24, 2011
- January 25, 2011
- February 7, 2011
- February 8, 2011
- February 21, 2011
- February 22, 2011
- March 8, 2011
- March 9, 2011
- March 21, 2011
- March 22, 2011

During the reporting period, monthly maintenance was performed on the SVE and treatment systems on the following dates:

- January 24, 2011
- January 25, 2011
- February 21, 2011

- February 22, 2011
- March 21, 2011
- March 22, 2011

During this reporting period, in addition to the standard biweekly and monthly planned maintenance activities, the following maintenance or repairs were performed for the various SVE and treatment systems that are operating at the Bulk Fuels Facility.

For the ST-106, Former Fuel Offloading Rack SVE and treatment system associated with the Stage 2 abatement action the following maintenance and repair activities were conducted during the first quarter of 2011:

- January 11, 2011 – Changed E1 carburetor.

For the KAFB-1065 SVE and treatment system operating as an interim remedial action for SS-111, the following maintenance and repair activities were conducted during the first quarter of 2011:

- January 23, 2011 – Changed E2 crankshaft pulley.
- February 22, 2011 – Changed E2 carburetor.
- February 28, 2011 – Changed E1 carburetor.

For the KAFB-1066 SVE and treatment system operating as an interim remedial action for SS-111, the following maintenance and repair activities were conducted during the first quarter of 2011:

- January 22, 2011 – Changed E2 catalytic converter.
- February 19, 2011 – Changed E2 starter and starter solenoids.
- March 30, 2011 – Changed E1 catalytic converter.

For the KAFB-1068 SVE and treatment system operating as an interim remedial action for SS-111, the following maintenance and repair activities were conducted during the first quarter of 2011:

- February 19, 2011 – Changed E2 starter and starter solenoids.
- February 26, 2011 – Changed E2 catalytic converter.
- March 27, 2011 – Changed E2 catalytic converter.
- March 24, 2011 – Changed E2 water pump.
- March 25-27, 2011 – KAFB-1068 down for E2 engine change out (approximately 72 hours).

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A-2. SVE and Treatment System Hydrocarbon Recovery Calculations

As part of the ongoing Stage 2 abatement action for ST-106 and the interim remedial actions for SS-111, vapor samples from the SVE and treatment systems' inlets and exhausts are regularly analyzed on site using a Horiba Mexa 554J emissions analyzer for petroleum hydrocarbon concentration in parts per million by volume (ppmv) and for percent oxygen (O_2), carbon monoxide (CO), and carbon dioxide (CO_2). The hydrocarbon concentrations from the SVE system influent as measured in the field with the Horiba instrument are used in the hydrocarbon recovery calculations. The paragraphs below describe the basic equations and constants that are used, along with the Horiba field measurements, to calculate total hydrocarbon recovery volumes.

For the SVE and treatment system associated with the Stage 2 abatement action at ST-106, the Horiba-measured influent hydrocarbon vapor concentration is used along with the molecular weight of the influent vapor stream, the gas constant, and the standard temperature to calculate the vapor concentration (C) in kilogram per cubic meter (kg/m^3). Vapor stream concentrations are measured by the Horiba instrument in parts per million by volume (ppmv), which can be converted into kg/m^3 for use in the following equation:

$$C = \frac{(conc)(MW)}{\mathrm{RT}}$$

Where:

Conc = vapor concentration (Horiba ppmv reading x 10^{-6})
MW = molecular weight of the vapor (98)
R = gas constant (0.0821) (L·atm/mol·K)
T = temperature (Kelvin [K]) (290)

The measured well gas inlet flow rate (cubic meters per hour [m^3/hr]) and hours of operation are then used to calculate recovered mass. Mass removal is estimated using the following conversion:

$$M = CQT$$

Where:

M	=	cumulative mass removed (kilogram [kg])
C	=	vapor concentration (kg/m^3)
Q	=	extraction flow rate (m^3/hr)
T	=	operational period (hour)

The recovered mass is then converted to equivalent gallons. The hydrocarbon recovery is calculated for each engine, and cumulatively summed over the operational period. As an example, the mass (kg) of recovered hydrocarbons for engine E1 during a given period can be calculated using the measured influent vapor concentration from a measurement date in that period (such as 32,400 ppmv), the well-gas inlet flow rate (such as 74.8 m3/hr), the engine E1 operational hours during the period (539.9 hours), and the constants defined above as follows:

$$C = \frac{(32{,}400 \times 10^{-6}) \times 980.0821 \times 290}{} = 0.075 \text{ kg/m}^3$$

$$M = (0.075)\ (74.9)\ (539.9) = 3{,}058 \text{ kg}$$

The gallons of equivalent hydrocarbon recovery are calculated using a mass to volume conversion of 6 pounds per gallon of hydrocarbon product and a conversion factor of 1 kg equals 2.205 pounds:

$$\text{Volume (gallons)} = (3{,}058 \text{ kg}) \times \frac{(2.205 \text{ pounds})}{1 \text{ kg}} \times \frac{1 \text{ gallon}}{6 \text{ pounds}} = 1{,}124 \text{ gallons}$$

The SVE and treatment systems at wells KAFB-1065, KAFB-1066, and KAFB-1068 have on-board telemetry that allows remote downloads of the SVE system data. The data that can be downloaded include the systems' running calculation of hydrocarbon recovery volumes that are made using the same basic equations outlined above.

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