APPENDIX C
SPIKING CALCULATIONS

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TAPI Spiking Calculations

A. Metals

1. Calculate maximum metals feed rate to meet HWC MACT emission limits.
   SVM Limit 230 µg/dscm @ 7% O_2
   LVM Limit 92 µg/dscm @ 7% O_2

From 2006 CPT, TAPI has determined SRE for
Pb = 99.5% Cr = 98%

Maximum stack gas flow rate (from 2006 CPT)
4300 dscfm @ 4% O_2
For calculation purposed, do not make O_2 correction, since 4% O_2 is conservative.

$$\frac{4300\ dscf}{min} \times \frac{60\ min}{hr} \times \frac{0.02832\ m^3}{ft^3} = \frac{7304.5\ dscm}{hr}$$

$$\frac{7304.5\ dscm}{hr} \times \frac{230\ \mu g}{dscm} \times \frac{1\ g}{1\times10^6\ \mu g} \times \frac{1\ lb}{453.59\ g} = 3.70\times10^{-3}\ lb/hr$$ Max SVM emissions

$$\frac{7304.5\ dscm}{hr} \times \frac{92\ \mu g}{dscm} \times \frac{1\ g}{1\times10^6\ \mu g} \times \frac{1\ lb}{453.59\ g} = 1.48\times10^{-3}\ lb/hr$$ Max LVM emissions

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SVM max feed rate = $\frac{3.70 \times 10^{-3}\ lb}{hr} \times \frac{1}{(1-0.995)} = 0.74\ lb/hr$

LVM max feed rate = $\frac{1.48 \times 10^{-3}\ lb}{hr} \times \frac{1}{(1-0.98)} = 0.074\ lb/hr$

Half can be fed to each incinerator:

0.37 lb/hr SVM to each incinerator.
0.037 lb/hr LVM to each incinerator.

2. Calculate minimum metal feed rate needed for detection in stack gas samples.
(Using data from recent stack tests)
Pb M29 train detection limit ~2.5 μg
Cr M29 train detection limit ~1.0 μg

Anticipated sample volume is ~1.5 dscm in 2 hr period.
Would like to have 10x detection limit, so

Pb 2.5 μg x10 = 25 μg / train

$\frac{25\ \mu g}{sample} \times \frac{1\ sample}{1.5\ dscm} = 16.7\ \mu g/dscm$

Cr 1.0 μg x10 = 10 μg / train

$\frac{10\ \mu g}{sample} \times \frac{1\ sample}{1.5\ dscm} = 6.7\ \mu g/dscm$

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Pb $\frac{16.7\ \mu g}{dscm} \times \frac{7306.5\ dscm}{hr} \times \frac{1}{(1-0.995)} = 24,403,710\ \mu g/hr$

24.4 g/hr
0.054 lb/hr

Cr $\frac{4.7\ \mu g}{dscm} \times \frac{7306.5\ dscm}{hr} \times \frac{1}{(1-0.98)} = 2,447,678\ \mu g/hr$

2.45 g/hr
0.0054 lb/hr

Feed to each incinerator is half.

12.2 g/hr or 0.027 lb/hr Pb to each incinerator
1.23 g/hr or 0.0027 lb/hr Cr to each incinerator

3. Calculate desired spiking rates.

Current feed rate limits are very low!

SVM 3.97×10^{-3} lb/hr ~ 1% of calculated max!
LVM 5.21×10^{-3} lb/hr ~ 14% of calculated max!

Anticipated feed rate from <u>average concentration</u> wastes:

Aqueous: Pb 0.038 mg/l, Cd 0.0085 mg/l
Cr 3.53 mg/l, As 0.05 mg/l, Be 0.006 mg/l

Organic: Pb 0.018 mg/l, Cd 0.01 mg/l
Cr 0.956 mg/l, Be 0.009 mg/l, As 0.02 mg/l

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Average Composition: (CPT Plan Tables 2-1 & 2-2)

Aqueous 0.0465 mg/l SVM 3.586 mg/l LVM

Organic 0.028 mg/l SVM 0.985 mg/l LVM

Feed rate per incinerator @ max feed rate.

Aqueous

$$\frac{12.8\ l}{min} \times \frac{0.0465\ mg}{l} \times \frac{1\ g}{1000\ mg} \times \frac{1\ lb}{453.59\ g} \times \frac{60\ min}{hr} = 7.83 \times 10^{-5}\ lb/hr\ SVM$$

$$\frac{12.8\ l}{min} \times \frac{3.586\ mg}{l} \times \frac{1\ g}{1000\ mg} \times \frac{1\ lb}{453.59\ g} \times \frac{60\ min}{hr} = 6.07 \times 10^{-3}\ lb/hr\ LVM$$

Organic

$$\frac{4.7\ l}{min} \times \frac{0.028\ mg}{l} \times \frac{1\ g}{1000\ mg} \times \frac{1\ lb}{453.59\ g} \times \frac{60\ min}{hr} = 1.74 \times 10^{-5}\ lb/hr\ SVM$$

$$\frac{4.7\ l}{min} \times \frac{0.985\ mg}{l} \times \frac{1\ g}{1000\ mg} \times \frac{1\ lb}{453.59\ g} \times \frac{60\ min}{hr} = 6.12 \times 10^{-4}\ lb/hr\ LVM$$

Total $7.83 \times 10^{-5} + 1.74 \times 10^{-5} = 9.57 \times 10^{-5}$ lb/hr SVM

$6.07 \times 10^{-3} + 6.12 \times 10^{-4} = 6.68 \times 10^{-3}$ lb/hr LVM

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Maximum Concentration (CPT Plan Tables 2-1 & 2-2)

Aqueous: 1.11 mg/l SVM, 22.5 mg/l LVM

Organic: 0.11 mg/l SVM, 3.17 mg/l LVM

Feed rate per incinerator @ max feed rates:

Aqueous

$$\frac{12.8\ l}{min} \times \frac{1.11\ mg}{l} \times \frac{1\ g}{1000\ mg} \times \frac{1\ lb}{453.59\ g} \times \frac{60\ min}{hr} = 1.88 \times 10^{-3}\ lb/hr\ SVM$$

$$\frac{12.8\ l}{min} \times \frac{22.5\ mg}{l} \times \frac{1\ g}{1000\ mg} \times \frac{1\ lb}{453.59\ g} \times \frac{60\ min}{hr} = 3.81 \times 10^{-2}\ lb/hr\ LVM$$

Organic

$$\frac{4.7\ l}{min} \times \frac{0.11\ mg}{l} \times \frac{1\ g}{1000\ mg} \times \frac{1\ lb}{453.59\ g} \times \frac{60\ min}{hr} = 6.84 \times 10^{-5}\ lb/hr\ SVM$$

$$\frac{4.7\ l}{min} \times \frac{3.17\ mg}{l} \times \frac{1\ g}{1000\ mg} \times \frac{1\ lb}{453.59\ g} \times \frac{60\ min}{hr} = 1.97 \times 10^{-3}\ lb/hr\ LVM$$

Total $1.88 \times 10^{-3} + 6.84 \times 10^{-5} = 1.95 \times 10^{-3}$ lb/hr SVM

$3.81 \times 10^{-2} + 1.97 \times 10^{-3} = 4.01 \times 10^{-2}$ lb/hr LVM

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Determine Spiking Rates for SVM and LVM

Criteria:

1. Spiking rate should allow detection in stack samples.
2. Spiking rate should be less than the maximum calculated to meet HWC MACT emission limits.
3. Spiking rates should be a reasonable fraction of the rates justified using the historical maximum waste concentrations of the regulated constituents.

Max Rates for HWC MACT Compliance (from pg 2)
Each incinerator: 0.37 lb/hr SVM; 0.037 lb/hr LVM

Min Rates for stack gas detection (from pg 3)
Each incinerator 0.027 lb/hr Pb; 0.0027 lb/hr Cr

Current feed rate limits (from pg 3)
Each incinerator 3.97×10^{-3} lb/hr SVM; 5.21×10^{-3} lb/hr LVM

Max feed rate at max historical concentrations (from pg 5)
Each incinerator 1.95×10^{-3} lb/hr SVM; 4.01×10^{-2} lb/hr LVM

Pb. Feed at minimum to detect in stack gas $\underline{2.7 \times 10^{-2}}$ lb/hr

Cr Feed at approximately twice current limit, which will be plenty to detect, will be less than maximum for compliance, and will only require extrapolation by a factor of ~2 to the max justified by historical data. $\underline{1.0 \times 10^{-2}}$ lb/hr

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B. Ash

1. Target total ash feed rate is 224 lb/hr, to each incinerator.
If waste has no ash, will need to spike all ash. Using NaCl (aqueous solution) for ash spiking. If average ash, then spike 174 lb/hr, each.

Will adjust spiking rate based on pre-test ash analysis.

C. Total Chlorine/Chloride

1. Target total chlorine/chloride feed rate is 241 lb/hr, to each incinerator.
Using ash (NaCl) and methylene chloride spiking to provide total chlorine/chloride.

CH_2Cl_2 is 83.5 wt% Cl
NaCl is 60.6 wt% Cl

If average total chlorine/chloride is present in feeds, then:
Chlorine/chloride from waste = 26.4 lb/hr
Chlorine/chloride from ash (NaCl) spike: $174 \times 0.606 = 105.4$ lb/hr

Chlorine/chloride needed from CH_2Cl_2: $241 - 26.4 - 105.4 = 109.2$ lb/hr

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2. Methylene chloride spiking rate.

$$\frac{83.1 \text{ lb Cl}}{\text{hr}} \times \frac{1 \text{ lb } MeCl_2}{0.835 \text{ lb Cl}} = 99.5 \text{ lb/hr } MeCl_2 \text{ each incinerator}$$

Will adjust spiking rate in the field based on pre-test chlorine/chloride analysis.