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February 25, 2010

Commissioner Anthony Eggert, Presiding Member
Vice Chair James D. Boyd, Associate Member
Mr. Craig Hoffman, Project Manager
Abengoa Mojave Solar Project (09-AFC-5)
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814

Re: Abengoa Mojave Solar Project (09-AFC-5): Revised Second Supplemental Written Response to Data Request Set 1A (nos. 1-93) for Air Quality and Public Health

Dear Commissioners Eggert and Boyd:

Abengoa Solar Inc. (the “Applicant”) hereby files these revised written responses to certain Data Requests in Set 1A promulgated by Staff on October 22, 2009. Following the February 2, 2010 submission of the Second Supplemental Written Response to Data Request Set 1A (nos. 1-93) for Air Quality and Public Health, the Applicant learned that the factors used to calculate fugitive emissions from the Heat Transfer Fluid (“HTF”) system were incorrect. The emissions factors the Applicant had applied were those developed by Kern County APCD staff as used in the Beacon Solar PDOC. Specifically, the Applicant learned, and received confirmation from Kern County APCD by e-mail to the Applicant’s consultant, TTECI, that the calculated factors had not been converted from units of kg/hr/source to lbs/hr/source (i.e., the values presented in the KCAPCD PDOC are actually in units of “kg/hr/source,” rather than “lbs/hr/source” as listed). The Applicant has communicated this information to both the CEC staff and the Mojave Desert Air Quality Management District.

In reevaluating the application of these factors, the Applicant agrees with the KCAPCD assumption that the HTF in service should be considered a light liquid, based upon its vapor pressure of 15.6 psia and 108 psia at common solar field operating temperatures of 500°F and 700°F, respectively. The factors applied were taken from “Protocol for Equipment Leak Emissions Estimates, EPA 453-R-95-017, November 1995,” as detailed on the attached calculation spreadsheet. The responses to Data Requests 30 and 83 were affected by this change, and therefore this submittal contains revised responses to Data Requests 30 and 83.

Because the calculated HTF fugitive emissions dropped significantly, new Health Risk Assessments were not performed. Those previously submitted did not indicate significant health impacts; therefore, the risks associated with reduced emissions would be even lower.

The Applicant appreciates Staff's time and efforts reviewing the enclosed materials. The Applicant looks forward to working with Staff to achieve complete and satisfactory resolution of all issues in a timely manner.

Thank you for your time and consideration of this matter.

Sincerely,

Christopher T. Ellison
Shane E. Conway
Ellison, Schneider & Harris, L.L.P.

Attorneys for Abengoa Solar Inc.

Attachment

HTF System Component Count and Fugitve Emissions Estimate
Mohave Solar Project

Component	Count #	Service	EF lb/hr/src	Hrs/day	lbs/hr	lbs/day	lbs/yr	tons/yr
Valves								
Sealed Bellows	0	Gas/Vapor & Lt. Liquid	0	0	0.000	0.000	0.000	0.000
	0	Fuel/N.Gas	0	0	0.000	0.000	0.000	0.000
AQMD Approved I&M	0	Gas Vapor	0	0	0.000	0.000	0.000	0.000
	3247	Lt. Liquid	0.00000108	16	0.004	0.056	20.479	0.010
	0	Hvy. Liquid	0	0	0.000	0.000	0.000	0.000
Pumps								
Sealess Type	0	Lt. Liquid	0	0	0.000	0.000	0.000	0.000
Double Mech Seals or Equivalent	24	Lt. Liquid	1.6535E-05	16	0.000	0.006	2.318	0.001
Single Mech Seal	0	Hvy. Liquid	0	0	0.000	0.000	0.000	0.000
Compressors	0	Gas/Vapor	0	0	0.000	0.000	0.000	0.000
Flanges/Connectors	1550	All	1.345E-06	16	0.002	0.033	12.175	0.006
PRVs	16	Gas	0.01242	8	0.199	1.590	580.262	0.290
Process Drains	0	All	0	0	0.000	0.000	0.000	0.000
Open-ended Lines	0	Lt. Liquid	0.003307	0	0.000	0.000	0.000	0.000
				Totals	0.20	1.69	615.23	0.31
Operating Days/Yr:	365							

Decomposition By Products:

Comment	CAS #	Substance ID	% wt of Total VOC	Fraction of VOC, wt	lbs/hr	lbs/day	lbs/yr	tons/yr
MSDS Trace Amount	71432	Benzene	1	0.01	0.002	0.017	6.152	0.003
MSDS Trace Amount	108952	Phenol	2.5	0.025	0.005	0.042	15.381	0.008
HTF Composition Value	92524	Biphenyl	26.5	0.265	0.054	0.447	163.037	0.082
			0	0	0.000	0.000	0.000	0.000
		***	0	0	0.000	0.000	0.000	0.000

Notes:
(1) VOC BACT is accepted as achieved in practice.
(2) Decomposition data from HTF manufacturer (Solutia) and related MSDS.
(3) All drains, vents, and inline relief valves are capped and they are included as "connectors".
(4) In line relief valves relieve light liquid from high pressure to successively lower pressures.
(5) The only relief valves to atmosphere are from Nitrogen blanketed vapor space (gas) on tanks and cleaning system.

Table of Contents

Air Quality

Item 30 (Revised):

Information Required:

Please identify whether the applicant is willing to stipulate to the incorporation of a carbon adsorption, or other VOC control system, to control VOC emissions from the HTF expansion system venting by at least 98 percent. If unwilling to stipulate to this condition, please identify the basis for this position.

Response:

The Applicant proposes the following system for VOC control from the HTF expansion system, which will achieve a minimum overall VOC emissions control efficiency of 98%.

NITROGEN VENTING OF THE HEAT TRANSFER FLUID SYSTEM

HTF Expansion System Basis

The heat transfer fluid (HTF) will be either Therminol VP-1 produced by Solutia, Inc. or Dowtherm A produced by Dow Chemical Company. Both materials are comprised of diphenyl oxide (73-73.5%) and biphenyl (26.5-27%). These materials in gaseous form represent VOCs with biphenyl and are classified as a hazardous air pollutant (HAP).

The Mojave project has two identical Alpha and Beta plants. The numbers on the following flow diagram are totals for both plants together. The HTF system of each plant will consist of 5 vertical ASME-rated expansion tanks, one nitrogen-condensing ASME-rated tank (same size as expansion tank) and two vertical HTF storage tanks.

These expansion tanks and the nitrogen condensing tanks will be sized such that during normal operation the expansion/contraction of the HTF will be kept within these tanks and an initial fill of nitrogen will also be kept within tanks by allowing the nitrogen/vapor space pressure to vary from 3 bara to 11 bara nominally. However, after filling all pipes initially at ambient temperature (with high density – lower specific volume), the expansion of the HTF from the ambient temperature to the daily operating temperatures will push the HTF that is not needed in the system during daily operation from the expansion tanks into two storage tanks that will be kept cooler (at about 165 °F) and blanketed with 2-15 inches Water Column (in. WC) nitrogen pressure.

During daytime operation, when the HTF is heated and expands, the expanded volume will move into the expansion tanks and the nitrogen will be compressed and pushed into the nitrogen condensing tank. At night when the HTF cools and contracts, the HTF will move back into the piping and the nitrogen in the vapor space will expand into the expansion tanks.

After some time of operation some of the HTF will break down into Low Boilers (LB's) such as Benzene, Phenol, etc.; and High Boilers (HB's) – heavier sludge. After a few years of operation, these HB's and LB's will accumulate to high enough concentrations that they need to be removed from the system.

Although venting would be limited by letting the nitrogen space pressure rise and fall as necessary to keep it contained within the expansion and nitrogen condensing tanks, the LB's which will be released into the vapor space at operating temperature will be removed from nitrogen space by condensing them in the nitrogen condensing tank by cooling them in the tank to about 176 °F.

HB's will be removed from the system through a side stream distillation system.

<u>Types of Venting</u>

There are two types of venting from HTF system:

- the daily venting of nitrogen due to HTF Storage Tank breathing
- venting of low boilers (HTF degradation products)

<u>Daily Breathing Venting</u>: As indicated above, during most normal operation there will be no exchange of HTF or nitrogen between expansion tanks and the storage tanks. However in unusual cases when the HTF temperature swings outside of the normal daily range, some hotter HTF and nitrogen may need to be transferred from expansion tanks into the storage tanks and vice versa. During these unusual exchanges the storage tank levels will fall and rise, thus requiring nitrogen space venting. The worst case would be if the HTF system got very cold (limited to 100 °F) in which case all the HTF from the storage tanks will be pumped into the system; and next time the system is brought back to normal operation, all HTF that was pumped out of the storage tanks will return to the storage tanks. Under that condition, the total amount of nitrogen vented is calculated to be 66,530 cu ft or 5200 lb/hr total for both plants.

The storage tanks have coolers on their vent stacks. Nitrogen and HTF mixture to be released passes through the vent coolers, cooled to 120 °F, that will condense most of the HTF vapor vented from the storage tanks before reaching atmosphere. The storage tanks are maintained at 165 ºF to minimize HTF venting. The HTF storage tank has a liquid HTF air cooler to maintain this tank's temperature at 165 ºF.

<u>Low Boilers Venting</u>: As the HTF is normally cycled from 428ºF to 740ºF every day, there will be some degradation of the HTF. This degradation will result in primarily phenol and benzene with smaller concentrations of toluene and naphthalene. These degradation products will affect the thermal efficiency of the HTF and increase vapor pressure.

As the HTF daily moves into and out of the expansion tanks, the LB's along with some vaporous HTF will be released into the vapor space. To help this separation of LB's into the vapor space, a side stream of HTF will also be sprayed to the top of the expansion tanks continuously. When the expansion tanks fill up with HTF and compress the nitrogen+vapors into the nitrogen condensing tanks which will be kept cooled to 176 °F, the LB's along with a large amount of HTF vapor will be condensed.

The HTF+LB's condensate will be sent to an HTF LB's and HB's Cleaning System in which the HTF will be recovered as much as achievable with a distillation system. The LB's will be pulled out of the top of the distillation unit and most of the LB's along with some residual HTF will be condensed at about 120 °F (with cooling water) and collected in a tank to be disposed/sold for heat value. The non-condensibles will then be vented through a single point (the same point) as the storage tanks vents.

As the concentrations of the LB's increases in the HTF system, more and more LB's will be released, condensed and recovered until daily degradation equals to the amount recovered for disposal plus a small amount that is vented to atmosphere along with nitrogen. Based on Solutia's simulations and lab and field tests, daily degraded low boilers are calculated to be approximately 46.5 lbs/day per plant (93 lbs/day total for both plants).

<u>Low Boilers Removal Scheme:</u> The HTF system is sized to not require nitrogen venting due to HTF expansion. However, to purge low boilers from the system, the expansion tanks will be vented at regular intervals instead of once per year recommended by HTF vendor. The amount of nitrogen vented is the volume of five expansion tanks from 0 to 90% volume. This vented nitrogen at 11 bars (159.5 psia) will include small amounts of HTF and HTF degraded by-products, the LB's. An ASPEN simulation predicted that it is better to condense low boilers under pressure than by expanding the mixture and cooling it (scrubbing through a cooler pool of liquid) in the HTF Storage Tank followed by atmospheric condensation. The expansion tanks' vent stream is cooled to 176 °F at 159.5 psia through a HTF-cooled nitrogen condenser and pressurized condensing tank. The majority of nitrogen is recycled back to the expansion tanks. Condensed HTF along with the low boilers are sent to a HTF Cleaning System.

This continuous cleaning system operating 8 hours/day is a side-stream distillation for removal of high boiling degradation products called high boilers consisting of dibenzofuran, phenoxy biphenyl isomers, terphenyl, quaterphenyls, and phenoxy-polyphenyl compounds. These high boilers form over time in HTF which must be effectively managed for extending fluid life. This can be done by either dilution (replacement of old fluid with new fluid) or on-site distillation. A small side stream of in-service heat transfer fluid is continuously fed into a distillation unit. The HTF and LB's originating from the expansion tanks are removed in the two separate overhead streams cut at different temperatures. An HTF stream containing small amounts of high and low boilers, taken as a middle stream from the distillation unit, is condensed and returned to service through the HTF Expansion Tanks. The LB's stream, taken as a top overhead stream from the distillation unit, is condensed at 120 °F, stored in a slightly pressurized tank and disposed of as a hazardous liquid. The bottoms stream is enriched in HB's (and insoluble solids), which are removed for disposal either as a hazardous liquid or sent to the HTF vendor under EPA "used oil" regulations for credit on recoverable HTF. The vent stream from the distillation unit will be combined with HTF Storage Tank breather vent and cooled to 120 °F through a water-cooled condenser to recover HTF and returned to HTF Storage Tank.

<u>Release Control Efficiency</u>: Maximum VOC emissions from nitrogen venting are thus 5.1 lb/day HTF with a maximum of 27% or 1.38 lb/day comprised of biphenyl, a hazardous air pollutant (HAP) and 4 lbs/day of benzene, toluene, and phenol. The Title V threshold for hazardous air pollutants is 10 tons/year for any individual HAP. So the HTF and benzene release as calculated is much less than the maximum level allowed. Since the expansion is expected to take place over the course of more than one hour in the morning, the maximum hourly emissions is also the same as daily maximums.

Based on the calculations submitted, this control reduces the potential mass of HTF released from 6867 lbs/day to 5.1 lbs/day resulting in an overall VOC control efficiency of about 99.9%.

Based on the above design considerations and system control efficiency, the project is not anticipating the need for any additional add-on VOC controls.

<u>Emissions Summary</u>

Therefore, the HTF tanking and venting system will result in VOC (HTF plus low boiler compounds) emissions on the order of 1.1375 lbs/hr, 9.1 lbs/day (based on 8 hours/day of venting), 3322 lbs/year, or 1.66 tpy for the entire facility. VOC emissions for a single power block would be approximately 0.57 lbs/hr, 4.55 lbs/day (based on 8 hours/day of venting), 1661 lbs/yr, or 0.831 tpy.

Waste hauling (total load-out emissions for the 250 MW facility) will be approximately 0.0013 lbs/hr, 0.0013 lbs/day, 0.0157 lbs/yr, or 7.84E-6 tpy. These emissions are based on the following data and assumptions:

a. 12 facility load-outs per year (1 per month) maximum.

b. 2 hours per load-out (1 hour at each power block). The actual load-out pumping or transfer time will be less than an hour, but an hour was used as the basic emissions period.

c. VOC emissions loss rate is ~0.0013 lbs/hr (based upon the haul truck evacuated vapor space volume and VOC concentration in the vapor per facility load-out).

HTF VOC fugitive emissions from valves, flanges, pumps, seals, etc., will be 0.20 lbs/hr, 1.69 lbs/day, 615.23 lbs/year, or 0.31 tpy, based on the data and assumptions in the VOC Component Count and Emissions spreadsheet attached at the end of these responses.

In addition, we note the following with respect to Staff concerns on the BACT for the HTF ullage system:

MDAQMD Rule 1303 Requirements state the following:

(A) Best Available Control Technology is required on:

(1) Any new Permit Unit which emits, or has the Potential to Emit, 25 pounds per day or more of any Nonattainment Air Pollutant shall be equipped with BACT,

(2) Any Modified Permit Unit which emits, or has the Potential to Emit, 25 pounds per day or more of any Nonattainment Air Pollutant shall be equipped with BACT,

(3) Any new or Modified Facility which emits, or has the Potential to Emit, 25 tons per year or more of any Nonattainment Air Pollutant shall be equipped with BACT for each new Permit Unit.

(4) For purposes of determining applicability of this Section, Potential to Emit is defined by District Rule 1301(UU) and SERs shall not be utilized to reduce such Potential to Emit.

Sections (A)(1) and (2) apply to the proposed HTF ullage system and the facility in general. In addition, the nonattainment pollutants affected by these provisions for the site are as follows:

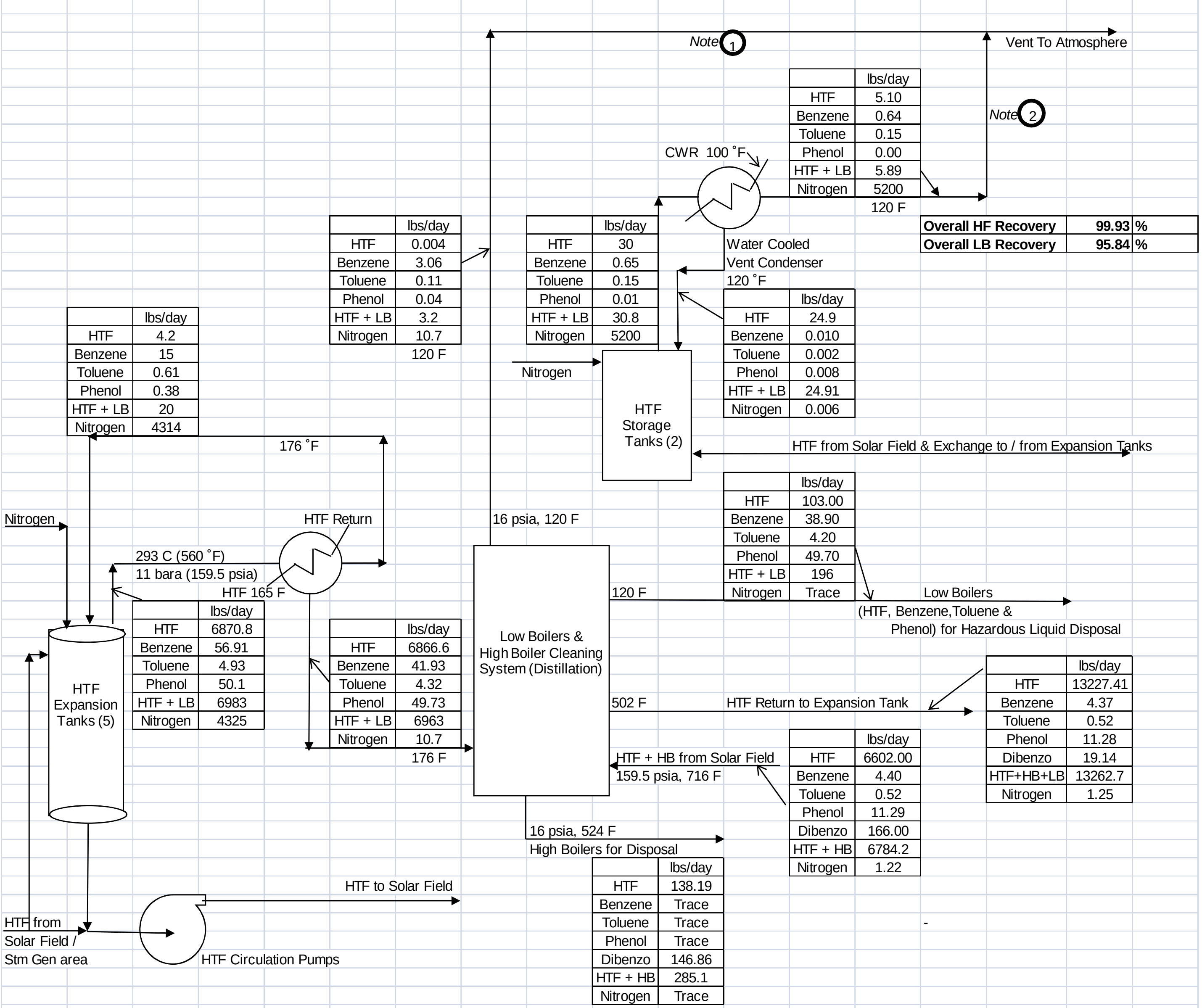
- For ozone – NOx, VOC, and the organic fraction of PM10
- For PM10 – the nitrate and sulfate fractions of NOx and SOx, the direct portion of PM10, and the organic fraction of PM10 from VOCs.

A review of the device/process specific emissions sheets presented at the conclusion of these responses indicates the following:

- No nonattainment pollutant is emitted in excess of 25 tons per year from the facility per Section (A)(3), therefore BACT is not required for each new permit unit.
- Each of the emergency electric generators (diesel engines) will emit NOx at a rate of 46.61 lbs/hr and 46.61 lbs/day. BACT for NOx would be required, and the applicant believes that data presented to date indicates that these engines meet the MDAQMD BACT requirements, NSPS requirements, as well as CARB and EPA Tiered emissions standards.
- HTF solar field components will emit VOC at a rate of 0.20 lbs/hr and 1.69 lbs/day. BACT for these field components is based upon the component design, maintaining the components (seals, valves, flanges, etc) in a leak-free condition, etc.
- The HTF ullage system is anticipated to have VOC emissions on the order of 1.138 lbs/hr and 9.1 lbs/day. As such, the BACT requirement is not triggered for the HTF ullage system under the MDAQMD NSR rules; therefore the applicant believes that the presently designed system of VOC controls for the ullage system is sufficient for purposes of controlling VOC emissions to the maximum extent possible considering the design of the project.

Process Flow Block Diagram - HTF Venting System

These numbers are total for two plants Alpha & Beta.



Vent to atmosphere (Note 2), 120 F:

	lbs/day
HTF	5.10
Benzene	0.64
Toluene	0.15
Phenol	0.00
HTF + LB	5.89
Nitrogen	5200

Overall HF Recovery	**99.93**	%
Overall LB Recovery	**95.84**	%

Distillation vent, 120 F:

	lbs/day
HTF	0.004
Benzene	3.06
Toluene	0.11
Phenol	0.04
HTF + LB	3.2
Nitrogen	10.7

HTF Storage Tanks vent to condenser:

	lbs/day
HTF	30
Benzene	0.65
Toluene	0.15
Phenol	0.01
HTF + LB	30.8
Nitrogen	5200

Condensate return to HTF Storage Tanks:

	lbs/day
HTF	24.9
Benzene	0.010
Toluene	0.002
Phenol	0.008
HTF + LB	24.91
Nitrogen	0.006

Expansion tank vent, 176 ˚F:

	lbs/day
HTF	4.2
Benzene	15
Toluene	0.61
Phenol	0.38
HTF + LB	20
Nitrogen	4314

Low Boilers, 120 F:

	lbs/day
HTF	103.00
Benzene	38.90
Toluene	4.20
Phenol	49.70
HTF + LB	196
Nitrogen	Trace

Expansion tank to HTF Return cooler, HTF 165 F:

	lbs/day
HTF	6870.8
Benzene	56.91
Toluene	4.93
Phenol	50.1
HTF + LB	6983
Nitrogen	4325

Feed to distillation, 176 F:

	lbs/day
HTF	6866.6
Benzene	41.93
Toluene	4.32
Phenol	49.73
HTF + LB	6963
Nitrogen	10.7

HTF Return to Expansion Tank:

	lbs/day
HTF	13227.41
Benzene	4.37
Toluene	0.52
Phenol	11.28
Dibenzo	19.14
HTF+HB+LB	13262.7
Nitrogen	1.25

HTF + HB from Solar Field:

	lbs/day
HTF	6602.00
Benzene	4.40
Toluene	0.52
Phenol	11.29
Dibenzo	166.00
HTF + HB	6784.2
Nitrogen	1.22

High Boilers for Disposal:

	lbs/day
HTF	138.19
Benzene	Trace
Toluene	Trace
Phenol	Trace
Dibenzo	146.86
HTF + HB	285.1
Nitrogen	Trace

-

Note 1: With 8 hours per day operation, the numbers are per day

Note 2: One hour per day during initial heat up in morning.

Public Health

Item 83 (Revised):

Information Required:

Please describe and discuss the potential for all toxic thermal degradation products of HTF.

Response:

According to the MSDS for both Therminol-VP1 and Dowtherm-A as provided in Appendix C.1 of the AFC, note the following:

1. Both fluids are stable under normal conditions of handling and storage.
2. Neither fluid has the potential to undergo hazardous polymerization.
3. Both fluids have compound characteristics similar to the RCRA class of chemicals identified as category D018 (benzene).
4. Both fluids can decompose at elevated temperatures.
5. Decomposition products may include "trace" amounts of benzene and phenol.

According to data provided by the HTF manufacturer and the HTF system designer, as analyzed by the project engineering staff (using the Aspen Plus Model, version 2006.5), the amounts and types of hazardous air pollutants in the ullage system decomposition off-gas would be approximately as follows:

- Benzene wt% of total VOC = 40.6%
- Phenol wt% of total VOC = 0.44%
- Toluene wt% of total VOC = 2.86%

And the HTF itself:

- Biphenyl wt% of total VOC = 14.9%
- Diphenyl Oxide (a.k.a. Diphenyl Ether) wt% of total VOC = 41.2%

For the breakdown of HAPs in the solar field components, the MSDS states that the decomposition products of benzene and phenol occur in "trace amounts". For purposes of calculating the HAPs emissions from the component fugitives in the solar field, a value of 5% by wt of total VOCs of each compound (except biphenyl at 26.5%) was used as an upper limit representative of a "trace amount".

The following table presents the estimates of emissions for the identified degradation products from the various HTF subsystems.

Summary of HTF Subsystem Degradation Product Emissions

HTF Subsystem	Units	Benzene	Phenol	Toluene	Biphenyl
Tank/Ullage Venting	Lbs/hr	0.463	0.005	0.0325	0.172
	Lbs/day	3.7	0.04	0.26	1.38
	Tons/Yr	0.675	0.0073	0.0475	0.252
Component Fugitives	Lbs/hr	0.002	0.005	neg	0.054
	Lbs/day	0.017	0.042	neg	0.447
	Tons/Yr	0.003	0.008	neg	0.082
Waste Load Fugitives	Lbs/hr	neg	neg	neg	neg
	Lbs/day	neg	neg	neg	neg
	Tons/Yr	neg	neg	neg	neg

Updated Operational Emissions Summary Table

HTF Component Fugitives (2 Solar Fields)

	NOx	CO	VOC	SOx	PM10	PM2.5	CO2e
Lbs/hr	-	-	0.20	-	-	-	-
Lbs/day	-	-	1.69	-	-	-	-
Tons/Yr	-	-	0.31	-	-	-	-

STATE OF CALIFORNIA

Energy Resources Conservation
and Development Commission

Application for Certification for the ABENGOA MOJAVE SOLAR POWER PLANT	))))	Docket No. 09-AFC-5

PROOF OF SERVICE

I, Karen A. Mitchell, declare that on February 25, 2010, I served the attached *Revised Second Supplemental Written Response to Data Request Set 1A (nos. 1-93) for Air Quality and Public Health* via electronic and U.S. mail to all parties on the attached service list.

I declare under the penalty of perjury that the foregoing is true and correct.

Karen A. Mitchell

Karen A. Mitchell

SERVICE LIST
09-AFC-5

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