

<b>DOCKET</b> <b>09-AFC-5</b>
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June 16, 2010

Alan Solomon  
Project Manager  
California Energy Commission  
1516 Ninth Street  
Sacramento, CA 95814


RE: **Blythe Solar Power Project, Docket No. 09-AFC-6**  
*HTF Fugitive Component Emission Factor Determination*

Dear Mr. Solomon:

Attached please find the following report summarizing the appropriate fugitive emission factors applicable to the heat transfer fluid that will be used at the proposed BSPP facility.

If you have any questions on this submittal, please feel free to contact me directly.

Sincerely,



Alice Harron  
Senior Director, Development

## HTF Fugitive Component Emission Factor Determination

by  
Russ Kingsley,  
Program Manager,  
AECOM Environment

### Introduction

For calculating Heat Transfer Fluid (HTF) fugitive component emissions during normal operating hours, the Kern County Air Pollution Control District (KCAPCD) proposed using “light liquid” emission factors based on the assumption that the HTF at elevated temperature and pressure resembled light liquids rather than “heavy liquids” as was proposed by Solar Millennium in its AFC. Subsequently, the California Energy Commission (CEC) adopted the methods and assumptions proposed by KCAPCD for its calculations for the various solar thermal projects that are currently under review (e.g., Blythe Solar Power Project [BSPP], Palen Solar Power Project [PSPP] and the Ridgecrest Solar Power Project [RSPP]). Finally, California Unions for Reliable Energy (CURE), in its comments to the South Coast Air Quality Management District (SCAQMD) regarding the PSPP Preliminary Determination of Compliance (PDOC), also suggested that the light liquid emission factors should be used for emission estimates during normal operating hours.

“Light liquid” and “heavy liquid” are terms of art used in the refinery industry and Synthetic Organic Chemical Manufacturing Industries (SOCMI) to identify appropriate regulatory requirements and develop appropriate emission factors for emission estimates from fugitive piping components. The grouping of organic compounds into these two classifications has been studied extensively by EPA in the development of emission factors for fugitive components. The relevant EPA studies thoroughly document the basis for the definitions and associated emission factors. It is inappropriate and unnecessary for CEC or KCAPCD to deviate from the definitions of light liquid and heavy liquid based on the properties of HTF at conditions of use such as elevated temperature or pressure, as EPA has established that the emission factors are not dependant on those properties. This Exhibit provides a summary and analysis of the various EPA guidance on the subject to substantiate this conclusion.

### EPA Development of Heavy and Light Liquid Definitions and Emission Factors

As noted above, KCAPCD, CEC and CURE have asserted that because HTF is operated at elevated temperature and pressure, the vapor pressure of HTF at operating condition more closely resembles light liquids at ambient conditions, and thus the light liquid emission factors should be applied. This logic is flawed, as EPA, in the development of the definitions of light and heavy liquid and the associated emission factors, took into account the operating conditions such as temperature and pressure in both light and heavy liquid streams by studying organic liquid emissions in operating refineries and SOCMI plants. Both light and heavy organic liquids are frequently processed at elevated temperatures and pressures in refineries and SOCMI plants. In addition, to further demonstrate that operating heavy liquids at elevated temperatures and pressures is not uncommon in a refinery, a summary of refinery process units, with process inputs, outputs and operating conditions is provided.

In its 1984 Guidelines Series,<sup>1</sup> EPA discussed how it developed emission factors using a model unit approach. The Guideline Series focuses on emissions of gases or liquid from pumps, compressors, in-line process valves, pressure relief devices, open-ended valves, sampling connections, flanges, and agitators. In the cases of pumps, compressors, in-line process valves, pressure relief devices, flanges and agitators, the potential source of a leak is a seal at the point where the process stream can contact a

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<sup>1</sup> U. S. EPA. Guideline Series: Control of Volatile Organic Compound Leaks from synthetic organic Chemical and Polymer Manufacturing Equipment, EPA-450/3-83-006, March 1984.

part of the equipment, e.g., at a valve stem. Leaks from open-ended valves and sampling connections typically are the result of an incompletely closed valve. Under these circumstances, EPA stated that “available data show that fugitive emissions are proportional to the number of potential sources but are not related to capacity, throughput, age, **temperature, or pressure** [emphasis added]”.<sup>2</sup> EPA’s conclusions are based on fugitive equipment located at 62 SOCMI plants which produce 35 different chemicals.

EPA also states: “Data from petroleum refineries indicates that emission rates of sources decrease as the vapor pressure (volatility) of the process fluid decreases. Three classes of volatility have been established based on the petroleum refinery data. These include gas/vapor service, light liquid service, and heavy liquid service. The split between light and heavy liquids for the refinery data is between naphtha and kerosene. Since similar streams names may have different vapor pressure, depending on site specific factors, it is difficult to quantify the light-heavy split. The break point is approximately at a vapor pressure of 0.3 kPa at 20°C [68°F]”.<sup>3</sup> A similar statement was made in a 1986 report: “the only equipment or proves variable found to correlate with fugitive emission rates was the volatility of the stream components.”<sup>4</sup>

During the EPA’s refinery study, process units at nine refiners were sampled, including atmospheric distillation, vacuum distillation, thermal operation (coking), catalytic cracking, catalytic reforming, catalytic hydrocracking, catalytic hydrotreating, alkylation, aromatics/isomerization, lube oil manufacture, asphalt manufacture, fuel gas/light ends processing liquefied petroleum gas, and sulfur recovery, so a range of operating temperatures and pressures were encountered.<sup>5</sup>

EPA reported that “in 1980, [it] coordinated a study of 24 individual chemical process units. The process units were selected to represent a cross-section of the population across SOCMI. Among the chemical compounds included in the survey were acrylonitrile, ethylene dichloride, formaldehyde, perchloroethylene, and vinyl chloride. Selections of equipment to be screened were made prior to screening activities: screening was conducted by two-person teams using portable organic analyzers. Calibration was done daily at a minimum. A large number of the following types of equipment were screened in the 24 units for determination of leak frequency: flanges, process drains, open-ended lines, agitator seals, relief valves, valves, pump seals, and compressor seals. These sources were further grouped by the chemical phase of the material being handled: in gas/vapor service, in light liquid services, and in heavy liquid service.”<sup>6</sup>

For reference purposes, the vapor pressure of selected liquids processed in refineries or SOCMI plants that meet the definition of a heavy liquid are presented in **Table 1**. Note that the HTF has a vapor pressure of 0.0026 – 0.0071 kilopascals (kPa) in the temperature range of 80 to 100°F. Vapor pressures at lower temperatures are not provided by the manufacturer as HTF crystallizes below 54°F. As shown in the table, the vapor pressure of HTF is much lower than any of these recognized “heavy” liquids.

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<sup>2</sup> U. S. EPA. Guideline Series: Control of Volatile Organic Compound Leaks from synthetic organic Chemical and Polymer Manufacturing Equipment, EPA-450/3-83-006, March 1984, pp. 2-17.

<sup>3</sup> U. S. EPA. Guideline Series: Control of Volatile Organic Compound Leaks from synthetic organic Chemical and Polymer Manufacturing Equipment, EPA-450/3-83-006, March 1984, pp. 2-18.

<sup>4</sup> U. S. EPA. Emission Factors for Equipment Leaks of VOC and HAP, EPA-450/3-86-002, January 1986, p. 3-2.

<sup>5</sup> U. S. EPA. Fugitive Emission Sources of Organic Compounds – Additional Information on Emissions, Emission Reductions, and Costs, April 1982, p. 2-2.

<sup>6</sup> U. S., EPA. Emission Factors for Equipment Leaks of VOC and HAP. EPA-450/3-86-002, January 1986, p. 3-6.

**Table 1 Vapor Pressure of Selected “Heavy” Organic Liquids (kPa)**

<b>Temperature °F (°C)</b>	<b>#2 Diesel</b>	<b>Jet kerosene</b>	<b>Mineral spirits</b>	<b>#6 Fuel oil</b>	<b>Decane</b>	<b>Methacrylic acid</b>
40 (4.4)	0.0031	0.0041	0.00773	2.00E-05	0.0210	0.0068
50 (10)	0.0045	0.006	0.01063	3.00E-05	0.0264	0.0080
60 (15.6)	0.0074	0.0085	0.01256	4.00E-05	0.3320	0.0100
70 (21.1)	0.009	0.011	0.01546	6.00E-05	0.0418	0.0135
80 (26.7)	0.012	0.015	0.02417	9.00E-05	0.0525	0.0160
90 (32.2)	0.016	0.021	0.02803	1.30E-04	0.0660	0.0200
100 (38)	0.022	0.09	0.03093	1.90E-04	0.0831	0.0271
Ref: U. S. EPA. TANKS 4.09d and Antoine Coefficients for Vapor Pressure found at <a href="http://www.lrcHe.com">www.lrcHe.com</a> .						

Several selected refinery processes are listed in **Table 2**, shown with process inputs and outputs, and typical operating conditions of temperature and pressure. As shown in the table, all of these refinery operations process light and/or heavy liquids at elevated temperatures and pressures.

**Table 2 Example Refinery Process Operating Parameters**

<b>Refinery process</b>	<b>Input examples</b>	<b>Temperatures and Pressures</b>	<b>Product examples</b>
Catalytic cracking unit (CCU)	Extra heavy gas oil, heavy gas oil	Ambient – 1,200 °F; 10 - 50 psig	Light gas oil
Catalytic gas plant	CCU main fractionator tops	Ambient to 390 °F; 10 - 175 psig	Light gasoline, heavy gasoline
Catalytic feed hydrotreater	Extra heavy gas oil, heavy gas oil	Ambient – 750 °F; 50 – 1,550 psig	CCU feed (flash distillate)
Catalytic gasoline hydrotreater	Light gasoline	Ambient - 750 °F; 40 - 900 psig	Volatile light hydrocarbons
Delayed Coker Unit	Resid, naphthenic bottoms, heavy and light flushing oils, marine fuel oil	Ambient - 950 °F; Atmospheric – 4,000 psig	Naphtha, light/heavy gas oils
Hydrotreater	Gas oils, heavy gas oil	Ambient - 950 °F; Atmospheric – 2,500 psig	Naphtha
Heavy gasoline hydrotreater	Naphtha, heavy gasoline, rich sponge oil	Ambient - 750 °F; Atmospheric – 1,250 psig	Various fractions

**Table 2 Example Refinery Process Operating Parameters**

<b>Refinery process</b>	<b>Input examples</b>	<b>Temperatures and Pressures</b>	<b>Product examples</b>
Crude unit/Vacuum flasher	Crude oil	Ambient to 750 °F; Vacuum to 25 psig	Naphtha, light gas oil, heavy gas oil, extra heavy gas oil
Naphtha hydrotreater (NHT), Gas oil hydrotreater (GOHT)	Naphtha, light gas oil	NHT - 740 °F, 650 psig GOHT - 602 °F; 1,500 psig	Stabilizer side stripper bottoms, stabilizer tops, stabilizer bottoms; primary side stripper bottoms; secondary bottoms; secondary tops
Flexicoker unit	Vacuum residue	Ambient – 1,700 °F; 2 - 165 psig	Naphtha, heavy gas oil, light gas oil, extra heavy gas oil
<p>Note that stream names often vary by refinery; not all refineries call these streams by these same names. Naphtha is a gasoline blending stock, with volatility similar to gasoline. Gas oils (extra heavy gas oil, heavy gas oil, light gas oil) are much less volatile than kerosene. Gas oils are typically processed through a hydrocracker to split these molecules into lighter components. Vacuum residue, resid, and bottom streams are typically much less volatile than kerosene.</p> <p>Ref: Refinery Process Overview, Martinez Refinery, Shell Oil Products US, 2003.</p>			

In conclusion, when developing the definitions and corresponding emission factors for heavy and light liquids, EPA evaluated refinery and SOCMI process streams, both heavy and light liquids, at actual operating temperatures and pressures. Those temperatures and pressures were typically substantially above ambient conditions, and in many cases would have been above the conditions that the HTF would operate at in a solar field. Based on their research, EPA concluded that the emissions expected from fugitive components are not dependent upon process temperature and pressure. Instead, EPA concluded that light and heavy liquids could be defined according to relative volatility, with the split between heavy and light liquids of 0.3 kPa at 68°F. The choice of 68°F is a convenience for classification of materials (as MSDS typically list vapor pressure at standard conditions of 68°F), and has no relationship to the conditions under which the material is processed. Simply stated, naphtha is a light liquid under all process conditions and kerosene is a heavy liquid under all process conditions. Based on the published vapor pressure of HTF and a comparison of the volatility of HTF to that of naphtha or kerosene, HTF is a heavy liquid, under all process conditions.

**STATE OF CALIFORNIA  
ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION**

***In the Matter of:***  
**APPLICATION FOR CERTIFICATION**  
**for the *BLYTHE SOLAR POWER PROJECT***

**Docket No. 09-AFC-6**  
**PROOF OF SERVICE**  
*(Revised 1/26/2010)*

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### **DECLARATION OF SERVICE**

I, Carl Lindner, declare that on June 16, 2010, I served and filed copies of the attached:

HTF Fugitive Component Emission Factor Determination

The original document, filed with the Docket Unit, is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at:

[\[http://www.energy.ca.gov/sitingcases/solar\\_millennium\\_blythe\]](http://www.energy.ca.gov/sitingcases/solar_millennium_blythe).

The document has been sent to the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

**(Check all that Apply)**

**For service to all other parties:**

  X   sent electronically to all email addresses on the Proof of Service list;

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**CALIFORNIA ENERGY COMMISSION**

Attn: Docket No. 09-AFC-6

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

Carl E. Lindner