EMISSION-FUGITIVE
Equipment Fugitive Emissions

USER MANUAL

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1.0 Introduction

The preferred method for estimating emissions from equipment leaks is based on measured screening values with the appropriate equipment correlation equation to predict the mass emission rate.

When no screening data is available average emission factors can be used until data becomes available, but will probably result in a higher emission rate prediction. In the absence of measured data the local environment agency should be contacted to discuss the most acceptable approach.

These approaches are suitable for estimating emissions from a population of equipment and are not intended for individual items.

The Environmental Protection Agency (EPA) has developed data for the Synthetic Organic Chemical Manufacturers Industries’ (SOCMI) processes and for the Petroleum Industry.

EMISSION-FUGITIVE module provides a structured format for estimating emissions from equipment leaks using both the correlation equation approach and the average emission factor methods. Estimations are provided for SOCMI and the Petroleum Industry emission rate data. The petroleum industry correlations apply to refineries, marketing terminals, and oil and gas production.

Alternative methods that can be used for estimating emissions from equipment leaks include the “Screening Range Approach” and the “Unit Specific Correlation Approach”. These methods are not included in EMISSION-FUGITIVE.

The screening range approach involves collecting data for specific types of equipment in the process unit and then applying equipment counts as in the average emission factor method.

Unit specific correlations are based on obtaining measured data for a specific process unit and can be expensive to implement. The Protocol for Equipment Leak Emission Estimates provides detailed information on this methodology.
2.0 Data Entry Rules

Refer Appendix I for the SOCMI report format and Appendix II for the Petroleum Industry report format.

Data input cells are blue.

In the appropriate report selection of the Equipment Type from the “pop-up box” in a table group applies the relevant emission factor or correlation equation to that table.

The “Average Emission Factor Method” and the “Correlation Equation Method” can be used in combination which allows average emission factors to be applied for a quantity of equipment types when screening data is not available.
3.0 Model Calculations

For SOCMI processes the following emission rate data is used, where SV is the measured screening value (ppmv). The emission rate for light liquid pumps can be applied to compressor seals, pressure relief valves, agitator seals and heavy liquid pumps.

**SOCMI TOC Emission Rates\(^{(1)}\) Correlation Equation Method Data**

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Default Zero Emission Rate</th>
<th>Pegged Emission Rates</th>
<th>Correlation Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kg/h per source</td>
<td>kg/h per source</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.0E04ppmv</td>
<td>1.0E06ppmv</td>
<td></td>
</tr>
<tr>
<td>Gas valves</td>
<td>6.6E-07</td>
<td>0.024</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.87E-06 x (SV)^0.873</td>
</tr>
<tr>
<td>Light liquid valves</td>
<td>4.9E-07</td>
<td>0.036</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6.41E-06 x (SV)^0.797</td>
</tr>
<tr>
<td>Light liquid pumps</td>
<td>7.5E-06</td>
<td>0.14</td>
<td>0.62</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.90E-05 x (SV)^0.824</td>
</tr>
<tr>
<td>Connectors</td>
<td>6.1E-07</td>
<td>0.044</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.05E-06 x (SV)^0.885</td>
</tr>
</tbody>
</table>

To estimate emissions the default zero emission rate is only used if the screening value, adjusted for background, equals 0 ppmv. If the monitoring device registers maximum scale value (pegged) then the appropriate pegged emission rate is used.

**SOCMI Average Emission Factors\(^{(2)}\)**

The light liquid pump seal factor can be used to estimate the leak rate from agitator seals.

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Service</th>
<th>Emission Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>kg/h per source</td>
</tr>
<tr>
<td>Valves</td>
<td>Gas</td>
<td>0.00597</td>
</tr>
<tr>
<td></td>
<td>Light liquid</td>
<td>0.00403</td>
</tr>
<tr>
<td></td>
<td>Heavy liquid</td>
<td>0.00023</td>
</tr>
<tr>
<td>Pump seals</td>
<td>Light liquid</td>
<td>0.0199</td>
</tr>
<tr>
<td></td>
<td>Heavy liquid</td>
<td>0.00862</td>
</tr>
<tr>
<td>Compressor seals</td>
<td>Gas</td>
<td>0.228</td>
</tr>
<tr>
<td>Pressure relief valves</td>
<td>Gas</td>
<td>0.104</td>
</tr>
<tr>
<td>Connectors</td>
<td>All</td>
<td>0.00183</td>
</tr>
<tr>
<td>Open-ended lines</td>
<td>All</td>
<td>0.0017</td>
</tr>
<tr>
<td>Sampling connections</td>
<td>All</td>
<td>0.0150</td>
</tr>
</tbody>
</table>

The SOCMI report format allows a combination of both methods to be used. The following equation is used:

\[
E_{TOC} = F_A \times W_{TOC} \times N \quad (kg/h)
\]

Where \(E_{TOC}\) = emission rate of TOC from all equipment in stream of a given equipment type
\(F_A\) = applicable average emission factor for equipment type (kg/h per source)
\(W_{TOC}\) = average weight fraction of TOC in the stream
\(N\) = number of pieces of equipment in the stream

The total VOC emission is obtained by applying plant operation hours.
For the petroleum industry the following emission rate data is used, where SV is the measured screening value (ppmv). These correlations apply to refineries, marketing terminals, and oil and gas production.

The “Other/All” equipment type category includes instruments, loading arms, pressure relief valves, stuffing boxes, compressors and dump lever arms.

**Petroleum Industry TOC Emission Rates**

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Default Zero Emission Rate</th>
<th>Pegged Emission Rates</th>
<th>Correlation Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kg/h per source</td>
<td>kg/h per source</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.0E04ppmv</td>
<td>1.0E06ppmv</td>
<td></td>
</tr>
<tr>
<td>Connector/All</td>
<td>7.5E-06</td>
<td>0.028</td>
<td>0.030</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.51E-06 x (SV)0.735</td>
</tr>
<tr>
<td>Flange/All</td>
<td>3.1E-07</td>
<td>0.085</td>
<td>0.084</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.44E-06 x (SV)0.703</td>
</tr>
<tr>
<td>Open-ended line/All</td>
<td>2.0E-06</td>
<td>0.030</td>
<td>0.079</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.16E-06 x (SV)0.704</td>
</tr>
<tr>
<td>Pump/All</td>
<td>2.4E-05</td>
<td>0.074</td>
<td>0.160</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.82E-06 x (SV)0.610</td>
</tr>
<tr>
<td>Valve/All</td>
<td>7.8E-06</td>
<td>0.064</td>
<td>0.140</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.28E-06 x (SV)0.746</td>
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<tr>
<td>Other/All</td>
<td>4.0E-06</td>
<td>0.073</td>
<td>0.110</td>
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<td></td>
<td></td>
<td></td>
<td>1.32E-05 x (SV)0.589</td>
</tr>
</tbody>
</table>

To estimate emissions the default zero emission rate is only used if the screening value, adjusted for background, equals 0 ppmv. If the monitoring device registers maximum scale value (pegged) then the appropriate pegged emission rate is used.

**Refinery Average Emission Factors**

These factors are for non-methane organic compounds; consult reference for further details. The light liquid pump seal factor can be used to estimate the leak rate from agitator seals.

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Service</th>
<th>Emission Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>kg/h per source</td>
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<tr>
<td>Valves</td>
<td>Gas</td>
<td>0.0268</td>
</tr>
<tr>
<td></td>
<td>Light liquid</td>
<td>0.0109</td>
</tr>
<tr>
<td></td>
<td>Heavy liquid</td>
<td>0.00023</td>
</tr>
<tr>
<td>Pump seals</td>
<td>Light liquid</td>
<td>0.114</td>
</tr>
<tr>
<td></td>
<td>Heavy liquid</td>
<td>0.021</td>
</tr>
<tr>
<td>Compressor seals</td>
<td>Gas</td>
<td>0.636</td>
</tr>
<tr>
<td>Pressure relief valves</td>
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<td>0.160</td>
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<tr>
<td>Connectors</td>
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<td>Open-ended lines</td>
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<td>0.0023</td>
</tr>
<tr>
<td>Sampling connections</td>
<td>All</td>
<td>0.0150</td>
</tr>
</tbody>
</table>

The petroleum industry report format allows a combination of both methods to be used. To correct for methane weight fraction ($WF_{TOC}$) the following equation should be applied:

$$E_{TOC} = F_A \times \frac{WF_{TOC}}{WF_{TOC} - WF_{methane}} \times N \text{ (kg/h)}$$

The total VOC emission is obtained by applying plant operation hours.
## Appendix I  Report Format - SOCMI

### SOCMI Average Emission Factor Method

| Equipment Type | Equipment Number | Operation | VOC | TC | CorrVal | VOC | VOC Emission
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
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<tbody>
<tr>
<td>A1</td>
<td>E10A</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
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<td>0</td>
<td>0.00</td>
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<td>0.00</td>
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<td>0.00</td>
<td>0</td>
<td>0.00</td>
</tr>
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<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>A7</td>
<td>E11G</td>
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<td>0</td>
<td>0.00</td>
<td>0</td>
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<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>A10</td>
<td>E12J</td>
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<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
</tr>
</tbody>
</table>

### SOCMI Correlation Equation Method

| Equipment Type | Equipment Number | Operation | VOC | TC | CorrVal | VOC | VOC Emission
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
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<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>A2</td>
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<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>A3</td>
<td>E10C</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
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<td>0.00</td>
</tr>
<tr>
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<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
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<td>0.00</td>
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<td>0.00</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
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<td>0</td>
<td>0.00</td>
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</table>
## Appendix II  Report Format - Petroleum

### Petroleum Average Emission Factor Method

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Operation</th>
<th>VDC</th>
<th>TDC</th>
<th>Emission Factor (%)</th>
<th>VOC Emission (kg/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>50%</td>
<td>100</td>
<td>100</td>
<td>1</td>
<td>3.5</td>
</tr>
<tr>
<td>1B</td>
<td>50%</td>
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<td>100</td>
<td>1</td>
<td>3.5</td>
</tr>
<tr>
<td>1C</td>
<td>50%</td>
<td>100</td>
<td>100</td>
<td>1</td>
<td>3.5</td>
</tr>
<tr>
<td>1D</td>
<td>50%</td>
<td>100</td>
<td>100</td>
<td>1</td>
<td>3.5</td>
</tr>
<tr>
<td>1E</td>
<td>50%</td>
<td>100</td>
<td>100</td>
<td>1</td>
<td>3.5</td>
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<tr>
<td>1F</td>
<td>50%</td>
<td>100</td>
<td>100</td>
<td>1</td>
<td>3.5</td>
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<td>100</td>
<td>1</td>
<td>3.5</td>
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<td>1J</td>
<td>50%</td>
<td>100</td>
<td>100</td>
<td>1</td>
<td>3.5</td>
</tr>
</tbody>
</table>

### Petroleum Correlation Equation Method

<table>
<thead>
<tr>
<th>Equipment Number</th>
<th>Petroleum Correlation Equation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>0.50% 0.0% 0.0% 0.0% 0.0% 0.0%</td>
</tr>
<tr>
<td>1B</td>
<td>0.50% 0.0% 0.0% 0.0% 0.0% 0.0%</td>
</tr>
<tr>
<td>1C</td>
<td>0.50% 0.0% 0.0% 0.0% 0.0% 0.0%</td>
</tr>
<tr>
<td>1D</td>
<td>0.50% 0.0% 0.0% 0.0% 0.0% 0.0%</td>
</tr>
<tr>
<td>1E</td>
<td>0.50% 0.0% 0.0% 0.0% 0.0% 0.0%</td>
</tr>
<tr>
<td>1F</td>
<td>0.50% 0.0% 0.0% 0.0% 0.0% 0.0%</td>
</tr>
<tr>
<td>1G</td>
<td>0.50% 0.0% 0.0% 0.0% 0.0% 0.0%</td>
</tr>
<tr>
<td>1H</td>
<td>0.50% 0.0% 0.0% 0.0% 0.0% 0.0%</td>
</tr>
<tr>
<td>1I</td>
<td>0.50% 0.0% 0.0% 0.0% 0.0% 0.0%</td>
</tr>
<tr>
<td>1J</td>
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</tbody>
</table>

### Petroleum Emission Correlation Method

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Operation</th>
<th>VDC</th>
<th>TDC</th>
<th>Emission Factor (%)</th>
<th>VOC Emission (kg/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>50%</td>
<td>100</td>
<td>100</td>
<td>1</td>
<td>3.5</td>
</tr>
<tr>
<td>1B</td>
<td>50%</td>
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<td>1</td>
<td>3.5</td>
</tr>
<tr>
<td>1C</td>
<td>50%</td>
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<td>100</td>
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<td>3.5</td>
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<td>50%</td>
<td>100</td>
<td>100</td>
<td>1</td>
<td>3.5</td>
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<td>50%</td>
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<td>100</td>
<td>1</td>
<td>3.5</td>
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<td>1J</td>
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<td>100</td>
<td>100</td>
<td>1</td>
<td>3.5</td>
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Page 8 of 8