MEMORANDUM

SUBJECT: Particulate Matter Potential to Emit Emission Factors for Activities at Sawmills, Excluding Boilers, Located in Pacific Northwest Indian Country

FROM: Dan Meyer, Environmental Engineer
Air Permits & Diesel Unit

THRU: Donald A. Dossett, P.E., Manager
Air Permits & Diesel Unit

TO: Permit File

EPA Region 10 has compiled the attached list of particulate matter (PM - CAA § 111 pollutant, PM$_{10}$ and PM$_{2.5}$ - criteria pollutants) emission factors (“EFs”) for use in determining the potential emissions, more commonly referred to as potential to emit (“PTE”), for activities at sawmills, excluding boilers, located in Pacific Northwest Indian Country. The EFs are presented in units appropriate for the particular activity. PTE generally represents the maximum capacity of a source to emit a pollutant under its physical and operational design taking into consideration restrictions that are federally enforceable. While PM, PM$_{10}$ and PM$_{2.5}$ PTE are all used to determine applicability of the Compliance Assurance Monitoring program and Prevention of Significant Deterioration construction permit program, only PM$_{10}$ and PM$_{2.5}$ are employed to determine applicability of the Title V operating permit program.

The Federal Air Rules for Reservations (“FARR”) limit particulate matter emissions from applicable activities at sawmills. The rules and the rationale for not employing them to determine PTE are as follows: (a) 20 percent opacity limit (40 CFR § 49.124) – lack of a correlation between opacity and particulate matter emissions, (b) requirements for limiting fugitive emissions (40 CFR § 49.126) – lack of a correlation between compliance with requirements and particulate matter emissions, (c) non-combustion stack 0.1 grain per dry standard cubic foot PM emission limit (40 CFR § 49.125) – resultant PTE would be unrealistically high as we assume that an unreasonable amount of wood residue is exhausted to atmosphere rather than recovered for sale or combustion in on-site boiler.

There are no other federal regulations beyond the FARR that limit particulate matter emissions from activities addressed by this memorandum. Under the circumstances, it is appropriate to employ the EFs presented in the attachment to estimate PTE, unless a more representative (e.g. site-specific) EF is available.

1 Activities include log bucking and debarking, sawing, lumber drying, mechanical and pneumatic conveyance of wood residue, wind erosion of wood residue piles and traffic along paved and unpaved roads.

2 October 16, 1995 EPA memorandum entitled, "Definition of Regulated Pollutant for Particulate Matter for Purposes of Title V"
## EF Reference No.

<table>
<thead>
<tr>
<th>Emissions Generating Activity</th>
<th>PM$^2$</th>
<th>PM$_{10}$</th>
<th>PM$_{2.5}$</th>
<th>PM$_{2.5}$</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log Bucking$^3$</td>
<td>0.035</td>
<td>50</td>
<td>0.0175</td>
<td>25</td>
<td>lb/ton log</td>
</tr>
<tr>
<td>Log Debarking$^5$</td>
<td>0.024</td>
<td>50</td>
<td>0.012</td>
<td>25</td>
<td>lb/ton log</td>
</tr>
<tr>
<td>Sawing$^7$</td>
<td>0.350</td>
<td>50</td>
<td>0.175</td>
<td>25</td>
<td>lb/ton log</td>
</tr>
<tr>
<td>Lumber Drying - Resinous Softwood Species$^4$</td>
<td>0.02</td>
<td>100</td>
<td>0.02</td>
<td>100</td>
<td>lb/mbf</td>
</tr>
<tr>
<td>Lumber Drying - Non-Resinous Softwood Species$^5$</td>
<td>0.05</td>
<td>100</td>
<td>0.05</td>
<td>100</td>
<td>lb/mbf</td>
</tr>
</tbody>
</table>

### Notes:
- **1**: If any activity occurs within a building, reduce the PM, PM$_{10}$, and PM$_{2.5}$ emission factor ("EF") by 100 percent (engineering judgement) as emissions struggle to escape through doorways and other openings. If an activity's by-products are evacuated pneumatically to a target box, cyclone or bag filter system, then only the associated downstream conveyance emissions are counted.
- **2**: PM refers to the CAA § 111 pollutant generally measured using EPA Reference Method 5 to determine the filterable fraction of particulate matter. "Particulate matter" is a term used to define an air pollutant that consists of a mixture of solid particles and liquid droplets found in the ambient air. PM does not include a condensable fraction.
- **3**: EF for log bucking, debarking and sawing are expressed in units of "lb/ton log" in the table above. The EF can be expressed in units of "lb/mbf" lumber as follows:
  \[
  \text{lb/mbf} = \left( \frac{\text{lb PM/ton log}}{2000 \text{ lb}} \right) \times (LD \text{ lb/ft}^3) \times (LRF \text{ bf lumber/ft}^3) \times (1000 \text{ bf/mbf})
  \]
  where "LD" stands for log density and "LRF" stands for log recovery factor.
- **4**: Douglas Fir, Engelmann Spruce, Larch, Lodgepole Pine, Ponderosa Pine and Western White Pine
- **5**: White Fir, Western Hemlock and Western Red Cedar
- **6**: The "material" in this entry refers to bark, hogged fuel, green chips, dry chips, green sawdust, dry sawdust, shavings and any other woody by-product of lumber production.
Although this activity may be subject to the FARR visible emissions limit of 20% opacity (40 CFR § 124(d)), the limit was not further considered in deriving an emission factor due to the lack of a correlation between opacity and particulate matter emissions.

Although this activity may be subject to the FARR requirements for limiting fugitive particulate matter emissions (40 CFR §126), those requirements were not further considered in deriving an emission factor due to lack of a correlation between compliance with requirements and particulate matter emissions.

Although this activity may be subject to the FARR stack PM emission limit of 0.1 gr/dscf (40 CFR § 125(d)(3)), that limit was not further considered in deriving an emission factor because the resultant PTE would be unrealistically high.

For PM, PM$_{10}$, and PM$_{2.5}$ EF, apply engineering judgement to estimate that log bucking emissions are one-tenth sawing emissions. EPA has stated that log bucking is normally a negligible source of fugitive PM emissions. See page 2-125 of Assessment of Fugitive Particulate Emission Factor for Industrial Processes, EPA-450/3-78-107, September 1978. The document can be downloaded from internet at http://nepis.epa.gov/Simple.html by entering EPA publication number. For sawing emissions details, see Reference No. 3 below.

- For PM, see Table 2-47 of Assessment of Fugitive Particulate Emission Factor for Industrial Processes, EPA-450/3-78-107, September 1978. See also Table 2-59 of Technical Guidance for Controls of Industrial Process Fugitive Particulate Emissions, EPA-450/3-77-010, March 1977. Both documents can be downloaded from internet at http://nepis.epa.gov/Simple.html by entering EPA publication number. EPA revoked the PM EF from WebFIRE on January 1, 2002. See detailed search results for SCC 3-07-008-01 (include revoked factors) at http://cfpub.epa.gov/webfire/index.cfm?action=fire.detailedSearch
  - For PM$_{10}$ and PM$_{2.5}$ EF, apply engineering judgement to estimate that (a) PM$_{10}$ emissions are one-half PM emissions and (b) PM$_{2.5}$ emissions are one-half PM$_{10}$ emissions.

  - Sawing consists of the following cumulative activities: breaking the log into cants and flitches with a smooth edge, breaking cant further down into multiple flitches and/or boards, taking the flitch and trim off all irregular edges to leave four-sided lumber and trimming to square the ends.

  - For PM EF, see Table 2-47 of Assessment of Fugitive Particulate Emission Factor for Industrial Processes, EPA-450/3-78-107, September 1978. See also Table 2-59 of Technical Guidance for Controls of Industrial Process Fugitive Particulate Emissions, EPA-450/3-77-010, March 1977. Both documents can be downloaded from internet at http://nepis.epa.gov/Simple.html by entering EPA publication number. EPA revoked the PM EF from WebFIRE on January 1, 2002. See detailed search results for SCC 3-07-008-01 (include revoked factors) at http://cfpub.epa.gov/webfire/index.cfm?action=fire.detailedSearch
  - For PM$_{10}$ and PM$_{2.5}$ EF, apply engineering judgement to estimate that (a) PM$_{10}$ emissions are one-half PM emissions and (b) PM$_{2.5}$ emissions are one-half PM$_{10}$ emissions.

  - For PM EF, see ODEQ ACDP Application Guidance AQ-EF02 (4/25/00). Douglas fir is a resinous softwood species and western hemlock is a non-resinous softwood species.
  - For PM$_{10}$ and PM$_{2.5}$ EF, apply engineering judgement to estimate that all PM emitted is organic aerosols and fully PM$_{10}$ and PM$_{2.5}$ emissions.

  - See Section 13.2.4 of EPA's AP-42, November 2006 at http://www.epa.gov/ttn/chief/ap42/ch13final/c13s0204.pdf. Apply Equation 1 on page 13.2.4-4 to estimate emissions resulting from material drops as follows: \( E \ [\text{lb PM/ton}] = (k) X (0.0032) X (U/5)^{1.3} / (M/2)^{1.4} \)

  - Wet Material Drop

<table>
<thead>
<tr>
<th>Particulate</th>
<th>k</th>
<th>( (U/5)^{1.3} )</th>
<th>( (M/2)^{1.4} )</th>
<th>lb PM/ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM</td>
<td>0.74</td>
<td>0.0032</td>
<td>6.6693</td>
<td>21.0552</td>
</tr>
<tr>
<td>PM$_{10}$</td>
<td>0.35</td>
<td>0.0032</td>
<td>21.0552</td>
<td>0.000035</td>
</tr>
<tr>
<td>PM$_{2.5}$</td>
<td>0.053</td>
<td>21.0552</td>
<td>0.000005</td>
<td></td>
</tr>
</tbody>
</table>

The following conservative assumptions were made in applying Equation 1:

- Mean wind speed \( (U) \) = 15 miles per hour
- Material moisture content \( (M) \) = 34 percent. Value based upon observations

\[ \frac{MCD}{MCW} = \frac{1}{(1-MCW)}; \text{where} \]

\[ MCD: \text{moisture content dry basis} \]

\[ MCW: \text{moisture content wet basis} \]

\[ 0.51 = \frac{MCW}{(1-MCW)} \]

\[ 0.51 - (0.51)(MCW) = \frac{MCW}{(1.51)(MCW)} = 0.51 \]

\[ MCW = 0.34, \text{or 34 percent} \]

Note: Mean wind speed of 15 mph is a reasonable upper bounder estimate.

- Moisture content of 34 percent for "wet" material is based upon observation that average moisture content (dry basis) of green douglas fir lumber (common to the Pacific Northwest) is 51 percent as recorded prior to lab scale kiln VOC emissions testing conducted by Oregon State University's Mike Milota and organized in Microsoft Excel workbook entitled, "EPA Region 10 HAP and VOC Emission Factors for Lumber Drying, December 2012." 51 percent moisture content (dry basis) is equivalent to 34 percent moisture content (wet basis) as illustrated below:

\[ MCD = \frac{MCW}{(1-MCW)} \]

\[ MCD: \text{moisture content dry basis} \]

\[ MCW: \text{moisture content wet basis} \]

\[ 0.51 = \frac{MCW}{(1-MCW)} \]

\[ 0.51 - (0.51)(MCW) = MCW \]

\[ (1.51)(MCW) = 0.51 \]

\[ MCW = 0.34, \text{or 34 percent} \]
Dry Material Drop

<table>
<thead>
<tr>
<th>Particulate</th>
<th>k</th>
<th>((U/5)^{1.3})</th>
<th>((M/2)^{1.4})</th>
<th>lb PM ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM</td>
<td>0.74</td>
<td>0.0032</td>
<td>6.6693</td>
<td>0.0015</td>
</tr>
<tr>
<td>PM_{10}</td>
<td>0.35</td>
<td>0.0032</td>
<td>6.6693</td>
<td>0.0007</td>
</tr>
<tr>
<td>PM_{2.5}</td>
<td>0.053</td>
<td>10.5552</td>
<td>0.0001</td>
<td></td>
</tr>
</tbody>
</table>

The following conservative assumptions were made in applying Equation 1:

- Mean wind speed \((U)\) = 15 miles per hour
- Material moisture content \((M)\) = 13 percent

Note: • Mean wind speed of 15 mph is a reasonable upper bound estimate.

• Moisture content of 13 percent for "dry" material is based upon observation that typical moisture content (dry basis) of kiln-dried lumber is 15 percent as recorded during lab scale kiln emissions testing conducting by Oregon State University's Mike Milota and organized in Microsoft Excel workbook entitled, "EPA Region 10 HAP and VOC Emission Factors for Lumber Drying, December 2012," 15 percent moisture content (dry basis) is equivalent to 13 percent moisture content (wet basis) as illustrated below:

\[
\begin{align*}
MCD & = \frac{MCW}{1 - MCW} ; \text{ where} \\
MCD & : \text{ moisture content dry basis} \\
MCW & : \text{ moisture content wet basis} \\
0.15 & = MCW / (1 - MCW) \\
0.15 - (0.15)(MCW) & = MCW \\
(1.15)(MCW) & = 0.15 \\
MCW & = 0.13, \text{ or } 13 \text{ percent}
\end{align*}
\]

9 For PM EF, see Oregon Department of Environmental Quality (ODEQ) Wood Products Emission Factors, AQ-EF02 Revised 08/01/11. http://www.deq.state.or.us/aq/permit/acdp/docs/AQ-EF02.pdf

9 For PM_{10} and PM_{2.5} EF, see ODEQ Wood Products Emission Factors - PM_{10}/PM_{2.5} Fractions, AQ-EF03 Revised 08/01/11. http://www.deq.state.or.us/aq/permit/acdp/docs/AQ-EF03.pdf

10 For PM EF, see last row of Table 11.9-4 on page 11.9-11 of Section 11.9 of EPA's AP-42, July 1998 at http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s09.pdf.

10 For PM_{10} and PM_{2.5} EF, apply engineering judgement to estimate that (a) PM_{10} emissions are one-half PM emissions and (b) PM_{2.5} emissions are one-half PM_{10} emissions.
