§ 87.23 Exhaust emission standards for Tier 6 and Tier 8 engines.

This section describes the emission standards that apply for Tier 6 and Tier 8 engines. The standards of this section apply for aircraft engines manufactured on or after July 18, 2012, except where we specify that they apply differently by year, or where the engine is exempt from one or more standards of this section. Except as specified in paragraph (d) of this section, these standards apply based on the date the engine is manufactured. Where a gaseous emission standard is specified by a formula, calculate and round the standard to the nearest 0.1 g/kN (for standards at or above 100 g/kN). Where a smoke standard is specified by a formula, calculate and round the standard to the

(iii) The following Tier 0 emission standard applies for engines of a type or model of which the date of manufacture of the first individual production model was on or before December 31, 1995 and for which the date of manufacture of the individual engine was on or before December 31, 1999.

Oxides of Nitrogen: \((40 + 2(r_{PR}))\) grams/kilonewton rO.

(iv) The following Tier 2 emission standard applies for engines of a type or model of which the date of manufacture of the first individual production model was after December 31, 1995 or for which the date of manufacture of the individual engine was after December 31, 1999:

Oxides of Nitrogen: \((32 + 1.6(r_{PR}))\) grams/kilonewton rO.

(v) The emission standards prescribed in paragraphs (d)(1)(iii) and (iv) of this section apply as prescribed beginning July 7, 1997.

(vi) The following Tier 4 emission standards apply for engines of a type or model of which the date of manufacture of the first individual production model was after December 31, 2003:

(A) Engines with a rated pressure ratio of 30 or less:

(1) Engines with a maximum rated output greater than 89 kilonewtons:

Oxides of Nitrogen: \((19 + 1.6(r_{PR}))\) grams/kilonewton rO.

(2) Engines with a maximum rated output greater than 26.7 kilonewtons but not greater than 89 kilonewtons:

Oxides of Nitrogen: \((37.572 + 1.6(0.4296(r_{PR}) - 0.3087(r_{O})))\) grams/kilonewton rO.

(B) Engines with a rated pressure ratio greater than 30 but less than 62.5:

(1) Engines with a maximum rated output greater than 89 kilonewtons:

Oxides of Nitrogen: \((7 + 2(r_{PR}))\) grams/kilonewton rO.

(2) Engines with a maximum rated output greater than 26.7 kilonewtons but not greater than 89 kilonewtons:

Oxides of Nitrogen: \((42.71 + 1.4226(r_{PR}) - 0.4013(r_{O}) + 0.000642(r_{PR} \times r_{O}))\) grams/kilonewton rO.

(C) Engines with a rated pressure ratio of 62.5 or more:

Oxides of Nitrogen: \((32 + 1.6(r_{PR}))\) grams/kilonewton rO.

(vii) The emission standards prescribed in paragraph (d)(1)(vi) of this section shall apply as prescribed beginning December 19, 2005.

(2) Class TSS: Engines manufactured on or after January 1, 1984:

Hydrocarbons=\(140(0.92)^{r_{PR}}\) grams/kilonewton rO.

(e) Smoke exhaust emissions from each gas turbine engine of the classes specified below shall not exceed:

(1) Class TF of rated output less than 26.7 kilonewtons manufactured on or after August 9, 1985:

\[SN = 93.6(r_{O})^{0.274} \text{ (ro is in kilonewtons) not to exceed a maximum of } SN = 50.\]

(2) Classes T3, T8, TSS and TF of rated output equal to or greater than 26.7 kilonewtons manufactured on or after January 1, 1984:

\[SN=83.6(r_{O})^{0.274} \text{ (ro is in kilonewtons) not to exceed a maximum of } SN=50.\]

(3) Class TP of rated output equal to or greater than 1,000 kilowatts manufactured on or after January 1, 1984:

\[SN=187(ro)^{0.168} \text{ (ro is in kilowatts)}\]

(f) The standards in this section refer to a composite emission sample measured and calculated in accordance with the procedures described in subpart G of this part.

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nearest 0.1 SN. Engines comply with an applicable standard if the testing results show that the engine type certificate family’s characteristic level does not exceed the numerical level of that standard, as described in § 87.60. The tier of standards identified for an engine relates to NO\(_X\) emissions and that the specified standards for HC, CO, and smoke emissions apply independent of the changes to the NO\(_X\) emission standards.

(a) New turboprop aircraft engines with rated output at or above 1,000 kilowatts must comply with a smoke standard of \(187 \cdot rO^{-0.168}\).

(b) New supersonic engines must comply with the standards shown in the following table:

### TABLE 1 TO § 87.23—SMOKE AND GASEOUS EMISSION STANDARDS FOR NEW SUPERSONIC ENGINES

<table>
<thead>
<tr>
<th>Rated output</th>
<th>Smoke number</th>
<th>HC (g/kN rated output)</th>
<th>NO(_X) (g/kN rated output)</th>
<th>CO (g/kN rated output)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(rO \leq 26.7 \text{ kN})</td>
<td>(83.6 \cdot rO^{-0.374} \text{ or } 50.0, \text{ whichever is smaller.})</td>
<td>140 (\cdot 0.92^{\text{PR}})</td>
<td>36 (\cdot 2.42 \cdot r\text{PR})</td>
<td>4550 (\cdot r\text{PR}^{-1.03})</td>
</tr>
<tr>
<td>(rO &gt; 26.7 \text{ kN})</td>
<td>(83.6 \cdot rO^{-0.374} \text{ or } 50.0, \text{ whichever is smaller})</td>
<td>140 (\cdot 0.92^{\text{PR}})</td>
<td>36 (\cdot 2.42 \cdot r\text{PR})</td>
<td>4550 (\cdot r\text{PR}^{-1.03})</td>
</tr>
</tbody>
</table>

(c) New turbofan or turbojet aircraft engines that are installed in subsonic aircraft must comply with the following standards:

### TABLE 2 TO § 87.23—SMOKE, HC, AND CO STANDARDS FOR NEW SUBSONIC TURBOFAN OR TURBOJET ENGINES

<table>
<thead>
<tr>
<th>Rated output (kN)</th>
<th>Smoke standard</th>
<th>Gaseous emission standards (g/kN rated output)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(rO \leq 26.7 \text{ kN})</td>
<td>(83.6 \cdot rO^{-0.374} \text{ or } 50.0, \text{ whichever is smaller})</td>
<td>(19.6)</td>
</tr>
<tr>
<td>(rO &gt; 26.7 \text{ kN})</td>
<td>(83.6 \cdot rO^{-0.374} \text{ or } 50.0, \text{ whichever is smaller})</td>
<td>(118)</td>
</tr>
</tbody>
</table>

(2) The Tier 6 NO\(_X\) standards apply as described in this paragraph (c)(2). See paragraph (d) of this section for provisions related to models introduced before these standards started to apply and engines determined to be derivative engines for emissions certification purposes under the requirements of this part.

### TABLE 3 TO § 87.23—TIER 6 NO\(_X\) STANDARDS FOR NEW SUBSONIC TURBOFAN OR TURBOJET ENGINES WITH RATED OUTPUT ABOVE 26.7 kN

<table>
<thead>
<tr>
<th>If the rated pressure ratio (rPR) is—</th>
<th>and the rated output (in kN) is—</th>
<th>The NO(_X) emission standard (in g/kN rated output) is—</th>
</tr>
</thead>
<tbody>
<tr>
<td>(rPR \leq 30)</td>
<td>(26.7 &lt; rO \leq 89)</td>
<td>38.5486 (+ 1.6623 \cdot rPR - 0.2453 \cdot rO - 0.00308 \cdot rPR \cdot rO)</td>
</tr>
<tr>
<td>(30 &lt; rPR \leq 82.6)</td>
<td>(26.7 &lt; rO \leq 89)</td>
<td>46.1600 (+ 1.4286 \cdot rPR - 0.5303 \cdot rO + 0.00642 \cdot rPR \cdot rO)</td>
</tr>
<tr>
<td>(rPR \geq 82.6)</td>
<td>(rO &gt; 89)</td>
<td>(-1.04 + 2.6 \cdot rPR)</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>(32 + 1.6 \cdot rPR)</td>
</tr>
</tbody>
</table>

(3) The Tier 8 NO\(_X\) standards apply as described in this paragraph (c)(3) beginning January 1, 2014. See paragraph (d) of this section for provisions related to models introduced before January 1, 2014 and engines determined to be derivative engines for emissions certification purposes under the requirements of this part.
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TABLE 4 TO § 87.23—TIER 8 NOX STANDARDS FOR NEW SUBSONIC TURBOFAN OR TURBOJET ENGINES WITH RATED OUTPUT ABOVE 26.7 kN

<table>
<thead>
<tr>
<th>If the rated pressure ratio (rPR) is</th>
<th>and the rated output (rO) is</th>
<th>The NOX emission standard (in g/kN rated output) is—</th>
</tr>
</thead>
<tbody>
<tr>
<td>rPR ≤ 30</td>
<td>26.7 &lt; rO ≤ 89</td>
<td>40.052 + 1.5681·rPR – 0.3615·rO – 0.0018·rPR·rO</td>
</tr>
<tr>
<td></td>
<td>rO &gt; 89</td>
<td>7.88 + 1.4080·rPR</td>
</tr>
<tr>
<td>30 &lt; rPR &lt; 104.7</td>
<td>26.7 &lt; rO ≤ 89</td>
<td>41.9435 + 1.505·rPR – 0.5823·rO + 0.005562·rPR·rO</td>
</tr>
<tr>
<td></td>
<td>rO &gt; 89</td>
<td>9.88 + 2.0·rPR</td>
</tr>
<tr>
<td>rPR ≥ 104.7</td>
<td>all</td>
<td>32 + 1.6·rPR</td>
</tr>
</tbody>
</table>

(d) This paragraph (d) specifies phase-in provisions that allow continued production of certain engines after the Tier 6 and Tier 8 standards begin to apply.

(1) Engine type certificate families certificated with characteristic levels at or below the Tier 4 NOX standards of §87.21 (as applicable based on rated output and rated pressure ratio) and introduced before July 18, 2012 may be produced through December 31, 2012 without meeting the Tier 6 NOX standards of paragraph (c)(2) of this section. This also applies for engines that are covered by the same type certificate and are determined to be derivative engines for emissions certification purposes under the requirements of this part. Note that after this production cutoff date for the Tier 6 NOX standards, such engines may be produced only if they are covered by an exemption under §87.50. This production cutoff does not apply to engines installed (or delivered for installation) on military aircraft.

(2) Engine type certificate families certificated with characteristic levels at or below the Tier 6 NOX standards of paragraph (c)(2) of this section with an introduction date before January 1, 2014 may continue to be produced. This also applies for engines that are covered by the same type certificate and are determined to be derivative engines for emissions certification purposes under the requirements of this part.

(3) An engine manufacturer may produce up to six newly manufactured Tier 4 engines on or after July 18, 2012, subject to the provisions of this paragraph (d)(3). Tier 4 engines meeting the criteria of this paragraph (d)(3) are excepted without request from the otherwise applicable Tier 6 NOX emission standard. To be eligible for this exception the engines must have a date of manufacture prior to August 31, 2013 and be fully compliant with all requirements applicable to Tier 4 engines. The manufacturer must include these engines in the report required by §87.50. This exception is void for any manufacturer that produces more than six excepted engines under this paragraph.


Subpart D—Exhaust Emissions (In-Use Aircraft Gas Turbine Engines)

§ 87.30 Applicability.

The provisions of this subpart are applicable to all in-use aircraft gas turbine engines certified for operation within the United States of the classes specified beginning on the dates specified.

§ 87.31 Standards for exhaust emissions.

(a) Exhaust emissions of smoke from each in-use aircraft gas turbine engine of Class T8, beginning February 1, 1974, shall not exceed: Smoke number of 30.

(b) Exhaust emissions of smoke from each in-use aircraft gas turbine engine of class TF and of rated output of 129 kilonewtons thrust or greater, beginning January 1, 1976, shall not exceed:  

\[ SN = 83.6(rO)^{-0.2744} \text{ (rO is in kilonewtons)} \]

(c) The standards set forth in paragraphs (a) and (b) of this section refer to exhaust smoke emissions emitted during operations of the engine as specified in the applicable section of subpart H of this part, and measured and calculated in accordance with the procedures set forth in this subpart.