Environmental Protection Agency

Emission Standards for Locomotives and Locomotive Engines

40 CFR Part 92

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January 30, 2001
• Final Rule establishing emission standards promulgated April 16, 1998 (63FR18977)

• Rulemaking documents available at http://www.epa.gov/otaq/locomotv.htm#regs

• Regulations contained in 40 CFR Part 92
Locomotive Emissions
Regulatory Background

• Locomotives currently emit over one million tons of NOx each year - about 5 percent of total NOx emitted by all sources

• Primary focus of rulemaking is reduction of NOx emissions - with reduction of HC and PM emissions a secondary focus

• Expected to result in a 40 percent reduction in locomotive fleet NOx emissions by 2010
Emission standards apply when locomotive becomes new (at manufacture and remanufacture) - standards remain applicable throughout useful life

Emission standards apply to all locomotives except:
- Locomotives manufactured before 1973
- Historic steam locomotives
- Locomotives powered by engines less than 750 kW (1006 hp)
- Repowered locomotives and switch locomotives using certified nonroad engines
- Tier 0 locomotives owned and operated by small businesses
- Exported locomotives
- Mexican and Canadian locomotives used for border traffic
• Other exemptions available for:
  – Manufacturer- or remanufacturer-owned locomotives
  – Locomotives used for display, testing, or other developmental work
  – National security
• Standards were phased-in beginning on January 1, 2000

• Three sets of standards applicable depending on date of locomotive's original manufacture (all percents relative to line-haul baseline)
  – Tier 0 (1973-2001 locomotives), 27% NOx reduction, with caps on other pollutants
  – Tier 1 (2002-2004 locomotives), 43% NOx reduction, with caps on other pollutants
  – Tier 2 (2005+ locomotives), 58% NOx reduction, 50 % PM and HC reductions

• EPA established standards for two duty-cycles:
  – high power duty cycle based on typical line-haul operation
  – low power duty cycle based on typical switch operation
• All locomotives are required to comply over both duty-cycles (except Tier 0 switch locomotives)

• Notch caps for emissions in individual power notches to ensure consistent emissions reductions

• Passenger locomotives are regulated beginning 2002
  – Freshly manufactured locomotives must meet Tier 1 standards in 2002
## Emission Standards (Line-Haul)

### Regulatory Background

<table>
<thead>
<tr>
<th>Emission Standards for High-Power (Line-haul) Duty - cycle (g/bhp-hr)</th>
<th>NOx</th>
<th>PM</th>
<th>HC</th>
<th>CO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Baseline Emission Rate</td>
<td>13.0</td>
<td>0.32</td>
<td>0.48</td>
<td>1.3</td>
</tr>
<tr>
<td>Tier 0 Standard</td>
<td>9.5</td>
<td>0.60</td>
<td>1.00</td>
<td>5.0</td>
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<tr>
<td>Tier 1 Standard</td>
<td>7.4</td>
<td>0.45</td>
<td>0.55</td>
<td>2.2</td>
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<tr>
<td>Tier 2 Standard</td>
<td>5.5</td>
<td>0.20</td>
<td>0.30</td>
<td>1.5</td>
</tr>
</tbody>
</table>
## Emission Standards (Switch)

### Regulatory Background

<table>
<thead>
<tr>
<th>Emission Standards for Low-Power (Switch) Duty - cycle (g/bhp-hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>Avg. Baseline Emission Rate</td>
</tr>
<tr>
<td>Tier 0 Standard</td>
</tr>
<tr>
<td>Tier 1 Standard</td>
</tr>
<tr>
<td>Tier 2 Standard</td>
</tr>
</tbody>
</table>
Manufacturers and remanufacturers have the option of certifying to less stringent CO standards with more stringent PM standards.

Intended to address CNG-fueled locomotives, but available for all fuel types.

Alternate Emission Standards (g/bhp-hr)

<table>
<thead>
<tr>
<th>Line-Haul</th>
<th>CO</th>
<th>PM</th>
<th>Switch</th>
<th>CO</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 0 Standard</td>
<td>10.0</td>
<td>0.30</td>
<td>Tier 0 Standard</td>
<td>12.0</td>
<td>0.36</td>
</tr>
<tr>
<td>Tier 1 Standard</td>
<td>10.0</td>
<td>0.22</td>
<td>Tier 1 Standard</td>
<td>12.0</td>
<td>0.27</td>
</tr>
<tr>
<td>Tier 2 Standard</td>
<td>10.0</td>
<td>0.10</td>
<td>Tier 2 Standard</td>
<td>12.0</td>
<td>0.12</td>
</tr>
</tbody>
</table>
Manufacturers/remanufacturers of locomotives must apply yearly for a certificate of conformity which permits introduction/reintroduction into commerce of freshly manufactured locomotives/remanufactured locomotives.

Phase-in of Tier 0 requirements provides 2 options:

- Locomotives originally manufactured on or after 1/1/90 for which a certified remanufacturing system is available at a reasonable cost must comply with Tier 0 standards as of 1/1/00.
Option 1
- Freshly manufactured locomotives built on or after 1/1/01 must meet Tier 0 standards
- Remanufactured locomotives originally manufactured on or after 1/1/94 which are remanufactured on or after 1/1/01 must meet Tier 0 standards

Option 2
- Locomotives not in widespread use are exempt if:
- The manufacturer makes available at a reasonable cost a certified remanufacturing system prior to 1/1/00 for primary locomotives originally manufactured between 1/1/94 and 1/1/98, and
- All freshly manufactured locomotives that are similar to primary locomotives must comply with Tier 0 standards on 1/1/00
- Other models which are not similar to the primary model are exempt

EMD certified using this option
### Phase-in of Compliance Requirements
By Locomotive Type and Year of Manufacture

<table>
<thead>
<tr>
<th>Calendar Years</th>
<th>Locomotive Type</th>
<th>Year of Original Manufacture</th>
<th>Certified System Available?</th>
<th>Compliance Required?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 Freight</td>
<td>1973-1989</td>
<td>NA*</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>2000 Freight</td>
<td>1990-1999</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>2000 Freight</td>
<td>1990-1999</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>2000 Freight</td>
<td>2000</td>
<td>NA*</td>
<td>No**</td>
<td></td>
</tr>
<tr>
<td>2000 Passenger</td>
<td>1973-2000</td>
<td>NA*</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>2001 Freight</td>
<td>1973-1989</td>
<td>NA*</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>2001 Freight</td>
<td>1990-1993</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>2001 Freight</td>
<td>1990-1993</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>2001 Freight</td>
<td>1994-2001</td>
<td>NA*</td>
<td>Yes**</td>
<td></td>
</tr>
<tr>
<td>2001 Passenger</td>
<td>1973-2001</td>
<td>NA*</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>2002-2006 Freight</td>
<td>1973-2006</td>
<td>NA*</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>2002-2006 Passenger</td>
<td>1973-2001</td>
<td>NA*</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>2002-2006 Passenger</td>
<td>2002-2006</td>
<td>NA*</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>2007 Freight</td>
<td>1973-2007</td>
<td>NA*</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>2007 Passenger</td>
<td>1973-2007</td>
<td>NA*</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

* Availability criteria not applicable to this category.

** See §92.12(a)(3) for details about a one-year exemption that is available for new models originally manufactured in 2001. This exemption requires that existing models comply with the Tier 0 standards in 2000.
For model years 2002-2006, remanufacturers that qualify as small businesses (generally fewer than 1000 employees) may certify using less expensive test procedures - with two options

Option #1 - FTP-type certification
- Small remanufacturers may certify an unlimited number of locomotives
- Remanufacturer testing complies with FTP but omits HC, CO, and or PM measurements
- Remanufacturer may use dynamometer that does not meet regulatory specifications for electric dynamometers - provided it is consistent with good engineering practice
• Option #2 - Other short test
  – Small remanufacturers may certify a limited number of locomotives using a short test - subject to EPA approval
    • No limit in model year 2002
    • Up to 300 locomotives in model year 2003
    • Up to 200 locomotives in model year 2004
    • Up to 100 locomotives in model year 2005
    • Up to 50 locomotives in model year 2006

• Under both options, small remanufacturers required to include engineering analyses in application demonstrating that emissions controls will work
Useful Life and Deterioration Factors

- Locomotive must comply with emission standards over their entire useful life.

- EPA set minimum value 7.5 MW-hrs/hp (i.e., 7.5 times rated hp) - intended to be equivalent to 750,000 miles

- Minimum for existing locomotives without MW-hr meters is 750,000 miles

- Deterioration Factors (DFs)
  – correct for emissions deterioration over the useful life of the engine/locomotive.
  – DFs represent the difference between or the ratio of the useful life and low hour emissions
  – Locomotive must comply after DFs are applied to Cert results
• Application consists of
  – Family information form - general info, ABT, technical description
  – Test data - notch emission data, smoke emissions, official, deteriorated emission results for switch, line-haul, and smoke.
  – Locomotive models
  – Part numbers – parts that make up a certified locomotive
  – Maintenance instructions
  – Statement of compliance
Submitting an Application

- Applications may be submitted electronically (e-mail or disk) using templates made for a commercially available database or on paper

- The applications may be express mailed to:

  Greg Orehowsky, Team Leader  
  Engine Certification Team  
  Engine Programs Group  
  U.S. Environmental Protection Agency  
  501 3rd St NW, Mail Code 6403-J  
  Washington DC 20001
Averaging, Banking and Trading

Applicability

- Applicable to NOx and PM standards under Part 92, Subpart A
- Provisions apply in 1999 and later model years
- Exported locomotives or locomotive engines may not participate
• The FEL replaces the applicable standard for the engine family and becomes the “standard” for that engine family for compliance purposes

• Family Emission Limit (FEL) is selected by manufacturer or remanufacturer for each family

• Tier 1 and Tier 2 NOx and/or PM FEL’s are constrained by the upper limit
  – The upper limit for Tier 1 engine families is the applicable Tier 0 standard
  – The upper limit for Tier 2 engine families is the applicable Tier 1 standard
• The FEL must be to the same number of significant digits as the applicable standard

• The FEL must be included on the labels required in § 92.212

• A change in the FEL after production requires PLT to verify new FEL
• Once a FEL is established for a locomotive, the locomotive must meet that FEL for the rest of its service life unless it is recertified at time of remanufacture to a different FEL.

• Credits generated on a remanufactured locomotive are prorated by the proration factor, Fp.

• This factor adjusts for the decreasing use of the locomotive as it ages.
• Line-haul and switch AB&T programs are separate
  – credits from one group cannot be used for compliance within the other group

• Within either the line-haul or switch averaging programs, credits can be used across tiers except as follows:
  – for NOx from freshly manufactured locomotives in 2005 and 2006 MY, credits can only be used for up to 75% of projected production (remainder must meet Tier 2 standards)
  – for NOx from freshly manufactured locomotives in 2007 MY, credits can only be used for up to 50% of projected production (remainder must meet Tier 2 standards)
  – banked credits from remanufactured locomotives prior to January 1, 2002 can only be used to comply with Tier 1 or later standards
Averaging, Banking and Trading
Credit Calculation

• When useful life is in MW-hrs:

\[
\text{Credit} = (\text{std} - \text{FEL}) \times (\text{UL}) \times (\text{Production}) \times (\text{Fp}) \times (10^{-3} \text{ Kw-Mg/MW-g})
\]

where:
std = applicable standard
FEL = Family Emission Limit
UL = sales weighted useful life in MW-hrs
Production = number of engines from the participating family
Fp = proration factor

• When useful Life is in miles or years:
  – \( \text{UL} = (\text{useful life miles})/(100,000) \times (\text{weighted average Hp}) \)
• Manufacturer/remanufacturer must reconcile credits at year-end

• Insufficient credits at year-end is a violation of the conditions of the certificate(s) and may result in certificate(s) being voided ab initio.
• Begins in 2002

• Testing can be done on an engine dynamometer or in the locomotive using the certification test procedure

• Manufacturer tests 1% of engines per engine family
  – Maximum of 5 engines per family
  – Minimum of 1 engine per family

• For each failed engine, two more of the next 15 are tested

• Audit failure occurs if the average of the initial failed locomotive and the two additional locomotives exceeds the standard or FEL for any pollutant
• Begins in 2002

• Remanufactured PLTs are installation audits
  – correct part numbers
  – installation
  – calibration

• Certificate holder audits 5% of annual sales per model year per installer
  – Maximum of 10 per engine family per installer

• Audits can be done by owners or operators of locomotives

• For each failed engine, two more of the next 10 are audited

• Audit failure occurs, if in one model year, 3 locomotives in the same engine family are improperly remanufactured.
• Begins in 2002 or 2007 for small remanufactures
• EPA selects an engine family per year for testing
• Locomotives shall be tested between ½ to ¾ of useful life.
• Selected locomotives shall have representative maintenance history
• Minimal set-to-spec maintenance, as provided in owners instructions, may be performed
• A minimum of 2 locomotives are to be tested
• Two additional locomotives are tested for each failing locomotive
• Maximum of 10 locomotives can be tested
• In-use fail occurs when EPA determines a substantial number of properly maintained locomotives exceed an emission standard
• Begins in 2005 for Class I freight railroad
• Number of locomotives to be tested is at least 0.15 percent of the locomotive in fleet during the previous calendar year
• Testing done using certification test procedure
• Locomotives shall have been operated for at least 100% of useful life.
  – EPA can specify other locomotives for testing
• EPA can require a Class I railroad to provide up to 5 locomotive per year
• EPA can require any non-Class I railroad to provide up to 2 locomotives per year
Questions?

- You can reach us at:

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