

**ENVIRONMENTAL PROTECTION AGENCY****40 CFR Part 87****[AMS-FRL-5821-3]****Control of Air Pollution From Aircraft and Aircraft Engines; Emission Standards and Test Procedures****AGENCY:** Environmental Protection Agency (EPA).**ACTION:** Direct final rule (DFRM).

**SUMMARY:** This rulemaking amends the existing United States regulations governing the exhaust emissions from new commercial aircraft gas turbine engines. Under the authority of section 231 of the Clean Air Act (CAA), the Environmental Protection Agency (EPA) is promulgating new emission standards for oxides of nitrogen (NO<sub>x</sub>) and carbon monoxide (CO) for newly manufactured and newly certified commercial aircraft gas turbine engines with rated thrust greater than 26.7 kilonewtons (kN). This action will codify into United States law the current voluntary NO<sub>x</sub> (a two-staged NO<sub>x</sub> standard) and CO emission standards of the United Nations International Civil Aviation Organization (ICAO), and thereby bring the United States emission standards into alignment with the internationally adopted standards. These ICAO CO and NO<sub>x</sub> standards are being added to the current EPA regulations for smoke and hydrocarbon emissions that have been in effect since 1984. EPA is also adopting ICAO's requirement that these standards also apply to applications that otherwise would have been fulfilled by turbojet and turbofan engines (e.g. propfan, unducted fan, and advanced ducted fan). In addition, today's action also amends the test procedures for gaseous exhaust emissions and smoke exhaust emissions to correspond to recent amendments to the ICAO test procedures for these emissions. EPA is also amending its certification test fuel specifications to make them consistent with ICAO's test fuel specifications.

All of the affected engines are already meeting the ICAO CO and first-stage NO<sub>x</sub> emission standards that EPA is adopting today. Most engines also meet the ICAO second-stage NO<sub>x</sub> standard; only a few models need minor reductions in emissions to meet this standard. In addition, most manufacturers routinely measure these emissions today even though it is not required by federal regulation. Today's amendments to the emission test procedures are those recommended by ICAO and are widely used by the aircraft engine industry. Thus, today's

rulemaking promulgates action that will establish consistency between U.S. and international standards, requirements, and test procedures. Since aircraft and aircraft engines are international commodities, there is some commercial benefit to consistency between U.S. and international emission standards and control program requirements (i.e., easier to qualify products for international markets since the Federal Aviation Administration (FAA) can certify engines for ICAO compliance). In addition, today's action ensures that domestic commercial aircraft will meet the current international standards, and thus, the public can be assured they are receiving the air quality benefits of the international standards.

**DATES:** This rule is effective July 7, 1997 unless notice is received by June 9, 1997 that adverse or critical comments will be submitted on a specific element of this rule. EPA will publish a timely document in the **Federal Register** withdrawing this rulemaking if adverse comments are received. The incorporation by reference of certain publications listed in the regulations is approved by the Director of the Federal Register as of July 7, 1997.

**ADDRESSES:** Interested parties may submit written comments in response to this notice (in duplicate if possible) to Public Docket No. A-94-66, at: Air Docket Section, U.S. Environmental Protection Agency, Attention: Docket No. A-94-66, First Floor, Waterside Mall, Room M-1500, 401 M Street SW., Washington, DC 20460. A copy of the comments should also be sent to Bryan Manning, U.S. EPA (EPCD-12), Engine Programs and Compliance Division, 2565 Plymouth Road, Ann Arbor, MI 48105.

Materials relevant to this notice have been placed in Docket No. A-94-66 by EPA. The docket is located at the above address and may be inspected from 8:00 a.m. to 5:30 p.m. on weekdays. EPA may charge a reasonable fee for copying docket materials.

A copy of this action and the Regulatory Support Document is available through the Technology Transfer Network Bulletin Board System (TTNBBS) under OMS, Rulemaking and Reporting, Non-Road, and Aviation Emissions. TTNBBS is available 24 hours a day, 7 days a week except Monday morning from 8-12 eastern standard time (EST), when the system is down for maintenance and backup. For help in accessing the system, call the systems operator at 919-541-5384 in Research Triangle Park, North Carolina, during normal business hours EST. In addition, the TTNBBS can be accessed

through the following internet addresses: World Wide Web: <http://ttnwww.rtpnc.epa.gov> or TELNET: [ttnbbs.rtpnc.epa.gov](http://ttnbbs.rtpnc.epa.gov).

**FOR FURTHER INFORMATION CONTACT:** Mr. Bryan Manning, U.S. EPA (EPCD-12), Engine Programs and Compliance Division, 2565 Plymouth Road, Ann Arbor, MI 48105. Telephone (313) 741-7832.

**SUPPLEMENTARY INFORMATION:**

**Regulated entities.** Entities potentially regulated by this action are those that manufacture and sell aircraft engines and aircraft in the United States. Regulated categories include:

Category	Examples of regulated entities
Industry .....	New aircraft engine manufacturers.
Industry .....	New aircraft manufacturers.

This table is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely to be regulated by this action. This table lists the types of entities that EPA is now aware could potentially be regulated by this action. Other types of entities not listed in the table could also be regulated. To determine whether your activities are regulated by this action, you should carefully examine the applicability criteria in 40 CFR 87.20. If you have any questions regarding the applicability of this action to a particular entity, consult the person listed in the preceding **FOR FURTHER INFORMATION CONTACT** section.

**I. Introduction****A. History of EPA's Regulation of Aircraft Engine Emissions**

Section 231 of the Clean Air Act (CAA) directs the EPA Administrator to "issue proposed emission standards applicable to the emission of any air pollutant from any class or classes of aircraft or aircraft engines which in his judgment causes, or contributes to, air pollution which may reasonably be anticipated to endanger public health or welfare" (42 U.S.C. 7571(a)(2)). Under this authority EPA has conducted several rulemakings establishing emission standards and related requirements for several classes (commercial and general aviation engines) of aircraft and aircraft engines. In 1973, EPA promulgated emission regulations for vented fuel, smoke, and exhaust (HC, NO<sub>x</sub>, and CO) emissions (38 FR 19088, July 17, 1973). Three tiers of standards were promulgated: retrofit standards for in-use engines, standards

for newly manufactured engines (those engines built after the effective date of the regulations) and for newly certified engines (those engines designed and certified after the effective date of the regulations). On August 16, 1976 (41 FR 34722) EPA promulgated emission standards for supersonic aircraft engines. On January 7, 1980 (45 FR 1419), EPA rescinded all gaseous emission requirements for piston engines (P1) and auxiliary power units (APU). On December 30, 1982 (47 FR 58462) EPA revisited aircraft engine emissions and amended regulations as follows:

(1) Withdrew HC, CO, and NO<sub>x</sub> emission standards for gas turbine engines used only for general aviation applications, for aircraft gas turbine engines of rated thrust less than 26.7 kN, and for newly certified aircraft gas turbine engines (i.e., engine models produced for the first time) in all rated thrust categories;

(2) Withdrew CO and NO<sub>x</sub> emission standards for newly manufactured aircraft gas turbine engines (i.e., engines already being produced) of rated thrust equal to or greater than 26.7 kN;

(3) Decreased the stringency of the HC emission standards for newly manufactured aircraft gas turbine engines of rated thrust equal to or greater than 26.7 kN;

(4) Revised smoke emission standards for turboprop engines to agree with existing U.S. Air Force smoke standards;

(5) Revised compliance date for all gaseous emission standards from January 1, 1983 to January 1, 1984;

(6) Exempted engine models produced in quantities of 20 units per year or less or not more than 200 units total future production;

(7) Redefined the idle power set point for engine compliance testing;

(8) Revised the test fuel specification for engine compliance testing; and

(9) Transferred responsibility and authority for evaluation of requests for exemption from emission standards to the Secretary of Transportation (DOT). On October 18, 1984 (49 FR 41002) EPA amended the test fuel specifications by broadening the ranges of allowable test fuel naphthalenes content, hydrogen content, viscosity, and final boiling point values.

Prior to today's action, EPA regulations were limited to smoke and fuel venting emissions standards for all commercial jet aircraft classes (turboprop engines (TP), turbofan and turbojet engines (TF), turbine engines of the JT3D model family (T3), turbine engines of the JT8D model family (T8), and turbine engines for aircraft designed to operate at supersonic flight speeds

(TSS)) and HC emission standards for newly manufactured aircraft gas turbine engines (TF, T3, and T8) with a thrust greater than 26.7 kN. Separate HC emission standards exist for gas turbine engines employed in supersonic aircraft, and the smoke standards vary for the several different classes of engines (see 40 CFR part 87 for a summary of EPA's aircraft engine emission control requirements and 14 CFR part 34 for the Secretary of Transportation's regulations for ensuring compliance with these standards in accordance with section 232 of the Clean Air Act).

#### *B. Interaction With the International Community*

Since publication of the initial standards in 1973, EPA, together with the Federal Aviation Administration (FAA), has worked with the International Civil Aviation Organization (ICAO) on the development of international aircraft engine emission standards. ICAO was established in 1944 by the United Nations "in order that international civil aviation may be developed in a safe and orderly manner and that international air transport services may be established on the basis of equality of opportunity and operated soundly and economically."<sup>1</sup> In 1972 at the United Nations Conference on the Human Environment, ICAO's position on the human environment was developed to be the following: "[i]n fulfilling this role ICAO is conscious of the adverse environmental impact that may be related to aircraft activity and its responsibility and that of its member States to achieve maximum compatibility between the safe and orderly development of civil aviation and the quality of the human environment." Also, in 1972 ICAO established the position to continue " \* \* \* with the assistance and cooperation of other bodies of the Organization and other international organizations \* \* \* the work related to the development of Standards, Recommended Practices and Procedures and/or guidance material dealing with the quality of the human environment \* \* \*."<sup>2</sup> The United States is one of more than 150 participating member States of ICAO. Under the basic ICAO treaty established in 1944, the participating nations have an obligation to adopt to the extent possible the ICAO standards. A nation which elects not to

do so must provide a written explanation to ICAO describing why a given standard is impractical to comply with or not in their national interest. However, ICAO standards are voluntary and therefore have no punitive powers for states that elect not to adopt ICAO standards.

On June 30, 1981, ICAO issued its first international standards and recommended practices covering aircraft engine emissions. These provisions applied to many of the same classes of engines to which the U.S. standards in force at that time applied. As mentioned above, with the establishment of the international standards, the U.S. was obligated under the Convention on International Civil Aviation to notify ICAO regarding differences between U.S. standards and ICAO standards and to provide notification on the date by which the program requirements would be consistent. At the time that the 1981 ICAO standards were issued, EPA was in the midst of a rulemaking reconsidering various provisions of the aircraft emission regulations in effect at that time. Among other actions, this rulemaking ultimately resulted in the scaling back of the U.S. program originally promulgated in July 1973 including withdrawal of the CO and NO<sub>x</sub> emission standards for newly manufactured gas turbine engines and exemptions for general aviation engines and commercial gas turbine engines with less than 26.7 kN thrust. (See the December 30, 1982 **Federal Register** and public docket OMSAPC-78-1 for more information on the rationale for this action.) With the exception of the changes made above (most notably an EPA decision not to adopt the ICAO CO and NO<sub>x</sub> standards at that time), these 1982 U.S. regulations were compatible with the ICAO requirements released in 1981 (Annex II, First Edition).<sup>3</sup>

On July 26, 1993 ICAO issued an amendment to existing NO<sub>x</sub> emission standards and test procedures for aircraft engine emissions.<sup>4</sup> The new ICAO NO<sub>x</sub> emission standard (revised NO<sub>x</sub> emission standard will take effect in year 1996 for newly certified engines and year 2000 for newly manufactured engines) represents a 20 percent reduction over the ICAO NO<sub>x</sub> emission standard issued in 1981. As discussed above, the U.S. has an obligation under the Convention on International Civil Aviation to notify ICAO regarding differences between U.S. standards and

<sup>1</sup> ICAO, Booklet on "The Convention on International Civil Aviation—The First 35 Years", 1979.

<sup>2</sup> International Civil Aviation Organization (ICAO), Foreword of "Aircraft Engine Emissions," Annex 16, Volume II, Second Edition, July 1993.

<sup>3</sup> The U.S. notified ICAO of these differences.

<sup>4</sup> International Civil Aviation Organization (ICAO), "Aircraft Engine Emissions," Annex 16, Volume II, Second Edition, July 1993.

ICAO standards, and to provide notification on the date by which the program requirements will be consistent. In response to this action by ICAO and for the reasons discussed below, EPA is adopting ICAO's 1993 amendments, ICAO's existing NO<sub>x</sub> and CO emission standards issued in 1981, and other technical amendments to further align EPA and ICAO requirements.

## II. Environmental Need for Control

It has been more than ten years since EPA issued a rulemaking action with regard to aircraft and aircraft engines, and thus, U.S. standards and ICAO standards have been inconsistent throughout this same time period. As mentioned above, Section 231(a)(2) of the CAA authorizes EPA to, from time to time, revisit emission standards for aircraft engine emissions " \* \* \* which in his judgment causes, or contributes to air pollution which may \* \* \* endanger the public health or welfare." In judging the need for the NO<sub>x</sub> and CO standards promulgated in today's action, the Administrator has determined (1) that the public health and welfare is endangered in several air quality regions by violation of the National Ambient Air Quality Standards (NAAQS) for NO<sub>x</sub> (which contributes to ozone) and CO; and (2) that airports and aircraft are now or are projected to be, significant sources of emissions of NO<sub>x</sub> and CO in some of the air quality control regions in which the NAAQS are being violated. (EPA has found that at 16 different airports commercial aircraft emit over 1,000 tons per year of NO<sub>x</sub> and 2,000 tons per year of CO at the ground level.)<sup>5</sup>

Currently, aircraft are about 2 percent of the total U.S. mobile source NO<sub>x</sub> and CO ground level emissions inventory. Commercial aircraft emissions are about 70 and 30 percent respectively of these NO<sub>x</sub> and CO aircraft emissions inventories.<sup>6</sup> Commercial aircraft emissions are a fast growing segment of the transportation sector's emission inventory. This growth in commercial aircraft emissions is occurring at a time when other significant mobile and stationary sources are drastically reducing emissions, thereby accentuating the growth in aircraft emissions. For instance, commercial

aircraft in the Los Angeles area will consume about 4 percent of the basin's allowable emissions inventory by 2010, which would be double its current contribution.<sup>7</sup>

Air pollutants resulting from airport operations are emitted from several types of sources: aircraft main engines and auxiliary power units (APUs); ground support equipment (GSE), which include vehicles such as aircraft tugs, baggage tugs, fuel trucks, maintenance vehicles, and other miscellaneous vehicles used to support aircraft operations; ground access vehicles (GAV), which include vehicles from off-site used by passengers, employees, freight operators, and other persons utilizing an airport. EPA's previous estimates show aircraft engines comprise approximately 45 percent of total air pollutant emissions from airport operations; GAV account for another 45 percent, and APUs and GSEs combined make up the remaining 10 percent.<sup>8</sup> Since EPA continues to study the total effect of airport ground-level emission sources and will deal with GAVs in another venue, these sources could be part of future notices in which EPA will request comment on possible regulation.

Adopting the ICAO NO<sub>x</sub> and CO emission standards and related test procedures will help in achieving and/or maintaining compliance with the NAAQS for ozone (O<sub>3</sub>), NO<sub>x</sub>, CO, and particulate matter (PM). Some of the adverse effects on public health and welfare associated with these pollutants are discussed briefly below.

### A. NO<sub>x</sub>, PM, and Ground-Level Ozone

NO<sub>x</sub> is directly harmful to human health and the environment. Exposure to NO<sub>2</sub> (nitrogen dioxide) can reduce pulmonary function and increase airway irritation in healthy subjects as well as people with pre-existing pulmonary conditions. In children, exposure to NO<sub>2</sub> at or near the level of the ambient standard appears to increase the risk of respiratory illness. NO<sub>x</sub> and one of its key transformation products (nitric acid) also contribute to a number of adverse environmental impacts such as overgrowth of algae and oxygen depletion (eutrophication). (NO<sub>x</sub> and its products have a role in excess nitrogen loads to sensitive water bodies. For instance, 25 percent of excess nitrogen to the Chesapeake Bay comes from the air.) NO<sub>x</sub> and its products contribute to

acid rain, which affects both terrestrial and aquatic ecosystems (already under stress from sulfur related acidification), including acidification of surface waters, reduction in fish populations, damage to forests and associated wildlife, soil degradation, damage to materials, monuments, buildings, etc., and reduced visibility. In addition, NO<sub>x</sub> at cruise altitudes from subsonic aircraft is considered to be a precursor of tropospheric ozone and a contributor to greenhouse gas.<sup>9</sup>

NO<sub>x</sub> emitted at low altitude is also a precursor in the formation of some nitrate particulate matter (PM) in the atmosphere (mostly ammonium nitrate). In general, nitrate PM is a significant contributor to overall ambient PM concentrations in many parts of the western U.S., and thus, contributes to the overall health and welfare concerns related to PM. Essentially all nitrate PM is of such a diameter that it is respirable in humans.

NO<sub>x</sub> is also a primary precursor to atmospheric ozone (O<sub>3</sub>) on a broad regional scale. Ozone is a highly reactive chemical compound which can affect both biological tissues and man-made materials. Ozone can affect human pulmonary and respiratory health—symptoms include chest pain, coughing, and shortness of breath.

The presence of elevated levels of ozone is of concern in rural areas as well. Because of its high chemical reactivity, ozone causes damage to vegetation. Estimates based on experimental studies of the major commercial crops in the U.S. suggest that ozone may be responsible for significant agricultural crop yield losses. In addition, ozone causes noticeable leaf damage in many crops, which reduces marketability and value. Finally, there is evidence that exposures to ambient levels of ozone which exist in many parts of the country are also responsible for forest and ecosystem damage. Such damage may be exhibited as leaf damage, reduced growth rate, and increased susceptibility to insects, disease, and other environmental stresses and has been reported to occur in areas that attain the current NAAQS. There are complexities associated with evaluating such effects due to the wide range of species and biological systems that introduce significant uncertainties.<sup>10</sup>

<sup>9</sup>Intergovernmental Panel on Climate Change, "Radiative Forcing of Climate Change," 1994; United Nation Environment Programme/World Meteorological Organization, "Scientific Assessment of Ozone Depletion," 1994.

<sup>10</sup>U.S. Environmental Protection Agency, Advance Notice of Proposed Rule—"Control of Air Pollution from Heavy-Duty Engines," Section II,

<sup>5</sup>Energy and Environmental Analysis, "Work Assignment 04, Task 1: Final Report, Inventory of Civil Aircraft Emissions for Twenty-Five Nonattainment Areas," September 11, 1991.

<sup>6</sup>E.H. Pechan and Associates, Inc., "National Annual Aircraft Emissions by Subcategory from Trends 1995 Report" (National Air Pollutant Emission Trends 1995—EPA), Facsimile from Maureen Mullen to Bryan Manning of the U.S. EPA, August 16, 1996.

<sup>7</sup>U.S. EPA, California Federal Implementation Plan proposal, 59 FR 23355, May 5, 1994.

<sup>8</sup>The California FIP, signed by the Administrator 2/14/95, is located in EPA Air Docket A-94-09, item number V-A-1. The FIP was vacated by an act of Congress before it became effective.

### B. Carbon Monoxide

For CO emissions, the growth in aircraft emissions is a concern because of the role of CO plays in harming human health. It is important in both the airport occupational and community environments. CO enters the blood stream and reduces the delivery of oxygen to the body's organs and tissues. CO is most serious for those who suffer from cardiovascular disease, particularly those with angina or peripheral vascular disease. Exposure to high levels of CO is associated with the impairment of visual perception, work capacity, manual dexterity, learning ability and performance of complex tasks.<sup>11</sup>

### III. Description of Action

Under the authority of section 231 of the CAA, EPA today is adopting ICAO's June 1981 NO<sub>x</sub> and CO emission standards and ICAO's amendments of July 1993, which include a more stringent NO<sub>x</sub> standard for the future and other test procedure changes. EPA is adopting regulations for aircraft engine NO<sub>x</sub> and CO control for several reasons. Maintenance of the NAAQS requires that aircraft engines be subject to a program of control compatible with their significance as pollution sources. The development of cleaner gas turbine engine technology has demonstrated the technical feasibility at a reasonable cost of the ICAO standards adopted in 1981 and amended 1993. Aircraft and aircraft engines are international commodities and, as such, are designed and manufactured to meet international standards. Thus, even though the U.S. did not adopt the ICAO CO and NO<sub>x</sub> standards in 1982, engine manufacturers have continued to make progress in reducing these emissions. Today's action is aimed at assuring that this progress is not reversed in the future. It is important to note that section 233 of the CAA vests authority to implement emission standards for aircraft engines only in EPA.<sup>12</sup> States are preempted from taking independent action. Thus, while many states are implementing control programs to reduce mobile

source emissions, it is EPA's responsibility to assure that a comprehensive emission control program is established for aircraft engines. In addition, the U.S. has an obligation to be compatible with the ICAO program if deemed appropriate, as discussed above.

Today's promulgated emission standards and test procedures apply to commercial aircraft engines; no general aviation or military engines are covered by today's rule. The commercial aircraft engines subject to today's rule are those engines that are either newly certified or newly manufactured after the effective date of these regulations. The adopted emission standards, test procedures, and their effective dates are described below. For the sake of consistency and harmonization, the effective dates below for NO<sub>x</sub> standards are identical with those of the ICAO NO<sub>x</sub> standards. EPA recognizes that these requirements are not effective or federally enforceable for engines produced prior to July 7, 1997.

#### A. CO Standard

EPA adopts ICAO's CO emission standard for newly manufactured aircraft gas turbine engines (turbofan and turbojet engines) of rated thrust greater than 26.7 kilonewtons (kN) as follows:

For all engines, manufactured on or after July 7, 1997;

$$CO = 118 \text{ grams/kilonewton (g/kN)(rated output).}$$

This standard is identical to the ICAO standard that became effective in 1986. The CO emission standard does not provide compliance lead time since it was adopted in 1981 and all newly manufactured engines have met the ICAO standard for many years. According to data available to EPA at this time, all applicable engines covered by this promulgated emission standard currently meet this emission standard.<sup>13</sup>

#### B. NO<sub>x</sub> Standards

EPA adopts ICAO's NO<sub>x</sub> emission standard for newly certified and newly manufactured aircraft gas turbine engines (turbofan and turbojet engines) of rated thrust greater than 26.7 kN with compliance dates as follows:

For engines of a type or model of which that 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;

$$NO_x = (40 + 2(\text{rated pressure ratio}))/\text{g/kN}(\text{rated output});$$

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;

$$NO_x = (32 + 1.6(\text{rated pressure ratio}))/\text{g/kN}(\text{rated output}).$$

The first NO<sub>x</sub> emission standard presented above matches the ICAO standard that became effective in 1986. According to available data, the NO<sub>x</sub> emission standard for those engines certified on or before December 31, 1995 and manufactured on or before December 31, 1999 is now being met by all engines covered by this rulemaking. The later NO<sub>x</sub> emission standard above (for engines newly certified after 1995 and newly manufactured after the year 1999) matches the ICAO 1993 amendments' 20 percent reduction which becomes effective in the year 1996 for newly certified engines and in the year 2000 for newly manufactured engines. There is a four year period between when newly certified engines must meet the standards and when all newly manufactured engines must meet the standards to provide lead time for the production of 100 percent compliant products. According to available data, the NO<sub>x</sub> standard for those engines certified after December 31, 1995 or manufactured after December 31, 1999 is met by all but two of the affected aircraft gas turbine engine models (approximately 15 percent of the market).<sup>14</sup>

#### C. Feasibility of NO<sub>x</sub> and CO Standards

Section 231(b) of the CAA states that "Any regulation prescribed under this section \* \* \* shall take effect after such period as the Administrator finds necessary \* \* \* to permit the development and application of the requisite technology, giving appropriate consideration to the cost of compliance within such period." Accordingly, the Administrator has determined that emissions from aircraft and aircraft engines should be reduced to the extent practicable with present and developing technology. The standards adopted herein are not quantitatively derived from the air quality impact discussed above in section II of today's rule, but instead reflect EPA's judgment as to what reduced emission levels are currently practicable to achieve for gas

<sup>11</sup>Health Concerns and Air Quality Issues: NO<sub>x</sub>, VOC, Ozone, and Particulate Matter; 60 FR 45580, August 31, 1995.

<sup>12</sup>U.S. Environmental Protection Agency, "National Air Pollutant Emission Trends," EPA/454/R-94/027, October 1994; "Air Quality Criteria for Carbon Monoxide," EPA/600/8-90/045F, October 1991.

<sup>13</sup>CAA section 233 entitled "State Standards and Controls" states that "No State or political subdivision thereof may adopt or attempt to enforce any standard respecting emissions of any air pollutant from any aircraft or engine thereof unless such standard is identical to a standard applicable to such aircraft under this part."

<sup>14</sup>U.S. Environmental Protection Agency, Office of Mobile Sources, "Regulatory Support Document for Aircraft Engine Emissions Regulations", February 1997.

<sup>14</sup>U.S. Environmental Protection Agency, Office of Mobile Sources, "Regulatory Support Document for Aircraft Engine Emissions Regulations", February 1997.

turbine engines when considering the cost of compliance within the implementation dates presented above. (See Regulatory Support Document of today's rule for further discussion of engine emission levels.)

In the mid-1980's, EPA was concerned that the 1986 ICAO NO<sub>x</sub> and CO standards were not justifiable because the technological control methods were still in their infancy and the air quality impact of aircraft operations was not substantial enough compared to other sources. Over the years the aircraft engine industry has made substantial progress in controlling gas turbine engine emissions. EPA now believes that the 1986 ICAO NO<sub>x</sub> and CO emission standards and the 1993 ICAO amended standards will be easily met by the aircraft engine industry, as discussed below. Furthermore, the importance of controlling aircraft emissions has grown in many areas as controls on other sources become more stringent and attainment of the NAAQS's has still not been achieved. Therefore, it is appropriate to revisit the U.S. standards in today's rule as described below.

#### 1. Feasibility of NO<sub>x</sub> Standard

The two engine models that are not achieving the emission levels required by the later NO<sub>x</sub> standard (NO<sub>x</sub> standard which took effect in 1996 for newly certified engines and in 2000 for newly manufactured engines) currently are Pratt and Whitney's JT8D-200 series and Rolls-Royce's RB211 series (specifically RB211-524 and RB211-535), and both engine models are expected to still be in production in the year 2000. These engines have already been targeted for modification by Pratt & Whitney and Rolls-Royce based upon the ICAO 1993 amendments. Pratt and Whitney projects that the JT8D-200s (currently about 9 percent of Pratt & Whitney's turbofan engine market) will meet the new NO<sub>x</sub> standard as early as 1998 by using a new low-NO<sub>x</sub> can-annular combustor equipped with improved fuel nozzles to optimize mixing, flame temperature and residence time in the combustion chamber. In this improved combustor, the airflow would be reduced in the primary combustion zone and axially shifted from the dilution zone to the secondary combustion zone. This action would result in an enriched primary combustor zone and a rapid secondary combustion zone transition that would reduce the formation of NO<sub>x</sub> by about 20 percent, the amount of emission control needed to achieve the

standard.<sup>15</sup> (See Regulatory Support Document of this rule for further technological discussion.)

For the RB211 (currently about 70 percent of Rolls-Royce's turbofan engine market), Rolls-Royce stated in a January 3, 1997 letter to EPA that the RB211-524 (designated RB211-524G/H-T) will comply with the new NO<sub>x</sub> standard as early as mid 1997 and that the RB211-535 will meet this NO<sub>x</sub> standard by late 1999.<sup>16</sup> RB211 series engines comply with ICAO's 1986 NO<sub>x</sub> standard, but these engines currently have NO<sub>x</sub> levels that are about 20 percent above the new NO<sub>x</sub> standard.<sup>17</sup> Based on the information provided by Pratt and Whitney and Rolls-Royce, EPA believes the compliance date of January 1, 2000 for newly manufactured engines affected by this new NO<sub>x</sub> standard provides adequate lead time for the manufacturers of the two higher-emitting engines models (and manufacturers of other new model engines) to cost-effectively develop technology to comply with this new NO<sub>x</sub> standard. Moreover, since this new NO<sub>x</sub> standard is an international requirement which Pratt & Whitney and Rolls-Royce would meet to market their products, the costs incurred for technological improvements made by these two manufacturers to meet this standard should not necessarily be attributed to today's regulations. The ICAO standards ensure that (1) The technology is or will be available and (2) the costs of compliance will be minimal. EPA recognizes that the percentage reductions achieved are not trivial, nor are the costs already incurred or possible additional future costs necessary to achieve these reductions inconsequential, including certification costs. Nonetheless, EPA believes that the promulgated regulations will not impose any additional burden on manufacturers beyond that of the current ICAO requirements. (See section V. of today's rule for further discussion of regulatory impact).

<sup>15</sup> U.S. Environmental Protection Agency, "Record of EPA Communication with Pratt and Whitney Regarding EPA's Technological Feasibility Assessment of the 1993 ICAO Amended NO<sub>x</sub> Standards in Regards to the JT8D-200 series of Aircraft Engines," Memorandum from Bryan Manning to the docket, January 19, 1996.

<sup>16</sup> Rolls-Royce Aerospace Group, Rolls-Royce's technological feasibility assessment of the 1993 ICAO NO<sub>x</sub> standard in regards to the RB211, Letter from Ashley J. Owen of Combustion Engineering Department to Bryan Manning of the U.S. Environmental Protection Agency, January 3, 1997.

<sup>17</sup> Defense Research Agency, ICAO/CAEP Working Group 3 (Emissions)—Third Meeting—Bonn, Germany, "Combined Report of the Certification and Technology Subgroups," June 1995.

#### 2. Feasibility of CO Standard

To meet the 1986 ICAO emissions standards, manufacturers have combustors that utilize a short (straight through) annular design, fuel atomizers using air in some manner to assist the process, efficient cooling configuration, low residence times, minimum pressure drop, fixed geometry air entry and a fuel injector spacing approximately the same as the combustor height. Such combustors are designed to minimize CO, HC, NO<sub>x</sub>, and smoke emissions, while retaining combustor performance, operability and durability capabilities. CO and HC are products from lower power engine operations, whereas NO<sub>x</sub> and smoke are primarily from high power operation. CO and HC have been reduced significantly, by improvements in the fuel-air mixing, without significant adverse effects on NO<sub>x</sub>. The trade-offs between CO, HC, smoke and NO<sub>x</sub> emissions are now widely understood by manufacturers and have been successfully balanced to meet ICAO standards. Typically, current production engines have large margins in comparison to the existing CO and HC standards imposed by ICAO,<sup>18</sup> to which EPA's promulgated CO and current HC standard are identical.<sup>19</sup> Furthermore, the new ICAO NO<sub>x</sub> standard to become effective in 1996 for newly certified engines and 2000 for newly manufactured engines (the same as being adopted by EPA) will ensure that (1) the technology is or would be available to successfully balance CO, HC, and NO<sub>x</sub> emissions and (2) the cost of compliance will be minimal.

#### D. Amendments to Smoke and Gaseous Emission Test and Measurement Procedures, Compliance Procedures, and Test Fuel Specifications

##### 1. Smoke and Gaseous Emission Test and Measurement Procedures

In today's rule, EPA incorporates by reference ICAO's 1993 amendments to the test procedures for measuring smoke and gaseous emissions (ICAO International Standards and Recommended Practices Environmental Protection, Annex 16, Volume II,

<sup>18</sup> International Coordinating Council of Aerospace Industries Association (ICCAIA) stated in a December 19, 1996 memorandum to EPA in regards to CO emission levels of current production engines (as discussed above typically these levels are significantly lower than the existing ICAO CO standard), that "[m]odern combustor efficiencies exceed 99.5 percent at all power conditions, including idle, and there is little or no potential for further improvement."

<sup>19</sup> Defense Research Agency, ICAO/CAEP Working Group 3 (Emissions)—Third Meeting—Bonn, Germany, "Combined Report of the Certification and Technology Subgroups," June 1995.

"Aircraft Engine Emissions," Second Edition, July 1993, Appendices 2, 3, and 5) in 40 CFR 87.64 and 87.82. ICAO's amendments, which became effective on November 11, 1993, apply to subsonic (newly certified and newly manufactured for NO<sub>x</sub>) and supersonic gas turbine engines. These technical changes will simplify the measurement process and improve the measurement techniques and equipment of the test procedures for smoke and gaseous emissions. These test procedure amendments incorporated by reference will become effective on July 7, 1997. These amendments include the following: (1) Raising the temperature tolerance by  $\pm 5$  C degrees for sampling line of smoke emissions, (2) adding an option to install by-pass around the volume meter in the smoke analysis system, (3) adding an option to install a flow splitter to draw a higher sample flow rate through the probe of the smoke analysis system, (4) adding a test to show that a flow splitter does not change the smoke level in the smoke analysis system, (5) adding new leakage and cleanliness check procedures for gaseous emissions instruments, (6) revising the recommended curve fitting technique to relate emission indices to combustor inlet temperature for gaseous emissions, (7) adding precautions for performance specification accuracy of HC, CO, and carbon dioxide (CO<sub>2</sub>) analyzers for gaseous emissions, (8) revising the performance specifications of HC, CO, and CO<sub>2</sub> analyzers for gaseous emissions, (9) adding a check on the effect of oxygen on the CO<sub>2</sub> analyzer response for gaseous emissions, (10) adding calibrations of CO and CO<sub>2</sub> analyzers for gaseous emissions, (11) revising the performance specifications of NO<sub>x</sub> analyzers for gaseous emissions, (12) revising the calibration and test gas specifications for CO, CO<sub>2</sub>, and NO<sub>x</sub> for gaseous emissions, and (13) revising the calculation of the gaseous emissions parameters.

In the 1982 final rule, EPA incorporated by reference the then-existing ICAO testing and measurement procedures for aircraft engine emissions (ICAO International Standards and Recommended Practices Environmental Protection, Annex 16, Volume II, "Aircraft Engine Emissions," First Edition, June 1981, Appendices 2, 3, and 5 were incorporated by reference in 40 CFR 87.64 and 87.82) in order to eliminate confusion over minor differences in procedures for demonstrating compliance with the U.S. and ICAO standards. Also, in 1982 EPA specified that "[w]hile the U.S. standard

for gaseous emissions will now apply to HC only, it is recommended that CO and NO<sub>x</sub> measurements be made and reported to the certifying authority as well, for information only. \* \* \*

Manufacturers have been voluntarily conducting and reporting CO and NO<sub>x</sub> measurements for twelve years in accordance with EPA's recommendation, and FAA has certified the test data to ICAO.<sup>20</sup> Thus, formal adoption of the ICAO CO and NO<sub>x</sub> test procedures requires no new action by manufacturers. In addition, the existence of ICAO's requirements ensures that the costs of compliance (as well as the air quality impact) with these test procedures will be minimal.

## 2. Compliance Procedure for Gaseous and Smoke Emission Standards

In today's rule, EPA will also incorporate by reference the ICAO compliance procedure for gaseous and smoke emissions (ICAO International Standards and Recommended Practices Environmental Protection, Annex 16, Volume II, "Aircraft Engine Emissions," Second Edition, July 1993, Appendix 6) in 40 CFR 87.71 and 87.89. This ICAO compliance procedure applies to subsonic and supersonic gas turbine engines and has been in effect since February 18, 1982. By incorporating by reference ICAO's Appendix 6, EPA is today adopting this compliance procedure for gaseous and smoke emissions as an alternative to certification testing every engine for a type or model. This alternative compliance procedure incorporated by reference will become effective on July 7, 1997. This change in the EPA compliance procedure will simplify and reduce the testing burden of the compliance process. According to section 232 of the CAA, the Secretary of Transportation (DOT) has the authority to enforce the aircraft emission standards established by EPA.<sup>21</sup> On June 29, 1995 the Secretary (or more specifically the Administrator of the FAA) incorporated by reference ICAO's Appendix 6 as an alternative for demonstrating compliance to the gaseous and smoke emissions, and thus, established the level of confidence required for U.S. compliance testing. Therefore, today's action by EPA to adopt Appendix 6 as an alternative for compliance procedures concurs with the required level of confidence established by the Secretary for

certification testing, and thus it is an acceptable means of compliance.

This compliance procedure is as described above an alternative method of compliance, and thus, the use of the procedure is voluntary for manufacturers. Manufacturers have been using this compliance procedure to adhere to ICAO's requirements since 1982, and more recently manufacturers have been using it voluntarily as an alternative for DOT's compliance regulations. Thus, formal adoption of the ICAO compliance procedure for gaseous and smoke emissions as an alternative compliance procedure requires no new action by manufacturers. In addition, since the compliance procedure is optional and the ICAO requirements (and DOT's recently adopted regulations) have been in existence for years, the cost (as well as the air quality impact) of this alternative compliance procedure will be minimal.

## 3. Test Fuel Specifications

In July 1988, ICAO amended the test fuel specifications which it had previously adopted in 1981. Specifically, the 1988 amendments (apply to subsonic and supersonic gas turbine engines) broadened the ranges of allowable test fuel naphthalenes content, hydrogen content, viscosity, final boiling point values, and aromatics content and allowed wider bands of acceptability.

In 1982, EPA established test fuel specifications that matched ICAO's 1981 test fuel specifications. EPA has not changed its test fuel specifications since 1984, when EPA finalized amendments in response to reported difficulties by manufacturers in procuring fuels meeting the existing test fuel specifications.<sup>22</sup> The 1984 EPA amendments broadened the ranges of allowable test fuel naphthalenes content, hydrogen content, viscosity, and final boiling point values. These 1984 changes resulted in a difference in test fuel specifications between EPA and ICAO standards. However at that time, EPA believed ICAO would soon amend its test fuel specifications to match EPA's new specifications. Instead, since the 1984 amendments by EPA, differences between EPA and ICAO fuel specifications have remained, and ICAO's 1988 amendments did not address the disparity. In fact, in 1988 ICAO widened the range of acceptable fuels even further than the 1984 EPA specifications. As discussed above, the 1988 ICAO amendments, which became effective on November 17, 1988,

<sup>20</sup> These measurements have been shown to meet the existing ICAO CO and NO<sub>x</sub> standards.

<sup>21</sup> Specifically, the FAA of the DOT is responsible for enforcement of the aircraft emission standards established by EPA.

<sup>22</sup> See 49 FR 25643 (October 18, 1984).

broadened the ranges of allowable test fuel naphthalenes content, hydrogen content, viscosity, final boiling point values, and aromatics content and allowed wider bands of acceptability. In July 1993, ICAO amended its test fuel specifications slightly. These specifications, which became effective on November 11, 1993 and apply to subsonic and supersonic gas turbine engines, require aircraft engine testing fuel to have a certain density instead of a specific gravity, and changes the units of net heat of combustion of testing fuel from kilojoule/kilogram (kJ/kg) to megajoule/kilogram (MJ/kg).

In response to these differences, EPA has once again revisited the test fuel issue. For the 1993 ICAO amendments to the specific gravity and net heat of combustion, EPA believes that because these two changes to the ICAO test fuel specifications are merely changes to one property's description and another property's units, but not changes to the allowable range of values for these properties, EPA will adopt the 1993 ICAO changes from specific gravity to density and from kJ/kg to MJ/kg for net heat combustion (see section 87.61 of today's regulations). For the remaining test fuel differences, each property is discussed separately below. For purposes of comparison, the ICAO specifications and U.S. commercial jet fuel characteristics of interest are presented below in Table 1. Survey data on jet fuels conducted by the National Institute for Petroleum and Energy Research (NIPER) indicates that the aromatics content and kinematic

viscosity of current U.S. commercial jet fuels found in-use have values which overlap with the ICAO test fuel specifications.<sup>23</sup> The ICAO aromatics content specification has a higher maximum limit than the current U.S. specification. Since fuels with higher aromatics content generally are more severe for emissions testing purposes, adopting the ICAO aromatics content specification would not adversely affect in-use emissions. Lowering the kinematic viscosity minimum limit would also not affect emissions because it would only have an effect on the cold-starting operation of aircraft engines (not idle, landing-take-off, or cruise operations) due to the manner in which aircraft engines function, and the starting operation is not measured in the emissions test procedures. Thus for aromatic content and kinematic viscosity where differences existed in the past, not only are the current U.S. commercial jet fuels adequately similar to the ICAO specifications, but the ICAO specifications would not adversely affect in-use emissions; therefore, EPA will adopt these ICAO specifications for the purpose of certification emission testing.

The NIPER survey data shows that U.S. jet fuel distillation temperatures closely track EPA and ICAO requirements but that the ICAO specification allows a 5 °C lower 10 percent boiling point and final boiling point. However, adopting the ICAO specification for distillation temperature at 10 percent and final boiling points, which has a lower minimum limit than

the current U.S. specification, would have no discernible effect on emissions. In addition, similar to aromatics content, the ICAO naphthalenes content specification has a higher maximum limit than the current U.S. specification. Since fuels with a higher naphthalenes content are more severe for emission testing purposes, adopting the ICAO naphthalenes content specification would not adversely affect in-use emissions. For hydrogen content, adopting the ICAO specification, which has a 0.1 mass percent higher maximum limit, would be a minor change that would have no effect on emissions. Since distillation temperature, naphthalenes content, and hydrogen content have no adverse effect on in-use emissions, EPA will adopt the ICAO specifications for the purpose of certification emission testing. Moreover, the ICAO agreements to adopt today's NO<sub>x</sub> standards were based on these test fuel specifications. If EPA does not adopt these test fuel specifications, the U.S. NO<sub>x</sub> standards would not be entirely consistent with ICAO standards.

In addition, unless specified otherwise in the above discussion for test fuel specifications or in the accompanying test fuel regulations for this section (see 87.61 of the regulations), manufacturers should comply with the latest version of the aviation fuel specifications from the American Society for Testing and Materials (ASTM).<sup>24</sup>

TABLE 1.—COMPARISON OF U.S. JET FUEL CHARACTERISTICS TO CURRENT DIFFERENCES BETWEEN EPA AND ICAO TEST FUEL SPECIFICATIONS

Property	EPA	ICAO	Difference	Jet-A NIPER 1995	Jet-A NIPER 1994	Jet-A NIPER 1993	Jet-A ASTM spec.	ASTM test method	ASTM method reproducibility
Distillation, °C:									
10% Boiling Point ....	160–201 .....	155–201 .....	– 5 °C .....	161.7–198.3 ...	161.1–201.7 ...	167.8–197.2 ...	<205	D86	3.0+2.63 *S <sup>1</sup>
Final Boiling Pt. ....	240–285 .....	235–285 .....	– 5 °C .....	.....	.....	.....	<300		10.5 °C
Aromatics, vol. % .....	15–20 .....	15–23 .....	– 3 vol% .....	13–24.4 .....	13.7–22.6 .....	9.5–23.3 .....	<22 <sup>2</sup>	D1319	2.5–3.0 vol%
Naphthalenes, vol. % .....	1.0–3.0 .....	1.0–3.5 .....	– 0.5 vol% .....	0.5–2.88 .....	0.1–2.70 .....	0.2–2.98 .....	<3.0	D1840	0.11 vol%
Hydrogen, mass % .....	13.4–14.0 ...	13.4–14.1 ...	– 0.1 mass% .....	.....	.....	.....		D1018	0.18 wt%
								D3343	0.16 wt%
								D5291	–0.86 wt% <sup>3</sup>
								D445	0.7% of mean
Kinematic Viscosity @ – 20 °C, mm <sup>2</sup> /sec.	4.0–6.5 .....	2.5–6.5 .....	– 1.5 mm <sup>2</sup> /sec ...	3.79–7.7 .....	3.3–7.0 .....	1.4–6.8 .....	<8.0		

<sup>1</sup> S is the average slope of distillation line.

<sup>2</sup> Aromatic content of up to 25 vol% allowed by agreement between vendor and purchaser.

<sup>3</sup> Reproducibility given as the square root of the mean value times 0.2314.

<sup>23</sup> National Institute for Petroleum and Energy Research (NIPER), "Aviation Turbine Fuels, 1995", Cheryl L. Dickson and Gene P. Sturm, Jr., March 1996, NIPER-194 PPS 96/2.

<sup>24</sup> ASTM, "Standard Specification for Aviation Turbine Fuels," D1655.

*E. Engines "Designed for Applications That Otherwise Would Have Been Fulfilled by Turbojet and Turbofan Engines"*

In July 1993 ICAO amended the applicability of its regulations for subsonic turbojet and turbofan engines to include " \* \* \* engines designed for applications that otherwise would have been fulfilled by turbojet and turbofan engines." This ICAO provision evolved from recent industry developmental work performed on propfan, unducted fan, and advanced ducted propfan (ADP) engines. The propfan or unducted fan engines can be thought of as either an advanced version of the turboprop having a propeller capable of very high mach numbers or a turbofan with an extremely high effective bypass ratio. This high bypass ratio decreases fuel consumption and thus has a higher propulsion efficiency. Propfan engines have blades that are thin and swept back to increase their capability to withstand relative velocities.<sup>25</sup>

Pratt and Whitney's advanced ducted prop (ADP) is an example of a propfan. The ADP offers significantly reduced fuel consumption, low noise, and low emissions compared to high-bypass ratio turbofans. The ADP has these characteristics through the use of a special fan drive system allowing for a lower fan tip speed and slower exhaust gas velocities. Both the fan tip speed and the exhaust gas velocity are major sources of inefficiency in a turbine engine.<sup>26</sup>

In today's rule, EPA will apply its regulatory provisions for subsonic turbojet and turbofan engines to include these new applications. To meet public health and welfare protection requirements of section 231 of the CAA, EPA must ensure that, if any of these technologies become commercially viable, their emissions will be regulated, given that these new engines would contribute to overall aircraft emissions. Currently, none of these developmental engines have been certified, but if they certify in the future, they will be covered by the requirements that apply to turbojet and turbofan engines. (See the Regulatory Support Document for further discussion of these engine applications.) It is EPA's understanding that the development of the propfan and unducted fan engines has not been active recently, but the development of the ADP is ongoing. These engines will

need to comply with ICAO's 1993 amendments if produced, and thus, ICAO's standards will ensure that if these applications were developed they will have the technology to meet today's promulgated standards.<sup>27</sup> In addition, the existence of ICAO's 1993 standards ensures that the cost of compliance (as well as the air quality impact) of today's promulgated requirements to include these new engine applications will be minimal.

*F. Correction to the Exponent for Rated Output in the Equation of the Smoke Number for New Aircraft Turboprop Engines*

Because of an editorial error, the exponent for rated output in the equation of the smoke number for new aircraft turboprop engines was incorrectly specified as -168 (see section 87.31(e)(3) of the regulations). For this smoke number equation in section 87.31(e)(3) of the regulations, EPA today corrects the exponent value for rated output to -0.168.

#### IV. Coordination With FAA

The requirements contained in the notice are being adopted after consultation with the Secretary of Transportation in order to assure appropriate consideration of aircraft safety. Under section 232 of the CAA, the Secretary of Transportation (DOT), has the responsibility to enforce the aircraft emission standards established by EPA under section 231.<sup>28</sup> In addition, section 231(b) of the CAA states that "[a]ny regulation prescribed under this section \* \* \* shall take effect (after consultation with the Secretary of Transportation) to permit the development and application of the requisite technology, giving appropriate consideration to the cost of compliance \* \* \*." As in past rulemakings and pursuant to the above referenced sections of the CAA, EPA has coordinated with the Federal Aviation Administration (FAA) of the DOT during the process of formulating the promulgated emission standards and

test procedures for aircraft engine emissions set forth here.

Moreover, FAA is the official U.S. delegate to ICAO. FAA agreed to the 1993 amendments at ICAO's Second Meeting of the Committee on Aviation Environmental Protection (CAEP II)<sup>29</sup> after advisement from EPA. After CAEP II, FAA then notified EPA of the detailed revisions to the ICAO Standards and Recommended Practices for Aircraft Engine Emissions to be incorporated by EPA in its aircraft engine emissions regulations (if EPA chooses to take such action).<sup>30</sup> FAA was a member of two CAEP III subgroups (among others),<sup>31</sup> Economic and Analysis Subgroup and the Certification and Technology Subgroup, which both included projections of technology and cost considerations of the ICAO standards adopted in 1993 in separate CAEP III reports respectively. The reports were entitled, "ICAO CAEP Working Group 3 (Emissions)—Combined Report of the Certification and Technology Subgroups" and "ICAO CAEP Working Group 4, Coordination and Economic Analysis, Final Report of the Economic Analysis Subgroup" (Bonn, Germany, June 1995). These reports were a source for EPA's projections of the technology and cost considerations for compliance with today's action, and they serve as another form of consultation with the DOT.

In addition, as discussed above, FAA will have the responsibility to enforce today's promulgated requirements. As a part of its compliance responsibilities, FAA conducts the emission tests or delegates that responsibility to the engine manufacturer, which is then monitored by the FAA. Since the FAA does not have the resources or the funding to test engines themselves, FAA selects engineers at each plant to serve as representatives (called designated engineering representatives (DERs)) for the FAA while the manufacturer performs the test procedures. DERs' responsibilities include evaluating the test plan, the test engine, the test equipment, and the final testing report sent to FAA. DERs' responsibilities are determined by the FAA and today's rule will not affect their duties.

<sup>29</sup> The Second Meeting of CAEP (CAEP II) occurred in Montreal, Quebec from December 2 through 13 in 1991.

<sup>30</sup> U.S. Department of Transportation, Federal Aviation Administration, Revisions to the ICAO standards and recommended practices for aircraft engine emissions, Letter from Nicholas P. Krull to Richard Wilson of the U.S. Environmental Protection Agency, August 27, 1993.

<sup>31</sup> The Third Meeting of CAEP (CAEP III) occurred in Montreal, Quebec from December 5 through 15 in 1995.

<sup>25</sup> U.S. Environmental Protection Agency, "Regulatory Support Document for Aircraft Engine Emissions Regulations," February 1997.

<sup>26</sup> U.S. Environmental Protection Agency, "Regulatory Support Document for Aircraft Engine Emissions Regulations," February 1997.

<sup>27</sup> Although ICAO requirements in Annex 16, Volume II apply to such applications, specifically certifying propfan, unducted fan, and/or advanced ducted propfan applications may require variations to the test procedures specified by ICAO in Annex 16, Volume II. Thus, prior to certifying these engine applications as gas turbine engines, the test procedure variations would need to be worked out by ICAO. Due to the international nature of the aviation industry, this work would best be performed through a working group of the ICAO Committee on Aviation Environmental Protection (CAEP).

<sup>28</sup> Specifically, the FAA of the DOT has the responsibility to enforce the aircraft emission standards established by EPA.

## V. Regulatory Impacts

Aircraft engines are international commodities, and thus, they are designed to meet international standards. Today's rule will have the benefit of establishing consistency between U.S. and international emission standards and test procedures. Thus, an emission certification test which meets U.S. requirements will also be applicable to all ICAO requirements. As discussed above, all engines covered by today's federal standards already meet the standards or will meet them by the standards' effective dates. EPA knows of only 2 engine types that do not currently meet all of the standards. Pratt & Whitney and Rolls-Royce, the manufacturers of these two engine types, are already developing improved technology in response to the ICAO standards that match the standards adopted here, and EPA does not believe that the costs incurred by the aircraft industry as a result of the existing ICAO standards should be attributed to today's regulations. Also, the test data necessary to determine compliance are already collected by manufacturers during current engine certification tests. Therefore, EPA believes that the promulgated regulations will impose no additional burden on manufacturers.

The existence of ICAO's requirements results in minimal cost as well as air quality benefits from today's promulgated requirements. Since aircraft and aircraft engines are international commodities, there is some commercial benefit to consistency between U.S. and international emission standards and control program requirements (i.e., easier to qualify products for international markets since FAA can certify engines for ICAO compliance). While not a regulatory impact *per se*, EPA adoption of the ICAO standards and related requirements/test procedures meets our treaty obligations and strengthens the U.S. position in future ICAO/CAEP processes related to emission standards.

## VI. Public Participation

The Agency is publishing this action as a direct final rule because it views the provisions of today's action as non-controversial, and based on outreach efforts with all affected parties, EPA anticipates no adverse or critical comments. The existence of ICAO's requirements ensures that the promulgated regulations impose no additional burden on manufacturers. Aircraft engine manufacturers have indicated that they will not be adversely affected by this direct final rule, and thus, the Agency expects no adverse

comments for those manufacturers. Similarly, the Agency does not expect adverse comments from the environmental community or state and local governments, since the environmental impact is at least directionally positive.

This action will become effective July 7, 1997. If the Agency receives adverse comments by June 9, 1997, EPA will publish a subsequent **Federal Register** document withdrawing this rule. In the event that adverse or critical comments are received, EPA is also publishing a Notice of Proposed Rulemaking (NPRM) in a separate action today (found in the Proposed Rule section of this **Federal Register**), which proposes the same rule changes contained in this direct final rule. Any adverse comments received by the date listed above will be addressed in a subsequent final rule. EPA will not institute a second comment period on this action. Any parties interested in commenting on this action should do so at this time. If no such comments are received, the public is advised that this action will be effective July 7, 1997.

Nonetheless, if public comments are to be submitted, the Agency requests wherever applicable, full supporting data and detailed analysis should be submitted to allow EPA to make maximum use of the comments. Commenters are especially encouraged to provide specific suggestions for any changes to any aspect of the regulations that they believe need to be modified or improved. All comments should be directed to EPA Air Docket, Docket No. A-94-66 (See **ADDRESSES**).

Commenters desiring to submit proprietary information for consideration should clearly distinguish such information from other comments to the greatest possible extent, and clearly label it "Confidential Business Information." Submissions containing such proprietary information should be sent directly to the contact person listed above (See **ADDRESSES**), and not to the public docket, to ensure that proprietary information is not inadvertently placed in the docket.

Information covered by such a claim of confidentiality will be disclosed by EPA only to the extent allowed by the procedures set forth in 40 CFR part 2. If no claim of confidentiality accompanies the submission when it is received by EPA, it may be made available to the public without further notice to the commenter.

## VII. Statutory Authority

The statutory authority for today's rule is provided by sections 231 and 301(a) of the Clean Air Act, as amended, 42 U.S.C. 7571 and 7601. See section II.

of today's rule for discussion of how EPA meets the CAA's statutory requirements.

## VIII. Administrative Designation and Regulatory Analysis

Under Executive Order 12866, 58 FR 51735 (Oct. 4, 1993), the Agency must determine whether this regulatory action is "significant" and therefore subject to Office of Management and Budget (OMB) review and the requirements of the Executive Order. The order defines "significant regulatory action" as one that is likely to result in a rule that may:

- (1) Have an annual effect on the economy of \$100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;
- (2) Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;
- (3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or
- (4) Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

Pursuant to the terms of Executive Order 12866, EPA has determined that this direct final rule is not a "significant regulatory action" within the meaning of the Executive Order and is therefore not subject to OMB review. As a result of the ICAO standards, all aircraft engines covered by today's direct final rule already meet the standards or will do so by the time the standards go into effect. Thus, the annual effect on the economy of today's promulgated standards will be minimal, and none of the other thresholds identified in the executive order will be triggered by this action.

## IX. Compliance With Regulatory Flexibility Act

The Regulatory Flexibility Act (RFA) 5 U.S.C. 601-602, requires that federal agencies examine the effects of their regulations on small entities. The Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996 amended those requirements. The SBREFA requires an agency to prepare a Regulatory Flexibility Analysis in conjunction with the rulemaking, unless the agency head certifies that the rule will not have a significant economic impact on a substantial number of small entities. Pursuant to section 605(b) of the RFA as amended by SBREFA, EPA

has determined that it is not necessary to prepare a regulatory flexibility analysis in connection with this direct final rule. EPA has also determined that this rule will not have a significant economic impact on a substantial number of small entities. Because of the limited classes of aircraft engines to which today's regulations apply, no small entities are affected.

#### **X. Submission to Congress and the General Accounting Office**

Under 5 U.S.C. 801(a)(1)(A) as added by the Small Business Regulatory Enforcement Act of 1996, EPA submitted a report containing this rule and other required information to the U.S. Senate, the U.S. House of Representatives, and the Comptroller General of the General Accounting Office prior to the publication of the rule in today's **Federal Register**. This rule is not a "major rule" as defined by 5 U.S.C. 804(2).

#### **XI. Unfunded Mandates**

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA), P.L. 104-4, establishes requirements for Federal agencies to assess the effects of their regulatory actions on State, local, and tribal governments and the private sector. Under section 202 of the UMRA, EPA generally must prepare a written statement, including a cost-benefit analysis, for proposed and final rules with "Federal mandates" that may result in expenditures to State, local, and tribal governments, in the aggregate, or to the private sector, of \$100 million or more in any one year. Before promulgating an EPA rule for which a written statement is needed, section 205 of the UMRA generally requires EPA to identify and consider a reasonable number of regulatory alternatives and adopt the least costly, most cost-effective or least burdensome alternative that achieves the objectives of the rule. The provisions of section 205 do not apply when they are inconsistent with applicable law. Moreover, section 205 allows EPA to adopt an alternative other than the least costly, most cost-effective or least burdensome alternative if the Administrator publishes with the final rule an explanation why that alternative was not adopted. Before EPA establishes any regulatory requirements that may significantly or uniquely affect small governments, including tribal governments, it must have developed under section 203 of the UMRA a small government agency plan. The plan must provide for notifying potentially affected small governments, enabling officials of affected small governments to have meaningful and timely input in

the development of EPA regulatory proposals with significant Federal intergovernmental mandates, and informing, educating, and advising small governments on compliance with the regulatory requirements.

EPA has determined that this rule does not contain a Federal mandate that may result in expenditure of \$100 million or more for State, local, or tribal governments, in the aggregate or the private sector in any one year. As a result of the ICAO standards, all aircraft engines covered by today's rule already meet the promulgated standards or will do so by the time the standards will go into effect. Thus, the annual effect on the economy of today's promulgated standards will be minimal. Thus, today's rule is not subject to the requirements of sections 202 and 205 of the UMRA.

#### **XII. Paperwork Reduction Act**

This rule does not itself impose any reporting or recordkeeping requirements. Any reporting and recordkeeping requirements associated with these standards will be defined by the Secretary of Transportation in enforcement regulations issued later under the provisions of section 232 of the Clean Air Act. Since most if not all manufacturers already measure CO and NO<sub>x</sub> and report the results to the FAA, any additional reporting and record keeping requirements associated with FAA enforcement of these regulations are likely to be very small.

#### **List of Subjects in 40 CFR Part 87**

Environmental protection, Incorporation by reference, Aircraft engines.

Dated: April 29, 1997.

**Carol M. Browner,**  
*Administrator.*

40 CFR Part 87 is amended as follows:

#### **PART 87—CONTROL OF AIR POLLUTION FROM AIRCRAFT AND AIRCRAFT ENGINES**

1. The authority citation for part 87 continues to read as follows:

**Authority:** Secs. 231, 301(a), Clean Air Act, as amended (42 U.S.C 7571, 7601(a)).

#### **Subpart A—General Provisions**

2. Section 87.1 is amended by revising the definition of "Class TF" in paragraph (a) to read as follows:

##### **§ 87.1 Definitions.**

(a) \* \* \*

*Class TF* means all turbofan or turbojet aircraft engines or aircraft engines designed for applications that

otherwise would have been fulfilled by turbojet and turbofan engines except engines of class T3, T8, and TSS.

\* \* \* \* \*

3. Section 87.2 is amended by adding the following abbreviations in alphabetical order to read as follows:

##### **§ 87.2 Abbreviations.**

\* \* \* \* \*

CO Carbon Monoxide.

\* \* \* \* \*

NO<sub>x</sub> Oxides of nitrogen.

\* \* \* \* \*

#### **Subpart C—Exhaust Emissions (New Aircraft Gas Turbine Engines)**

4. Section 87.21 is amended by revising the paragraphs (d), (d)(1), and (e)(3) to read as follows:

##### **§ 87.21 Standards for exhaust emissions.**

\* \* \* \* \*

(d) Gaseous exhaust emissions from each new commercial aircraft gas turbine engine shall not exceed:

(1) Classes TF, T3, T8 engines greater than 26.7 kilonewtons rated output:

(i) Engines manufactured on or after January 1, 1984:

Hydrocarbons: 19.6 grams/kilonewton rO.

(ii) Engines manufactured on or after July 7, 1997.

Carbon Monoxide: 118 grams/kilonewton rO.

(iii) 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(rPR)) grams/kilonewtons rO.

(iv) 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(rPR)) grams/kilonewtons rO.

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

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

Hydrocarbons=140(0.92)<sup>rPR</sup> grams/kilonewtons rO.

(e) \* \* \*

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

SN=187(ro) <sup>-0.168</sup> (ro is in kilowatts)

\* \* \* \* \*

### Subpart G—Test Procedures for Engine Exhaust Gaseous Emissions (Aircraft and Aircraft Gas Turbine Engines)

5. Section 87.60 is amended by revising paragraph (c) to read as follows:

#### § 87.60 Introduction.

\* \* \* \* \*

(c) The exhaust emission test is designed to measure hydrocarbons, carbon monoxide, carbon dioxide, and oxides of nitrogen concentrations, and to determine mass emissions through calculations during a simulated aircraft landing-takeoff cycle (LTO). The LTO cycle is based on time in mode data during high activity periods at major airports. The test for propulsion engines consists of at least the following four modes of engine operation: taxi/idle, takeoff, climbout, and approach. The mass emission for the modes are combined to yield the reported values.

\* \* \* \* \*

6. Section 87.61 is revised to read as follows:

#### § 87.61 Turbine fuel specifications.

For exhaust emission testing, fuel meeting the specifications listed in this section shall be used. Additives used for the purpose of smoke suppression (such as organometallic compounds) shall not be present.

#### *Property and Allowable Range of Values*

Density kg/m<sup>3</sup> at 15 °C: 780–820.

Distillation temperature, °C: 10%

boiling point, 155–201; final boiling point, 235–285.

Net heat of combustion, MJ/kg: 42.86–43.50.

Aromatics, volume %: 15–23.

Naphthalenes, volume %: 1.0–3.5.

Smoke point, mm: 20–28.

Hydrogen, mass %: 13.4–14.1.

Sulfur, mass %: less than 0.3%.

Kinematic viscosity at –20 °C, mm<sup>2</sup>/s: 2.5–6.5.

7. Section 87.62 is amended by revising paragraph (a)(2) to read as follows:

#### § 87.62 Test procedure (propulsion engines).

(a) \* \* \*

(2) The taxi/idle operating modes shall be carried out at a power setting of 7% rated thrust unless the Secretary determines that the unique characteristics of an engine model undergoing certification testing at 7% would result in substantially different HC and CO emissions than if the engine model were tested at the manufacturers

recommended idle power setting. In such cases the Secretary shall specify an alternative test condition.

\* \* \* \* \*

8. Section 87.64 is revised to read as follows:

#### § 87.64 Sampling and analytical procedures for measuring gaseous exhaust emissions.

The system and procedures for sampling and measurement of gaseous emissions shall be as specified by Appendices 3 and 5 to International Civil Aviation Organization (ICAO) Annex 16, Environmental Protection, Volume II, Aircraft Engine Emissions, Second Edition, July 1993, which are incorporated herein by reference. This incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. These materials are incorporated as they exist on the date of the approval and a notice of any change in these materials will be published in the **Federal Register**. Frequent changes are not anticipated. Copies may be inspected at U.S. EPA, OAR, 401 M Street, Southwest, Washington, DC 20460, or at the Office of the Federal Register, 800 North Capitol Street, NW., suite 700, Washington DC. Copies of this document can be obtained from the International Civil Aviation Organization (ICAO), Document Sales Unit, P.O. Box 400, Succursale: Place de L'Aviation Internationale, 1000 Sherbrooke Street West, Suite 400, Montreal, Quebec, Canada H3A 2R2.

9. Section 87.71 is revised to read as follows:

#### § 87.71 Compliance with gaseous emission standards.

Compliance with each gaseous emission standard by an aircraft engine shall be determined by comparing the pollutant level in grams/kilowatt/thrust/cycle or grams/kilowatt/cycle as calculated in § 87.64 with the applicable emission standard under this part. An acceptable alternative to testing every engine is described in Appendix 6 to International Civil Aviation Organization (ICAO) Annex 16, Environmental Protection, Volume II, Aircraft Engine Emissions, Second Edition, July 1993, which is incorporated herein by reference. This incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. These materials are incorporated as they exist on the date of the approval and a notice of any change in these materials will be published in the **Federal Register**.

Frequent changes are not anticipated. Copies may be inspected at U.S. EPA, OAR, 401 M Street, Southwest, Washington, DC 20460, or at the Office of the Federal Register, 800 North Capitol Street, NW., suite 700, Washington, DC. Copies of this document can be obtained from the International Civil Aviation Organization (ICAO), Document Sales Unit, P.O. Box 400, Succursale: Place de L'Aviation Internationale, 1000 Sherbrooke Street West, Suite 400, Montreal, Quebec, Canada H3A 2R2. Other methods of demonstrating compliance may be approved by the Secretary with the concurrence of the Administrator.

10. Section 87.82 is revised to read as follows:

#### § 87.82 Sampling and analytical procedures for measuring smoke exhaust emissions.

The system and procedures for sampling and measurement of smoke emissions shall be as specified by Appendix 2 to International Civil Aviation Organization (ICAO) Annex 16, Volume II, Environmental Protection, Aircraft Engine Emissions, Second Edition, July 1993, which are incorporated herein by reference. This incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. These materials are incorporated as they exist on the date of the approval and a notice of any change in these materials will be published in the **Federal Register**. Frequent changes are not anticipated. Copies may be inspected at U.S. EPA, OAR, 401 M Street, Southwest, Washington, DC 20460, or at the Office of the Federal Register, 800 North Capitol Street, NW., suite 700, Washington, DC. Copies of this document can be obtained from the International Civil Aviation Organization (ICAO), Document Sales Unit, P.O. Box 400, Succursale: Place de L'Aviation Internationale, 1000 Sherbrooke Street West, Suite 400, Montreal, Quebec, Canada H3A 2R2.

11. Section 87.89 is revised to read as follows:

#### § 87.89 Compliance with smoke emission standards.

Compliance with each smoke emission standard shall be determined by comparing the plot of SN as a function of power setting with the applicable emission standard under this part. The SN at every power setting must be such that there is a high degree of confidence that the standard will not be exceeded by any engine of the model

being tested. An acceptable alternative to testing every engine is described in Appendix 6 to International Civil Aviation Organization (ICAO) Annex 16, Environmental Protection, Volume II, Aircraft Engine Emissions, Second Edition, July 1993, which is incorporated herein by reference. This incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. These materials are incorporated as they exist on the date of the approval and a notice of any change in these materials will be published in the **Federal Register**.

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