In conclusion, EPA seeks comment on whether a CO_2 emissions backstop is an appropriate complement to a footprint-based regulatory approach under the CAA to ensure that the program would achieve a minimum level of feasible carbon dioxide emissions reductions. EPA invites comments on both the potential backstop approaches discussed above, as well as suggestions for other approaches.

iii. Potential Test Procedures for Light-Duty Vehicle Tailpipe CO_2 Emissions

For the program options EPA analyzed to date, EPA would expect manufacturers and EPA to measure CO_2 for certification and compliance purposes over the same test procedures currently used for measuring fuel economy, except for A/C-related CO_2 emissions. This corresponds with the data used in our analysis of the potential footprint-based CO_2 standards presented in section VI.B.1.b of this advance notice, as the data on control technology efficiency was also developed in reference to these test procedures. These procedures are the Federal Test Procedure (FTP or ''city'' test) and the Highway Fuel Economy Test (HFET or ''highway'' test). EPA established the FTP for emissions measurement in the early 1970s. In 1976, in response to requirements in the Energy Policy and Conservation Act (EPCA), EPA extended the use of the FTP to fuel economy measurement and added the HFET. The provisions in the 1976 regulation, effective with the 1977 model year, established procedures to calculate fuel economy values both for labeling and for CAFE purposes. Under EPCA, EPA is required to use these procedures (or procedures which yield comparable results) for measuring fuel economy for cars for CAFE purposes, but not for fuel economy labeling purposes. EPCA does not impose this requirement on CAFE test procedures for light trucks, but EPA does use the FTP and HFET for this purpose.

On December 27, 2006, EPA established new ''5-cycle'' test procedures for fuel economy labeling—the information provided to the car-buying public to assist in making fuel economy comparisons from vehicle to vehicle. These procedures were originally developed for purposes of criteria emissions testing, not fuel economy labeling, pursuant to section 206(h) of the Clean Air Act, which requires EPA to review and revise as necessary test procedures for motor vehicles and motor vehicle engines ''to insure that vehicles are tested under circumstances which reflect the actual current driving conditions under which motor vehicles are used.'' In updating the fuel economy labeling regulations, EPA determined that these emissions test procedures take into account several important factors that affect fuel economy in the real world but are missing from the FTP and HFET tests. Key among these factors are high speeds, aggressive accelerations and decelerations, the use of air conditioning, and operation in cold temperatures. Consistent with section 206 (h), EPA revised its procedures for calculating the label estimates so that the miles per gallon (mpg) estimates for passenger cars and light-duty trucks would better reflect what consumers achieve in the real world. Under the new methods, the city miles per gallon estimates for the manufacturers of most vehicles have dropped by about 12% on average relative to the previous estimates, with estimates for some vehicles dropping by as much as 30%. The highway mpg estimates for most vehicles dropped on average by about 8%, with some estimates dropping by as much as 25% relative to the previous estimates. The new test procedures only affect EPA's vehicle fuel economy labeling program and do not affect fuel economy measurements for the CAFE standards, which continue to be based on the original 2-cycle test procedures (FTP/HFET).

EPA continues to believe that the new 5-cycle test procedures more accurately predict in-use fuel economy than the 2-cycle test procedures. Although, as explained below, to date there has been insufficient information to develop standards based on 5-cycle test procedures, such information could be developed and there is no legal constraint in the CAA to developing such standards. Indeed, section 206(h) provides support for such an approach. Now that automotive manufacturers are using the 5-cycle test procedure for labeling purposes, we anticipate significant amount of data regarding the impact of the 5-cycle test on vehicle CO_2 emissions will be made available to the Agency over the next several years.

However, for the programs analyzed in the Light-duty Vehicle TSD, EPA used the original 2-cycle test. Indeed, data were simply lacking for the efficiencies of most fuel economy control measures as measured by 5-cycle tests. Thus, existing feasibility studies and analyses, such as the 2002 National Academy of Sciences (NAS) and the 2004 Northeast States Center for a Clean Air Future (NESCCAF) studies that examined technologies to reduce CO_2, were based on the 2-cycle test procedures. However, as noted above, we expect that new data regarding the 5-cycle test procedures will be made available and could be considered in future analysis.

It is important to note, however, that all of our benefits inputs, modeling and environmental analyses underlying the potential programs analyzed in the Light-duty Vehicle TSD accounted for the difference between emissions levels as measured by the 2-cycle test and the levels more likely to actually be achieved in real world performance. Thus, EPA applied a 20% conversion factor (2-cycle emissions result divided by 0.8) to convert industry-wide 2-cycle CO_2 emissions test values to real world CO_2 emissions factors. EPA used this industry-wide conversion factor for all of its emission reduction estimates, and calculated such important values as overall emission reductions, overall benefits, and overall cost-effectiveness using these corrected values. In reality, this conversion factor is not uniform across all vehicles. For example, the conversion factor is greater than 20% for vehicles with higher fuel economy/lower CO_2 values and is less than 20% for vehicles with lower fuel economy/higher CO_2 values. But to simplify the technology feasibility analysis, the analysis assumed a uniform conversion factor of 20% for all vehicles. EPA does not believe the overall difference would have a significant effect on the standards because the errors on either side of 20% tend to offset one another.

EPA thus analyzed CO_2 standards based on the 2-cycle test procedures for our analysis to date. EPA would expect to continue to gain additional experience and data on the 5-cycle test procedures used in the labeling program. If EPA determined that analyzing potential CO_2 standards based on these test procedures would result in more robust control of those emissions, we would consider this in future analyses. EPA requests comments on the above test procedure issues, and the relative importance of using the 2-cycle versus the 5-cycle test in any future EPA action to establish standards for light-duty vehicle tailpipe CO_2 emissions.

2. Heavy-Duty Trucks

Like light-duty vehicles, EPA's regulatory authority to address pollution from heavy-duty trucks comes from section 202 of the CAA. The Agency first exercised this responsibility for heavy-duty trucks in 1974. Since that time, heavy-duty truck and diesel engine technologies have continued to improve, and the Agency has set increasingly stringent emissions standards (today's diesel engines are 98% cleaner than those from 1974). Over that same period, freight shipment by heavy-duty trucks has more than doubled. Goods shipped solely by truck account for 74% of the value of all commodities shipped within the United States. Trucked freight is projected to double again over the next two decades, growing from 11.5 billion tons in 2002 to over 22.8 billion tons in 2035.[139] Total truck GHG emissions are expected to grow with this increase in freight.

Reflecting important distinctions between light and heavy-duty vehicles, section 202 gives EPA additional guidelines for heavy-duty vehicle regulations for certain pollutants, including defined regulatory lead time criteria and authority to address heavy-duty engine rebuild practices. The Agency has further used the discretion provided in the CAA to develop regulatory programs for heavy-duty vehicles that reflect their primary function. Key differences between our light-duty and heavy-duty programs include vehicle standards for cars versus engine standards for heavy-duty trucks, gram per distance (mile) standards for cars versus gram per work (brake horsepower-hour) for trucks, and vehicle test procedures for cars versus engine-based tests for trucks. EPA has thus determined that in the heavy-duty sector, the appropriate metric to evaluate performance is per unit of work and that engine design plays a critical role in controlling criteria pollutant emissions. EPA's rules also reflect the nature of the heavy-duty industry with separate engine and truck manufacturers. As EPA considers the best way to address GHG emissions from the heavy-duty sector, we will again be considering the important ways that heavy-duty vehicles differ from light-duty vehicles.

In this section, we will characterize the heavy-duty GHG emissions inventory, broadly discuss the technologies available in the near- and long-term to reduce heavy-duty truck GHG emissions, and discuss potential regulatory options to address these emissions. We invite comment on the issues that are relevant to considering potential GHG emission standards for heavy-duty trucks. In particular, we invite commenters to compare and contrast potential heavy-duty solutions to our earlier discussion of light-duty vehicles and our existing heavy-duty criteria pollutant control program in light of the differences between GHG emissions and traditional criteria air pollutants.

a. Heavy-Duty Truck GHG Emissions

Heavy-duty on-road vehicles emitted 401 million metric tons of CO_2 emissions in 2006, or approximately 19% of the mobile source CO_2 emissions, the largest mobile source sub-category after light-duty vehicles.[140] CO_2 emissions from these vehicles are expected to increase significantly in the future, by approximately 29% between 2006 and 2030.[141]

Diesel powered trucks comprise 91% of the heavy-duty CO_2 emissions, with the remaining 9% coming from gasoline and natural gas engines. Heavy-duty GHG emissions come primarily from two types of applications, combination and single unit trucks. Combination trucks constitute 75% of the total heavy-duty GHG emissions—44% from long-haul and 31% from short-haul operations. Short-haul single unit trucks are the third largest source at 19%. The remaining 5% consists of long-haul single unit trucks; intercity, school, and transit buses; refuse trucks, and motor home emissions.[142]

GHG emissions from heavy-duty trucks are dominated by CO_2 emissions, which comprise approximately 99% of the total, while hydrofluorocarbon and N_2O emissions represent 0.5% and 0.3%, respectively, of the total emissions on a CO_2 equivalent basis.

b. Potential for GHG Emissions Reductions From Heavy-Duty Trucks

Based on the work from EPA's SmartWay Transport Partnership and the 21st Century Truck Partnership, we see a potential for up to a 40% reduction in GHG emissions from a typical heavy-duty truck in the 2015 timeframe, with greater reductions possible looking beyond 2015, through improvements in truck and engine technologies.[143] While highly effective criteria pollutant control has been realized based on engine system regulation alone, the following sections make clear that GHG emissions improvements to truck technology provide a greater potential for overall GHG emission reductions from this sector.

In this section, we will provide a brief summary of the potential for GHG emission reductions in terms of engine technology, truck technology and changes to fleet operations. The public docket for this Advance Notice includes a technical memorandum from EPA staff summarizing this potential in greater detail.[144] In discussing the potential for CO_2 emission reductions, it can be helpful to think of work flow through a truck's system. The initial work input is fuel. Each gallon of diesel fuel has the potential to produce some amount of work and will produce a set amount of CO_2 (about 22 lbs. of CO_2 per gallon of diesel fuel). The engine converts the chemical energy in the fuel to useable work to move the truck. Any reductions in work demanded of the engine by the vehicle or improvements in engine fuel conversion efficiency will lead directly to CO_2 emission reductions. Current diesel engines are about 35% efficient over a range of operating conditions with peak efficiency levels of a little over 40%. This means that approximately one-third of the fuel's chemical energy is converted to useful work and two-thirds is lost to waste heat in the coolant and exhaust. In turn, the truck uses this work output from the engine to overcome vehicle aerodynamic drag (53%), tire rolling resistance (32%), and friction in the vehicle driveline (6%) and to provide auxiliary power for components such as air conditioning and lights (9%).[145] While it may be intuitive to look first to the engine for CO_2 reductions given that only about one-third of the fuel is converted to useable work, it is important to realize that any improvement in vehicle efficiency reduces both the work demanded and also the energy wasted in proportional amounts.

In evaluating the potential to reduce GHG emissions from trucks and operations as a whole, it will be important to develop an appropriate metric to quantify GHG emission reductions. As discussed above, our current heavy-duty regulatory programs measure emissions expressed on a mass per work basis (g/bhp-hr). This approach has proven highly effective at controlling criteria pollutant emissions while normalizing the diverse range of

[139] Government Accountability Office. *Freight Transportation: National Policy and Strategies Can Help Improve Freight Mobility* GAO–08–287. Report to the Ranking Member, Committee on Environment and Public Works, U.S. Senate. January 2008.

[140] Emissions data in this section are from the United States Environmental Protection Agency. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006*. EPA 430–R–08–005. April 2008.

[141] Growth data in this section is from United States Department of Energy, Energy Information Administration. *Annual Energy Outlook 2008*. #DOE/EIA–0383. April 2008.

[142] Breakdown of emissions data in this section is from United States Environmental Protection Agency. MOVES model. April 8, 2008.

[143] 21st Century Truck Partnership. *Technology Roadmap for the 21st Century Truck Program*. 21CT–001. December 2000. *http://www.doe.gov/bridge*.

[144] Summary of GHG Emission Control Technologies for Heavy-Duty Trucks, Memorandum to Docket XXX, May 2008.

[145] Approximate truck losses at 65 mph from 21st Century Truck Partnership. 21st Century Truck Partnership Roadmap/Technical White Papers: Engine Systems. 21CT–003. December 2006. *http://www.doe.gov/bridge*.

heavy-duty vehicle applications to a single engine-based test metric. While such an approach could be applied to evaluate CO_2 emission reductions from heavy-duty engines, it would not readily provide a mechanism to measure and compare reductions due to vehicle improvements. Hence, we will need to consider other performance metrics such as GHG emissions per ton-mile. We request comment on what types of metrics EPA should consider to measure and express GHG emission rates from heavy-duty trucks.

We discuss below the wide range of engine, vehicle, and operational technologies available to reduce GHG emissions from heavy-duty trucks. Our discussion broadly assesses the availability of these technologies and their GHG emissions reduction potential. We request comment on all aspects of our current assessment summarized here and in more detail in our technical memorandum, including supporting data with regard to technology costs, GHG reduction effectiveness, the appropriate GHG metric to evaluate the technology and the timeframe in which these technologies could be brought into the truck market. More generally, we request comment on the overall GHG emissions reductions that can be achieved by heavy-duty trucks in the 2015 and 2030 timeframes.

i. Engine

The majority of heavy-duty vehicles today utilize turbocharged diesel engines. Diesel engines are more efficient compared to gasoline engines due to the use of higher compression ratios, the ability to run with lean air-fuel mixtures, and the ability to run without a throttle for load control. Modern diesel engines have a peak thermal efficiency of approximately 42%, compared to gasoline engines that have a peak thermal efficiency of 30%. Turbochargers increase the engine's power-to-weight ratio and recover some of the exhaust heat energy to improve the net efficiency of the engine.

Additional engine improvements could increase efficiency through combustion improvements and reductions of parasitic and pumping losses. Increased cylinder pressure, waste heat recovery, and low viscosity lubricants could reduce CO_2 emissions, but are not widely utilized in the heavy-duty industry. Individual improvements have a small impact on engine efficiency, but a combination of approaches could increase efficiency by 20% to achieve a peak engine efficiency of approximately 50%.[146]

Waste heat recovery technologies, such as Rankine bottoming cycle, turbocompounding and thermoelectric materials, can recover and convert engine waste heat to useful energy, leading to improvements in the overall engine thermal efficiency and consequent reduction in CO_2 emissions. We request comment on the potential of these technologies to lower both GHG emissions and overall heavy-duty vehicle operating costs.

In section VI.D below, we discuss the Renewable Fuel Standard (RFS) program and more broadly the overall role of fuel changes to reduce GHG emissions. As we have previously noted, the Agency has addressed vehicle emissions through a systems-based approach that integrates consideration of fuel quality and vehicle or engine emission control systems. For example, removing lead from gasoline and sulfur from diesel fuel has enabled the introduction of very clean gasoline and diesel engine emission control technologies. A systems approach may be a means to address GHG emissions as well. Since 1989, European engine maker Scania has offered an ethanol powered heavy-duty diesel cycle engine with traditional diesel engine fuel efficiency (the current version offers peak thermal efficiency of 43%).[147] Depending on the ethanol production pathway, such an approach could offer a significant reduction in GHG emissions from a life cycle perspective when compared to more traditional diesel fuels. We request comment on the potential for a systems approach considering alternate fuel and engine technologies to reduce GHG emission from heavy-duty trucks. We also request comment on how EPA might structure a program to appropriately reflect the potential for such GHG emission reductions.

ii. Vehicle systems

An energy audit of heavy-duty trucks shows that vehicle efficiency is strongly influenced by systems outside of the engine. As noted above, aerodynamics, tire rolling resistance, drivetrain, and weight are areas where technology improvements can significantly reduce GHG emissions through reduced energy losses. The fuel savings benefits of many of these technologies often offset the additional costs. Opportunities for HFC and additional CO_2 reductions are available through improved air conditioning systems.

For a typical combination tractor-trailer truck traveling at 65 mph, energy losses due to aerodynamic drag can total over 21% of the total energy consumed.[148] A recent study between industry and the federal government demonstrated that reducing the tractor-trailer gap and adding trailer side skirts, trailer boat tails, and aerodynamic mirrors can reduce aerodynamic drag by as much as 23%. If aerodynamic drag were reduced from 21% to 15% (a 23% reduction), GHG emissions at 65 mph would be reduced by almost 12%.[149] The cost of aerodynamic equipment installed on a new or existing trailer is generally paid back within two years.[150] As aerodynamic designs become more sophisticated, more consistency in how aerodynamics is measured is needed. There is no single, consistent approach used by industry to measure the coefficient of aerodynamic drag of heavy trucks. As a result, it is difficult for fleets to understand which truck configurations have the lowest aerodynamic drag. We request comment on the best approach to evaluate aerodynamic drag and the impact of aerodynamic drag on truck GHG emissions.

For a typical combination tractor-trailer truck traveling at 65 mph, energy losses due to tire rolling resistance can total nearly 13% of the total energy consumed.[151] Approximately 80–95% of the energy losses from rolling resistance occur as the tire flexes and deforms when it meets the road surface, due to viscoelastic heat dissipation in the rubber. For heavy trucks, a 10% reduction in rolling resistance can reduce GHG emissions by 1–3%.[152] Improvements of this magnitude and greater have already been demonstrated, and continued innovation in tire design

[146] 21st Century Truck Partnership. 21st Century Truck Partnership Roadmap/Technical White Papers: Engine Systems. 21CT–003. December 2006. *http://www.doe.gov/bridge*.

[147] Green Car Congress. Scania Extending Heavy-Duty Ethanol Engine Technology to Trucks. April 15, 2008. *http://www.greencarcongress.com/2008/04/scania-extendin.html* (April 30, 2008).

[148] 21st Century Truck Partnership. *Technology Roadmap for the 21st Century Truck Program.* 21CT–001. December 2000. *http://www.doe.gov/bridge*.

[149] United States Department of Energy, Lawrence Livermore National Laboratory. Working Group Meeting on Heavy Vehicle Aerodynamic Drag: Presentation, Summary of Contents and Conclusion. UCRL–TR–214683. May 2005.

[150] Bachman, L. Joseph,; Anthony Erb; Cheryl Bynum. Effect of Single Wide Tires and Trailer Aerodynamics on Fuel Economy and NO_x Emissions of Class 8 Line-Haul Tractor-Trailers. SAE Paper 2005–01–3551. 2005.

[151] 21st Century Truck Partnership. *Technology Roadmap for the 21st Century Truck Program.* 21CT–001. December 2000. http://www.doe.gov/bridge.

[152] 21st Century Truck Partnership. *Technology Roadmap for the 21st Century Truck Program. 21CT–001.* December 2000. http://www.doe.gov/bridge.

has the potential to achieve even larger improvements in the future. Specifying single wide tires on a new combination truck can have a lower initial cost and lead to immediate fuel savings.[153] Despite the well-understood benefits of lower rolling resistance tires, manufacturers differ in how they assess tire rolling resistance. We seek comment on the potential for low rolling resistance tires to lower GHG emissions, the need for consistent protocols to measure tire rolling resistance, and the need for a common ranking or rating system to provide tire rolling resistance information to the trucking industry.

Hybrid technologies, both electric and hydraulic, offer significant GHG reduction potential. The hybrid powertrain is a combination of two or more power sources: an internal combustion engine and a second power source with an energy storage and recovery device. Trucks operating under stop-and-go conditions, such as urban delivery trucks and refuse trucks, lose a significant amount of energy during braking. In addition, engines in most applications are designed to perform under a wide range of requirements and are often oversized for the majority of their requirements. Hybrid powertrain technologies offer opportunities to capture braking losses and downsize the engine for more efficient operation. We invite comment on the potential of GHG reductions from hybrids in all types of heavy-duty applications.

Currently most truck auxiliaries, such as the water pump, power steering pump, air conditioning compressor, air compressor and cooling fans, are mechanical systems typically driven by belts or gears off of the engine driveshaft. The auxiliary systems are inefficient because they produce power proportionate to the engine speed regardless of the actual vehicle requirements and require conversion of fuel energy to electrical or mechanical work. If systems were driven by electrical systems they could be optimized for actual requirements and reduced energy consumption. We request comment on the potential for these auxiliary systems to lower GHG emissions from heavy-duty trucks.

Air conditioning systems are responsible for GHG emissions from refrigerant leakage and from the exhaust emissions generated by the engine to produce the load required to run the air conditioning. The emissions due to leakage can be reduced by the use of improved sealing designs, low-permeation hoses, and refrigerant substitution. Replacing today's refrigerant, HFC–134a, which has a high global warming potential (GWP=1,300), with HFC–152a (GWP=120) or CO_2 (GWP=1) reduces the impact of the air conditioning leakage on the environment.[154] The load requirements of the air conditioning system can be reduced through the use of improved condensers, evaporators, and variable displacement compressors. We request comment on the impact of air conditioning improvements on GHG reductions in heavy-duty trucks.

iii. Operational

The operation of the truck, including idle time and vehicle speed, also has significant impact on the GHG emissions. Technologies that improve truck operation exist and provide benefits to owners through reduced fuel costs.

Idling trucks emit a significant amount of CO_2 emissions (as well as criteria pollutants). On average, a typical truck will emit 18 pounds of CO_2 per hour of idling.[155] Long haul truck idle reduction technologies can reduce main engine idling while still meeting cab comfort needs. Some idle reduction technologies have no upfront cost for the truck owner and hence represent an immediate savings in operating costs with lower GHG emissions. Other idle reduction technologies pay back within three years.[156] In addition to providing information about these systems, EPA seeks comment on whether it should work with stakeholders to develop a formal evaluation protocol for the effectiveness, cost, durability, and operability of various idle-reduction technologies.

Vehicle speed is the single largest operational factor affecting CO_2 emissions from large trucks. A general rule of thumb is that every mph increase above 55 mph increases CO_2 emissions by more than 1%. Speed limiters are generally available on new trucks or as a low-cost retrofit, and assuming a five mph decrease in speed, payback occurs within a few months.[157]

Automatic tire inflation systems maintain proper inflation pressure, and thereby reduce tire rolling resistance. Studies indicate that automatic tire inflation systems result in about 0.5 to 1% reduction of CO_2 emissions for a typical truckload or less-than-truckload over-the-road trucking fleet.[158] Automatic tire inflation systems can pay back in less than four years, assuming typical underinflation rates.

All of the technologies summarized here can provide real GHG reductions while providing value to the truck owner through reduced fuel consumption. We request comment on the potential of these specific technologies and on any other technologies that may allow vehicle operators to reduce overall GHG emissions.

c. Regulatory Options for Reducing GHGs From Heavy-Duty Trucks

In developing any GHG program for heavy-duty vehicles, we would rely on our past experience addressing the multifaceted characteristics of this sector. In the following sections, we discuss three potential regulatory approaches for reducing GHG emissions from the heavy-duty sector. We request comments on all aspects of these options. We also encourage commenters to suggest other approaches that EPA should consider to address GHG emissions from heavy-duty trucks, recognizing that there are some important differences between criteria air pollutants and GHG emissions.

The heavy-duty engine manufacturers have made great strides in reducing criteria pollutant emissions. We know these same manufacturers have already achieved GHG emission reductions through the introduction of more efficient engine technologies, and have the potential to realize even greater reductions. We estimate that approximately 30% of the overall GHG emission reduction potential from this sector comes from engine improvements, 60% from truck improvements, and 10% from operational improvements based on the technologies outlined in the 21st Century Truck roadmap and *Best Practices Guidebook for GHG Emissions Reductions in Freight Transportation*. We request comment on our assessment

[153] United States Environmental Protection Agency. *A Glance at Clean Freight Strategies: Single Wide-Based Tires.* EPA420–F–04–004. February 2004.

[154] Frey, H. Christopher and Po-Yao Kuo. Best Practices Guidebook for GHG Emissions Reductions in Freight Transportation. Prepared for U.S. Department of Transportation via Center for Transportation and the Environment. October 2007. Pages 26–27.

[155] United States Environmental Protection Agency. *A Glance at Clean Freight Strategies: Idle Reduction.* EPA420–F–04–009. February 2004.

[156] EPA SmartWay Transport Partnership, *Technology Package Savings Calculator, http://www.epa.gov/smartway/calculator/loancalc.htm.*

[157] American Trucking Associations *Petition to National Highway Traffic Safety Administration*, (Docket NHTSA–2007–26851, Document ID NHTSA–2007–26851–0005), October 20, 2006, and American Trucking Associations Comment to Docket (Docket NHTSA–2007–26851, Document ID NHTSA–2007–26851–3708), March 27, 2007.

[158] mission reduction and payback information from United States Environmental Protection Agency. *A Glance at Clean Freight Strategies: Automatic Tire Inflation Systems.* EPA420–F–04–010. February 2004.

of the relative contributions of engine, truck, and operational technologies.

The first approach we could consider would be a regulatory program based on an engine CO_2 standard or weighted GHG standard including N_2O and methane. One advantage to this option is its simplicity because it preserves the current regulatory and market structures. The heavy-duty engine manufacturers are familiar with today's certification testing and procedures. They have facilities, engine dynamometers, and test equipment to appropriately measure emissions. The same equipment and test procedures can be, and already are, used to measure CO_2 emissions. Measuring and reporting N_2O and methane emissions would require relatively simple additions to existing test cell instrumentation. We request comment regarding issues that EPA should consider in evaluating this option and the most appropriate means to address the issues raised. We recognize that an engine-based regulatory structure would limit the potential GHG emission reductions compared to programs that include vehicle technologies and the crediting of fleets for operational improvements. The other approaches considered below would have the potential to provide greater GHG reductions by providing mechanisms to account for vehicle and fleet operational changes.

Recognizing that GHG emissions could be further reduced through improvements to both engines and trucks, we request comment on an alternative test procedure that would include vehicle aspects in an engine-based standard. This option would still be based on an engine standard. However, it would provide a mechanism to adjust the engine test results to account for improvements in vehicle design. For example, if through an alternate test procedure (e.g., a vehicle chassis test) a hybrid truck were shown to reduce GHG emissions by 20%, under this option an engine based GHG test result could be adjusted downward by that same 20%. In this way, we could reflect a range of vehicle or perhaps even operational changes into an engine based regulatory program. In fact, we are already developing such an approach for a vehicle based change to provide a better mechanism to evaluate criteria emissions from hybrid vehicles.[159] We are currently working with the heavy-duty industry to develop these new alternate test procedures and protocols. These new procedures could provide a foundation for regulatory programs to address GHG emissions as well. We request comment on the potential for alternate test procedures to reflect vehicle technologies in an engine based GHG regulatory program.

A second potential regulatory option for heavy-duty truck GHG emissions would be to follow a model very similar to our current light-duty vehicle test procedures. Each truck model could be required to meet a GHG emissions standard based on a specified drive cycle. The metric for the standard could be either a weighted GHG gram/mile with prescribed test weight and payload or GHG gram/payload ton-mile to recognize that heavy-duty trucks perform work. This option would reflect an important change from our current regulatory approach for most heavy-duty vehicles by direct regulation of trucks (and therefore truck manufacturers) rather than engines.[160] As discussed earlier in this section, we have historically regulated heavy-duty engines rather than vehicles reflecting in part the heavy-duty industry structure and in part the preeminence of engine technology in controlling NO_X and PM emissions. Clearly truck design plays a much more important role in controlling GHG emissions due to significant energy losses through aerodynamic drag and tire rolling resistance, and therefore, this option directly considers the regulation of heavy-duty trucks. We request comment on all aspects of this option including the appropriate test metric, the need to develop new test procedures and potential approaches for grouping heavy-duty vehicles into subcategories for GHG regulatory purposes.

As described earlier, there are a number of technologies and operational changes that heavy-duty fleet operators can implement to reduce both their overall operating costs and their GHG emissions. Therefore, a third regulatory option that could be considered as a complement to those discussed previously would be to allow heavy-duty truck fleets to generate GHG emissions credits for applying technologies to reduce GHG emissions, such as idle reduction, vehicle speed limiters, air conditioning improvements, and improved aerodynamic and tire rolling resistance. In order to credit the use of such technologies, EPA would first need to develop procedures to evaluate the potential for individual technologies to reduce GHGs. Such a procedure could be based on absolute metrics (g/mile or g/ton-mile) or relative metrics (percent reductions). We would further need to address a wide range of complex potential issues including mechanisms to ensure that the reductions are indeed realized in use and that appropriate assurance of such future actions could be provided at the time of certification, which occurs prior to the sale of the new truck. Such a regulatory program could offer a significant opportunity to reward trucking fleets for their good practices while providing regulatory flexibility to help address the great diversity of the heavy-duty vehicle sector. It would not lead to any additional GHG reductions, however, as the credits generated by the fleet operators would be used by the engine or vehicle makers to comply with their standards. We welcome comments on the merits and issues surrounding potential approaches to credit operational and technical changes from heavy-duty fleets to reduce GHG emissions.

In considering the regulatory options available, we are cognizant of the significant burden that could result if these programs were to require testing of every potential engine and vehicle configuration related to its GHG emissions. Therefore, we have been following efforts in Japan to control GHG emissions through a regulatory program that relies in part on engine test data and in part on vehicle modeling simulation. As currently constructed, Japan's heavy-duty fuel efficiency regulation considers engine fuel consumption, transmission type, and final drive ratio in estimating overall GHG emissions. Such a modeling approach may be a worthwhile first step and may be further improved by including techniques to recognize design differences in vehicle aerodynamics, tire rolling resistance, weight, and other factors. We request comment on the appropriateness of combining emissions test data with vehicle modeling results to quantify and regulate GHG emissions. In particular, we welcome comments addressing issues including model precision, equality aspects of model based regulation, and the ability to standardize modeling inputs.

The regulatory approaches that we have laid out in this section reflect incremental steps along a potential path to fully address GHG emissions from this sector. These approaches should not be viewed as discrete options but rather as potential building blocks that could be mixed and matched in an

[159] As discussed in section VI.C.2, we have also applied a similar alternate test procedure approach in our new locomotive standards (see 40 CFR 1033.530(h)).

[160] For some years EPA has allowed gasoline and other non-diesel vehicle manufactures to certify to and comply with a vehicle based standard as compared to en engine based standard, at their option. See, e.g., 40 CFR 86.005–10.

overall control program. Given the potential for significant burden, EPA is also interested in considering how flexibilities such as averaging, banking, and/or credit trading that may help to reduce costs may be built into any of the regulatory options discussed above. We request comment on all of the approaches described in this section and the potential to implement one or more of these approaches in a phased manner to capture the more straightforward approaches in the near-term and the more complex approaches over a longer period.

3. Highway Motorcycles

The U.S. motorcycle fleet encompasses a vast array of types and styles, from small and light scooters with chainsaw-sized engines to large and heavy models with engines as big as those found in many family sedans. In 2006 approximately 850,000 highway motorcycles were sold in the U.S., reflecting a near-quadrupling of sales in the last ten years. Even as motorcycles gain in popularity, their overall GHG emissions remain a relatively small fraction of all mobile source GHG emissions. Most motorcycles are used recreationally and not for daily commuting, and use is seasonally limited in much of the country. For these reasons and the fact that the fleet itself is relatively small, total annual vehicle miles traveled for highway motorcycles is about 9.5 billion miles (as compared to roughly 1.6 trillion miles for passenger cars).[161]

The Federal Highway Administration reports that the average fuel economy for motorcycles in 2003 was 50 mpg, almost twice that of passenger cars in the same time frame. However, motorcycles are generally designed and optimized to achieve maximum performance, not maximum efficiency. As a result, many high-performance motorcycles have fuel economy in the same range as many passenger cars despite the smaller size and weight of motorcycles. Recent EPA emission regulations are expected to reduce fuel use and hence GHG emissions from motorcycles by: (1) Leading manufacturers to increase the use of electronic fuel injection (replacing carburetors); (2) reducing permeation from fuel lines and fuel tanks; and (3) eliminating the use of two-stroke engines in the small scooter category.[162]

There may be additional opportunities for further reductions in GHG emissions. Options available to manufacturers may include incorporating more precise feedback fuel controls; controlling enrichment on cold starts and under load by electronically controlling choke operation; allowing lower idle speeds when the opportunity exists; optimizing spark for fuel and operating conditions through use of a knock sensor; and, like light-duty vehicles, reducing the engine size and incorporating a turbo-charger. The cost of these fuel saving and GHG reducing technologies may be offset by the fuel savings realized over the lifetime of the motorcycle.

We request comment on information on what approaches EPA should consider for potential further reductions in GHG emissions from motorcycles. We also request comment and data regarding what technologies may be applicable to achieve further GHG reductions from motorcycles.

C. Nonroad Sector Sources

As discussed previously, CAA section 213 provides broad authority to regulate emissions from a wide array of nonroad engines and vehicles,[163] while CAA section 211 provides authority to regulate fuels and fuel additives from both on-highway and nonroad sources and CAA section 231 authorizes EPA to establish emissions standards for aircraft. Collectively, the Title II nonroad and fuel regulation programs developed by EPA over the past two decades provide a possible model for how EPA could structure a long-term GHG reduction program for nonroad engines and vehicles, fuels and aircraft.

In this section, we first review and request comment on a number of petitions received by EPA requesting action to regulate GHG emissions from these sources and we highlight the similarities and key issues raised in those petitions. We invite comment on all of the questions and issues raised in these petitions. For each of three primary groupings, nonroad, marine, and aircraft, we then discuss and seek comment on the GHG emissions from these sources and the opportunities to reduce GHG emissions through design and operational changes.

1. Petition Summaries

Since the *Massachusetts* decision, EPA has received seven additional petitions requesting that we make endangerment findings and undertake rulemaking procedures using our authority under CAA sections 211, 213 and 231 to regulate GHG[164] emissions from fuels, nonroad sources, and aircraft. The petitioners represent states, local governments, environmental groups, and nongovernmental organizations (NGO) including the states of California, New Jersey, New Mexico, Friends of the Earth, NRDC, OCEANA, International Center for Technology Assessment, City of New York, and the South Coast Air Quality Management District. Copies of these seven petitions can be found in the docket for this Advance Notice. Following is a brief summary of these petitions. We request comment on all issues raised by the petitioners.

a. Marine Engine and Vessel Petitions

The Agency has received three petitions to reduce GHG emissions from ocean-going vessels (OGVs). California submitted its petition on October 3, 2007. A joint petition was filed on the same day by EarthJustice on behalf of three environmental organizations: Oceana, Friends of the Earth and the Center for Biological Diversity (''Environmental Petitioners''). A third petition was received from the South Coast Air Quality Management District (SCAQMD) on January 10, 2008.

The California petition requests that EPA immediately begin the process to regulate GHG emissions from Category 3 powered OGVs.[165] According to the petition, the Governor of California has already recognized that, ''California is particularly vulnerable to the impacts of climate change,'' including the negative impact of increased temperature on the Sierra snowpack, one of the State's primary sources of water, and the further exacerbation of California's air quality problems.[166] The petition outlines the steps California has already taken to reduce its own contributions to global warming and states that it is petitioning the Administrator to take action to regulate GHG emissions from

[161] ''Highway Statistics 2003,'' U.S. Department of Transportation, Federal Highway Administration, Table VM–1, December 2004.

[162] See 69 FR 2398, January 15, 2004.

[163] The Act does not define ''vehicle'', but we have interpreted section 213 from its inception to include the broad array of equipment, machines, and vessels powered by nonroad engines, including those that are not self-propelled, such as portable power generators. In keeping with common usage, we typically use the generic terms ''equipment'', ''machine'', or ''application'', as well as the more application-specific terms ''vehicle'' and ''vessel'', to refer to these units, as appropriate.

[164] While petitioners vary somewhat in their definition of GHGs, collectively they define carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, water vapor, sulfur hexaflouride, and soot or black carbon as GHGs.

[165] A category 3 vessel is one where the main propulsion engine(s) have a per-cylinder displacement of more than 30 liters.

[166] State of California, Petition for Rulemaking Seeking the Regulation of Greenhouse Gas Emissions from Ocean—Going Vessels, page3, October 3, 2007 (''California Petition'').

OGVs because it believes national controls will be most effective.

California makes three key points in its petition. First, California claims that EPA has clear authority to regulate OGV GHG emissions under CAA section 213(a)(4). The State points out that the ''primary substantive difference'' between CAA section 202(a)(1), which the Supreme Court found authorizes regulation of GHGs emissions from new motor vehicles upon the Administrator making a positive endangerment finding, and section 213 is that section 202(a)(1) requires regulation if such an endangerment finding is made while section 213(a)(4) authorizes, but does not require, EPA to regulate upon making the requisite endangerment finding. But petitioner states that EPA's discretion to decide whether to regulate OGVs under section 213(a)(4) is constrained in light of the overall structure and purpose of the CAA. Citing the *Massachusetts* decision, California asserts that the Supreme Court has ''set clear and narrow limits on the kinds of reasons EPA may advance for declining to regulate significant sources of GHGs''.

The second claim California makes is that international law does not bar regulation of GHG emissions from foreign-flagged vessels by the U.S. California asserts that U.S. laws can operate beyond U.S. borders (referred to as extra-territorial operation of laws) when the conduct being regulated affects the U.S. and where Congress intended such extra-territorial application.[167] Petitioner believes that such application of the CAA is both ''permissible and essential in this case'' because to effectively control GHG emissions from shipping vessels, the EPA must regulate foreign-flagged vessels since they comprise 95% of the fleet calling on U.S. ports.[168] Petitioner cites two other instances where the U.S. has regulated foreign-flagged vessels. First, in *Specto* v. *Norwegian Cruiseline.* 545 U.S. 119 (2005), the Supreme Court held that the Americans with Disabilities Act (ADA) could be applied to foreign-flagged cruise ships that sailed from U.S. ports as long as the required accommodations for disabled passengers did not require major, permanent modification to the ships involved. Second, the National Park Service recently imposed air pollutant emissions controls on cruise ships, including foreign-flagged cruise ships that sail off the coast from Glacier Bay National Park, Alaska. The petitioner points out that in this case they did so to protect and preserve the natural resources of the Park, which is analogous to California's reasons for why EPA must regulate GHG emissions from foreign-flagged vessels.[169]

The third claim raised in California's petition is that technology is currently available to reduce GHG emissions from these vessels, either through NO_X reductions or by reducing fuel consumption. Options include, using marine diesel fuel oil instead of bunker fuel, using selective catalytic reductions and exhaust gas recirculation or by reducing speed. Petitioner states that the Clean Air Act was intended to be a technology-forcing statute and that EPA can and should consider OGV control measures that force the development of new technology.

California requests three forms of relief: (1) That EPA make a finding that carbon dioxide emissions from new marine engines and vessels significantly contribute to air pollution which may reasonably be anticipated to endanger public health and welfare; (2) that EPA use its CAA section 213(a)(4) authority to adopt regulations specifying emissions standards for CO_2 emissions from these engines and vessels; and (3) that EPA adopt regulations specifying fuel content or type necessary to carry out the emission standards adopted for new marine engines.

The second group requesting EPA action on OGVs, Environmental Petitioners, believes that climate change threatens public health and welfare and that marine shipping vessels make a significant contribution to GHG emissions, and that therefore EPA should quickly promulgate regulations requiring OGVs to meet emissions standards by ''operating in a fuel-efficient manner, using cleaner fuels and/or employing technical controls, so as to reduce emissions of carbon dioxide, nitrous oxide, and black carbon.'' These petitioners further state that EPA should also control ''the manufacture and sale of fuels used in marine shipping vessels by imposing fuel standards'' to reduce GHG emissions.[170]

The Environmental Petitioners focus their petition on four specific arguments. First, like California, they assert that OGVs play a significant role in global climate change. They focus on the emissions of four pollutants: CO_2, NO_X, N_20, and black carbon (also known as soot). Petitioners cite numerous studies that they assert document that the impact of these GHG emissions are significant today and that industry trends indicate these emissions will grow substantially in future decades. Second, petitioners lay out a detailed legal argument asserting that EPA has clear authority to regulate these four air pollutants from OGVs, and contending that the *Massachusetts* decision must guide EPA's actions as it decides how to regulate GHG emissions from OGVs. Third, petitioners discuss a number of regulatory measures that can effectively reduce GHG emissions from OGVs and which EPA could adopt using its regulatory authority under CAA section 213(a)(4), including measures requiring restrictions on vessel speed; requiring the use of cleaner fuels in ships and other technical and operations measures petitioners believe are relatively easy and cost-effective. Lastly, petitioners assert that the CAA section 213 provides EPA with clear authority to regulate GHG emissions from both new and remanufactured OGV engines as well as from foreign-flagged vessels.

SCAQMD petition also requests Agency action under section 213 of the CAA and states that it has a strong interest in the regulation of GHG emissions from ships including emissions of NO_X, PM, and CO_2. SCAQMD states that the net global warming effect of NO_X emissions is potentially comparable to the climate effect from ship CO_2 emissions and that PM emissions from ships in the form of black carbon can also increase climate change.[171] Finally, because international shipping activity is increasing yearly, SCAQMD asserts that if EPA dos not act quickly, future ship pollution will become even worse, increasing both ozone and GHG levels in the South Coast area of California. As with other petitioners, SCAQMD states that there is a clear legal basis for EPA to regulate ships GHG emissions under section 213(a)(4).

SCAQMD makes two additional assertions in its petition which mirror the California and Environmental Petitions. First, EPA can avoid regulation of ship GHG emissions only if it determines that ''endangerment'' can be avoided without regulation of ship emissions.[172] Second, SCAQMD believes that EPA has the authority to regulate foreign-flagged vessels under at

[167] Petitioners cite *EEOC* v. *Arabian American Oil Co.,* 499 U.S. 244 (1991) (''Aramco'') as supporting this principle.

[168] California Petition, page 13.

[169] Petitioners cite regulations found at 36 CFR 13.65 (b)(4) and 61 FR 27008, at 27011.

[170] Environmental Petition, Petition for Rulemaking Under the Clean Air Act to Reduce the Emissions of Air Pollutants from Marine Shipping Vessels that Contribute to Global Climate Change, page 2, October 3, 2007.

[171] SCAQMD, Petition for Rulemaking under the Clean Air Act to Reduce Global Warming Pollutants from Ships, page 2, January 10, 2008.

[172] SCAQMD Petition, page 9.

least two circumstances: (1) For a foreign owned and operated vessel, where the regulation(s) would not interfere with matters that ''involve only the internal order and discipline of the vessel,'' *Spector* v. *Norwegian Cruise Lines,* 545 U.S. 119, 131 (2005), and (2) where the vessel is owned and operated by a U.S. corporation, even if it is foreign-flagged.[173]

SCAQMD requests two types of relief: (1) That EPA, within six months of receiving its petition, make a positive endangerment determine for CO_2, NO_X, and black carbon emissions from new marine engines and vessels ''because of their contribution to climate change;'' and (2) that EPA promulgate regulations under CAA section 213 (a)(4) to obtain the maximum feasible reductions in emissions of these pollutants. We invite comment on all elements of the petitioners' assertions and requests.

b. Aircraft Petitions

The Agency has received two petitions to reduce GHG emissions from aircraft.[174] The first petition was submitted on December 4, 2007, by California, Connecticut, New Jersey, New Mexico, Pennsylvania's Department of Environmental Protection, the City of New York, the District of Columbia, and the SCAQMD (''State Petitioners''). A second petition was filed on December 31, 2007, by Earthjustice on behalf of four environmental organizations: Friends of the Earth, Oceana, Center for Biological Diversity and NRDC (''Environmental Petitioners'').

All petitioners request that EPA exercise its authority under section 231(a) of the CAA to regulate GHG emissions from new and existing aircraft and/or aircraft engine operations, after finding that aircraft GHG emissions cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare.[175] Petitioners suggest that these regulations could allow compliance through technological controls, operational measures, emissions fees, or a cap-and-trade system.

Both petitions discuss how aircraft engines emit GHG emissions which they assert have a disproportionate impact on climate change. Petitioners cite a range of scientific documents to support their statements. They assert that ground-level aircraft NO_X, a compound they identify as a GHG, contributes to the formation of ozone, a relatively short-lived GHG. NO_X emissions in the upper troposphere and tropopause, where most aircraft emissions occur, result in greater concentrations of ozone in those regions of the atmosphere compared to ground level ozone formed as a result of ground level aircraft NO_X emissions. Petitioners contend that aircraft emissions contribute to climate change also by modifying cloud cover patterns. Aircraft engines emit water vapor, which petitioners identify as a GHG that can form condensation trails, or ''contrails,'' when released at high altitude. Contrails are visible line shaped clouds composed of ice crystals that form in cold, humid atmospheres. Persistent contrails often evolve and spread into extensive cirrus cloud cover that is indistinguishable from naturally occurring cirrus clouds. The petitioners state that over the long term this contributes to climate change.

State Petitioners highlight the effects climate change will have in California and the City of New York as well as efforts underway in both places to reduce GHG emissions. They argue that without federal government regulation of GHG emissions from aircraft, their efforts at mitigation and adaptation will be undermined. Both petitioners urge quick action by EPA to regulate aircraft GHG emissions since these emissions are anticipated to increase considerably in the coming decades due to a projected growth in air transport both in the United States and worldwide. They cite numerous reports to support this point, including an FAA report, which indicates that by 2025 emissions of CO_2 and NO_X from domestic aircraft are expected to increase by 60%.[176]

We request comment on all issues raised in the petitions, particularly on two assertions made by Environmental Petitioners: (1) That technology is available to reduce GHG emissions from aircraft allowing EPA to take swift action, and (2) that EPA has a mandatory duty to control GHG emissions from aircraft and can fulfill this duty consistent with international law governing aircraft. In addition, we invite comment on the petitioners' assessment of the impact of aircraft GHG emissions on climate change, including the scientific understanding of these impacts, and whether aircraft GHG emissions cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare.

With regard to technology, petitioners highlight existing and developing aviation procedures and technologies which could reduce GHG emissions from new and existing aircraft. For example, they point to various aviation operations and procedures including minimizing engine idling time on runways and employing single engine taxiing that could be undertaken by aircraft to reduce GHG emissions. Petitioners also discuss the availability of more efficient aircraft designs to reduce GHG emissions, such as reducing their weight, and they suggest that using alternative fuels could also reduce aviation GHG emissions.

Environmental Petitioners contend that once EPA makes a positive endangerment finding for aircraft GHG emissions, EPA has a mandatory duty to act, but that the potential regulatory responses available to EPA are quite broad and should be considered for all classes of aircraft, including both new and in-use aircraft and aircraft engines. In addition, petitioners argue that EPA's authority to address GHG emissions from aircraft is consistent with international law-in particular the Convention on International Civil Aviation (the ''Chicago Convention'')—and that the United States'' obligations under the Convention do not constrain EPA's authority to adopt a program that addresses aviation's climate change impacts, including those from foreign aircraft.

The State and Environmental Petitioners each request the following relief: (1) That EPA make an explicit finding under CAA section 231(a)(2)(A) that GHG emissions from aircraft cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare; (2) that EPA propose and adopt standards for GHG emissions from both new and in-use aircraft as soon as possible; (3) that EPA adopt regulations that allow a range of compliance approaches, including emissions limits, operations practices and/or fees, a cap-and-trade system, as well as measures that are more near-

[173] SCAQMD Petition, page10.

[174] While aircraft engines are not ''nonroad engines'' as defined in CAA section 216(10) and aircraft are not ''nonroad vehicles'' as defined in CAA section 216(11), such that aircraft could be subject to regulation under CAA section 213, for organizational efficiency we include aircraft in this ''Nonroad Sector Sources'' section of today's notice.

[175] Petitioners maintain that aircraft engine emissions of CO_2, NO_X, water vapor, carbon monoxide, oxides of sulfur, and other trace components including hydrocarbons such as methane and soot contribute to global warming and that in 2005, aircraft made up 3% of U.S. CO_2 emissions from all sectors, and 12% of such emissions from the transportation sector. States of California *et al*, Petition for Rulemaking Seeking the Regulation of Greenhouse Gas Emissions from Aircraft, page 11, December 4, 2007, and Friends of the Earth *et al.*, Petition for Rulemaking under the Clean Air Act to Reduce the Emissions of Air Pollutants from Aircraft that Contribute to Global Climate Change, pages 6–7, December 31, 2007.

[176] FAA, Office of Environment and Energy, *Aviation and Emission: A Primer,* January 2005, page 10, available at *http://www.faa.gov/regulations_policies/policy_guidance/envir_policy/media/aeprimer.pdf.*

term, such as reduced taxi time or use of ground-side electricity measures. The Environmental Petitioners' also request that EPA issue standards 90 days after proposal. We invite comment on all elements of the petitioners' assertions and requests, as well as the scientific and technical basis for their assertions and requests.

c. Nonroad Engine and Vehicle Petitions

On January 29, 2008, EPA received two petitions to reduce GHG emissions from nonroad engines and vehicles. The first petition was submitted by California, Connecticut, Massachusetts, New Jersey and Oregon and Pennsylvania's Department of Environmental Protection (''State Petitioners''). The second petition was submitted by the Western Environmental Law Center on behalf of three nongovernmental organizations: the International Center for Technology Assessment, Center for Food Safety, and Friends of the Earth (''NGO Petitioners'').

Both petitions request that EPA exercise its authority under CAA section 213(a)(4) to adopt emissions standards to control and limit GHG emissions from new nonroad engines excluding aircraft and vessels. Both petitions seek EPA regulatory action on a wide range of nonroad engines and equipment, which the petitioners believe, contribute substantially to GHG emissions, including outdoor power equipment, recreational vehicles, farm and construction machinery, lawn and garden equipment, logging equipment and marine vessels.[177]

The State Petitioners, mirroring the earlier State petitions on ocean-going vessels and aircraft, describe the harms which they believe will occur due to climate change, including reduced water supplies, increased wildfires, and threats to agricultural outputs in California; loss of coastal wetlands, beach erosion, saltwater intrusion of drinking water in Massachusetts and Connecticut; and similar harms to the Pennsylvania, New Jersey and Oregon. The petition highlights actions that California has already taken to reduce its own contributions to global warming but points out that only EPA has authority to regulate emissions from new farm and construction equipment under 175 horsepower, ''which constitutes a sizeable portion of all engines in this category.* * * ''[178]

The State Petitioners present three claims which, they believe compel EPA action to reduce GHG emissions from nonroad sources. First, petitioners claim that GHG emissions from these sources are significant.[179] Petitioners cite various reports documenting national GHG emissions from a broad range of nonroad categories which, they contend, provide evidence that nonroad GHG emissions are already substantial, and will continue to increase in the future. Petitioners, also cite additional inventory reports that nonroad GHG emissions already exceed total U.S. GHG emissions from aircraft as well as from boats and ships, rail, and pipelines combined.[180] Petitioner's present California nonroad GHG emissions data which, they contend, mirror national GHG emission trends for nonroad engines and bolster their claim that GHG emissions from the nonroad sector, as a whole, are significant and are substantial for three categories: Construction and mining equipment, agricultural, and industrial equipment.

State Petitioners' second claim is that EPA has the authority to regulate GHG emissions from nonroad sources, although they acknowledge that CAA section 213(a)(4) is discretionary. Petitioners contend this discretion is not unlimited and that the structure of the CAA must guide EPA's actions. Petitioners maintain that since the CAA prohibits States from undertaking their traditional police power role in regulating pollution from new construction or agricultural sources under 175 horsepower, ''Congress has implicitly invested EPA with the responsibility to act to prevent [these] harmful emissions.'' The third and final claim raised by State Petitioners is that both physical and operational controls are currently available to achieve fuel savings and/or to limit GHG emissions. Such measures include idle reduction, electrification of vehicles, the use of hybrid or hydraulic-hybrid technology, as well as use of ''cool paints'' that reduce the need for air conditioning.

NGO petitioners make three similar claims in their petition. First, petitioners argue that serious public health and environmental consequences are projected for this century unless effective and timely action is taken to mitigate climate change. Petitioners further contend that GHG emissions from nonroad engines and vehicles are responsible for a significant and growing amount of GHG emissions and, like the State petitioners previously, they highlight three nonroad sectors responsible for a large portion of these GHG emission—construction, mining, and agriculture.

Petitioners' second claim is that once EPA renders a positive endangerment determination under CAA section 202 for motor vehicles and engines, this finding should also satisfy the endangerment determination required under CAA section 213(a)(4) for nonroad engines. EPA's discretion under CAA section 213(a)(4) is limited, petitioners assert, by the relevant statutory considerations, as held by the Supreme Court in *Massachusetts* v. *EPA*, so that the Agency ''can decline to regulate nonroad engine and vehicle emissions only if EPA determines reasonably that such emissions do not endanger public health or welfare, or else, taking into account factors such as cost, noise, safety and energy, no such regulations would be appropriate.''[181] Like State petitioners, NGOs point out that because the CAA restricts states' ability to regulate pollution from new construction or farm vehicles and engines under 175 horsepower, Congress ''implicitly invested EPA with unique responsibility to act in the states'' stead so as to prevent such harmful emissions.'' Petitioners also argue that the National Environment Policy Act (NEPA) section 101(b) compels EPA action to fulfill its duty ''as a trustee of the environment for succeeding generations.''

NGO Petitioners' third claim is that a wide range of technology is currently available to reduce GHG emissions from nonroad engines and vehicles and that, in addition, the CAA was intended to be a technology-forcing statute so that EPA ''can and should'' establish regulations that ''substantially limit GHG emissions.* * * even where those regulations force the development of new technology.'' Regarding technology availability, petitioners provide a list of technologies that they believe are currently available to reduce GHG emissions from nonroad vehicles and engines, including auxiliary power unit systems to avoid engine use solely to

[177] The two petitions request that EPA regulate slightly different categories of nonroad engines and vehicles under CAA section 213. State Petitioners exclude from their request aircraft, locomotives and ocean-going vessels and do not include rebuilt heavy-duty engines. The *NGO Petitioners* exclude only aircraft and ocean-going vessels but also request that EPA use its CAA section 202 authority to regulate GHG emissions from rebuilt heavy-duty engines.

[178] States Petition for Nonroad, page 7–8.

[179] Petitioners indicate that in 2007, non-transportation mobile vehicles and equipment were responsible for approximately 220 million tons of CO_2 emissions (data derived from EPA's Nonroad Emissions model for 2007). State of California et al, Petition for Rulemaking Seeking the Regulation of Greenhouse Gas Emissions from Nonroad Vehicles and Engines, page 8, January 29, 2008, and International Center for Technology Assessment et al, Petition for Rulemaking Seeking the Regulation of Greenhouse Gas Emissions from Nonroad Vehicles and Engines, page 5, January 29, 2008.

[180] State Petition for Nonroad, page 9.

[181] *NGO Petition*, page 8.

heat or cool the cab; tire inflation systems; anti-idling standards; use of hybrid or hydraulic-hybrid technology; use of low carbon fuels; and use of low viscosity lubricants.

Both State and NGO Petitioners request three types of relief: (1) That EPA make a positive endangerment determination for GHG emissions from nonroad vehicles and engines;[182] (2) that EPA adopt regulations to reduce GHG emissions from this sector; and (3) that regulations necessary to carry out the emissions standards also be adopted.[183] We invite comment on all of the petitioners' assertions and requests.

2. Nonroad Engines and Vehicles

In this section, we discuss the GHG emissions and reduction technologies that are or may be available for the various nonroad engines and vehicles that are the subject of the petitioners described above. Since section 213 was added to the CAA in 1990, the Agency has completed a dozen major rulemakings which established programs that reduce traditional air pollutants from nonroad sources by over 95%, benefitting local, regional, and national air quality. EPA's approach has been to set standards based on technology innovation, with flexibility for the regulated industries to meet environmental goals through continued innovation that can be integrated with marketing plans.

With help from industry, environmental groups and state regulators, EPA has designed nonroad regulatory programs that have resulted in significant air quality gains with little sacrifice of products' ability to serve their purpose. In fact, manufacturers have generally added new features and performance improvements that are highly desirable to users. Because GHG reductions from nonroad sources can be derived from fuel use reductions that directly benefit the user's bottom line, we expect that manufacturers' incentive to increase the fuel efficiency of their products will be even stronger in the future. This potential appears higher for nonroad engines compared to highway engines because in the past energy consumption has been less of a focus in the nonroad sector, so there may be more opportunity for improvement, while at the same time higher fuel prices are now beginning to make fuel expenses more important to potential equipment purchasers.

The Agency and regulated industries have in the past grouped nonroad engines in a number of ways. The first is by combustion cycle, with two primary cycles in use: compression-ignition (CI) and spark-ignition (SI). The combustion cycle is closely linked to grouping by fuel type, because CI engines largely burn diesel fuel while SI engines burn gasoline or, for forklifts and other indoor equipment, liquefied petroleum gas (LPG). It has also been useful to group nonroad engines by application category. Regulating nonroad engine application categories separately has helped the Agency create effective control programs, due to the nonroad sector's tremendous diversity in engine types and sizes, equipment packaging constraints, affected industries, and control technology opportunities. Although for the sake of discussion we use these application groupings, we solicit comment on what grouping engines and applications would make the most sense for GHG regulation, especially if flexible emissions credit and averaging concepts are pursued across diverse applications.

a. Nonroad Engine and Vehicle GHG Emissions

Nonroad engines emitted 249 million metric tons of CO_2 in 2006, 12% of the total mobile source CO_2 emissions.[184] CO_2 emissions from the nonroad sector are expected to increase significantly in the future, approximately 46% between 2006 and 2030. Diesel engines emit 71% of the total nonroad CO_2 emissions. The other 29% comes from gasoline, LPG, and some natural gas-fueled engines. CO_2 emissions from individual nonroad application categories in decreasing order of prominence are: Nonroad diesel (such as farm tractors, construction and mining equipment), diesel locomotives, small SI (such as lawn mowers, string trimmers, and portable power generators), large SI (such as forklifts and some construction machines), recreational marine SI, and recreational offroad SI (such as all terrain vehicles and snowmobiles).

GHG emissions from nonroad applications are dominated by CO_2 emissions which comprise approximately 97% of the total. Approximately 3% of the GHG emissions (on a CO_2 equivalent basis) from nonroad applications are due to hydrofluorocarbon emissions, mainly from refrigerated rail transport. Methane and N_2O make up less than 0.2% of the nonroad sector GHG emissions on a CO_2 equivalent basis. Much of the following discussion focuses on technology opportunities for CO_2 reduction, but we note that these technologies will generally reduce N_2O and methane emissions as well, and we ask for comment on measures and options for specifically addressing N_2O and methane emissions.

b. Potential for GHG Reductions From Nonroad Engines and Vehicles

The opportunity for GHG reductions from the nonroad sector closely parallels the highway sector, especially for the heavy-duty highway and nonroad engines that share many design characteristics. In addition, there is potential for significant further GHG reductions from changes to vehicle and equipment characteristics. A range of GHG reduction opportunities is summarized in the following discussion. Comment is requested on these opportunities and on additional suggestions for reducing GHGs from nonroad sources.

It should be noted that any means of reducing the energy requirements necessary to power a nonroad application can yield the desired proportional reductions of GHGs (and other pollutants as well). Although in past programs, the Agency has typically focused on a new engine's emissions per unit of work, such as gram/brake horsepower-hour (g/bhp-hr), it may prove more effective to achieve GHG reductions by redesigning the equipment or vehicle that the engine powers so that the nonroad application accomplishes its task while expending less energy. Improvements such as these do not show up in measured g/bhp-hr emissions levels, but would be reflected in some other metric such as grams emitted by a locomotive in moving a ton of freight one mile.

EPA solicits comment on possible nonroad GHG emissions reduction strategies for the various ''pathways'' by which GHGs can be impacted. Although it is obvious that internal combustion engines emit GHGs via the engine exhaust, it is helpful to take the analysis to another level by putting it in the context of energy use and examining the pathways by which energy is expended in a nonroad application, such as through vehicle braking. Because of the diversity of nonroad applications, we are taking a different approach here than in other sections of this notice: first, we summarize some of the engine, equipment, and operational pathways

[182] In addition, NGO Petitioners also request that EPA make a determination under CAA section 202 (a)(3)(D) that GHG emissions from rebuilt heavy-duty engines also are significant contributors to air pollution which may reasonably be anticipated to endanger public health and welfare. NGO Petition, page 11.

[183] State Petitioners indicate that adopting regulations specifying fuel type, for example, may be necessary to carry out the emission limitations.

[184] Emissions data in this section are from *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006.* EPA 430–R–08–005. April 2008, and EPA NONROAD2005a model.

and opportunities for GHG reductions that are common to all or at least a large number of nonroad applications; next, we examine more closely just one of the hundreds of nonroad applications, locomotives, to illustrate the many additional application-specific pathways for GHG reductions that are available. Our assessment is that, despite the great diversity in nonroad applications, technology-based solutions exist for every application to achieve cost-effective and substantial GHG emissions reductions.

i. Common GHG Reduction Pathways

To ensure that this advance notice initiates the widest possible discussion of potential GHG control solutions, the following discussion includes all three types of possible control measures: engine, equipment, and operational.

(1) Engine Pathways

To date, improving fuel usage in many nonroad applications has not been of great concern to equipment users and therefore to designers. There is potential for technologies now fairly commonplace in the highway sector, such as advanced lubricants and greater use of electronic controls, to become part of an overall strategy for GHG emissions reduction in the nonroad sector. We welcome comment on the opportunities and limitations of doing so.

One engine technology in particular warrants further discussion. Two-stroke gasoline engines have been popular especially in handheld lawn care applications and recreational vehicles because they are fairly light and inexpensive. However, they also produce more GHGs than four-stroke engines. Much progress has been made in recent years in the development of four-stroke engines that function well in these applications. We ask for comment on the extent to which a shift to four-stroke engines would be feasible and beneficial.

Although today's nonroad gasoline and diesel engines produce significantly less GHGs than earlier models, further improvements are possible. Engine designers are continuing to work on new designs incorporating technologies that produce less GHGs, such as homogeneous charge CI, waste heat recovery through turbo compounding, and direct fuel injection in SI engines. Most of this work has already been done for the automotive sector where economies of scale can justify the large investments. Much of this innovation can eventually be adapted to nonroad applications, as has occurred in the past with such technologies as electronic fuel injection and common rail fueling. We therefore request comment on the feasibility and potential for these advanced highway sector technologies, discussed in section VI.B, to be introduced or accelerated in the nonroad sector.

(2) Equipment and Operational Pathways

Technology solutions in both the equipment design and operations can reach beyond the engine improvements to further reduce GHG emissions. We broadly discuss the following technologies below: Regenerative energy recovery and hybrid power trains, CVT transmissions, air conditioning improvements, component design improvements, new lighting technologies, reduced idling, and consumer awareness.

Locomotives, as an example, have significant potential to recover energy otherwise dissipated as heat during braking. An 8,000-ton coal train descending through 5,000 feet of elevation converts 30 MW-hrs of potential energy to frictional and dynamic braking energy. Storing that energy on board quickly enough to keep up with the energy generation rate presents a challenge, but may provide a major viable GHG emissions reduction strategy even if only partially effective. Another regenerative opportunity relates to the specific, repetitive, predictable work tasks that many nonroad machines perform. For example, a forklift in a warehouse may lift a heavy load to a shelf and in doing so expend work. Just as often, the forklift will lower such a load from the shelf, and recover that load's potential energy, if a means is provided to store that energy on board.

There are, however, many nonroad applications that may not have much potential for regenerative energy recovery (a road grader, for example), but in those applications a hybrid diesel-electric or diesel-hydraulic system without a regenerative component may still provide some GHG benefits. A machine that today is made with a large engine to handle occasional peak work loads could potentially be redesigned with a smaller engine and battery combination sized to handle the occasional peak loads.

Besides pre-existing electrical or hydraulic systems, some nonroad applications have one additional advantage over highway vehicles in assessing hybrid prospects: They often have quite predictable load patterns. A hybrid locomotive, for example, can be assigned to particular routes, train sizes, and consist (multi-locomotive) teams, to ensure it is used as close to full capacity as possible. The space needs of large battery banks could potentially be accommodated on a tender car, and the added weight would be offset somewhat by a smaller diesel fuel load (typically 35,000 lbs today) and dynamic brake grid. At least one locomotive manufacturer, General Electric, is already developing a hybrid design, and battery energy storage has been demonstrated for several years in rail yard switcher applications.

We request comment on all aspects of the hybrid and regeneration opportunity in the nonroad sector, including the extent to which the electric and hydraulic systems already designed into many nonroad machines and vehicles could provide some cost savings in implementing this technology, and the extent to which plug-in technologies could be used in applications that have very predictable downtime such as overnight at construction sites, or that can use plug-in electric power while working or while sitting idle between tasks.

A Continuously Variable Transmission (CVT) has an advantage over other conventional transmission designs by allowing the engine to operate at its optimum speed over a range of vehicle speeds and typically over a wider range of available ratios, which can provide GHG emission reductions. It has been estimated that CVTs can provide a 3 to 8% decrease in fuel use over 4-speed automatic transmissions.[185] They are already in use some in nonroad vehicles such as snowmobiles and all-terrain vehicles, and could possibly be used in other nonroad applications as well. We request comment on the opportunities to apply CVT to various nonroad applications.

Some nonroad applications have air conditioning or refrigeration equipment, including large farm tractors, highway truck transport refrigeration units (TRUs), locomotives, and refrigerated rail cars. Reducing refrigerant leakage in the field or reducing its release during maintenance would work to reduce GHG emissions In addition, a switch to refrigerants with lower GHG emissions than the currently-used fluorinated gases can have a significant impact. We expect that the measures used to reduce nonroad equipment refrigerant GHGs would most likely involve the same strategies that have been or could be pursued in the highway and stationary

[185] ''Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards,'' National Research Council, National Academy of Sciences, 2002.

source sectors, and the reader is referred to section VI.B.1 for additional discussion. We request comment on the degree to which nonroad applications emit fluorinated gases, and on measures that may be taken to reduce these emissions.

An extensive variety of energy-consuming electrical, mechanical, and hydraulic accessories are designed into nonroad machines to help them perform their tasks. Much of the energy output of a nonroad engine passes through these components and systems in making the machine do useful work, and all of them have associated energy losses through bearing friction, component heating, and other pathways. Designing equipment to use components with lower GHG impacts in these systems can yield substantial overall reductions in GHG emissions.

Some nonroad applications expend significant energy in providing light, such as locomotive headlights and other train lighting. Furthermore, diesel-powered portable light towers for highway construction activities at night are increasingly being used to reduce congestion from daytime lane closures. We request comment on the extent to which a switch to less energy-intensive lighting could reduce GHG emissions.

Many nonroad diesel engines are left idling during periods when no work is demanded of them, generally as a convenience to the operator, though modern diesel engines are usually easy to restart. In some applications this may occupy hours every day. Even though the hourly fuel rate is fairly low during idle, in the past several years railroads have saved considerable money by adding automatic engine stop start (AESS) systems to locomotives. These monitor key parameters such as state of battery charge, and restart the engine only as needed, thereby largely eliminating unnecessary idling. They reduce GHG emissions and typically pay for themselves in fuel savings within a couple of years. Our recent locomotive rule mandated these systems for all new locomotives as an emission control measure (40 CFR 1033.115(g)). AESS or similar measures may be feasible for other nonroad applications with significant idling time as well. We request comment on the availability and effectiveness of nonroad idle reduction technologies.

ii. Application-Specific GHG Pathways

As mentioned above, we discuss application-specific approach for further reducting GHG emissions from one nonroad application, locomotives, to illustrate application-specific opportunities for GHG emission reductions beyond those discussed above that apply more generally. We note that some of these application-specific opportunities, though limited in breadth, may be among the most important, because of their large GHG reduction potential.

We have chosen locomotives for this illustration in part because rail transportation has already been the focus of substantial efforts to reduce its energy use, resulting in generally favorable GHG emissions per ton-mile or per passenger-mile. The Association of American Railroads calculates that railroads move a ton of freight 423 miles on one gallon of diesel fuel.[186] Reasons for the advantage provided by rail include the use of medium-speed diesel engines, lower steel-on-steel rolling resistance, and relatively gradual roadway grades. Rail therefore warrants attention in any discussion on mode-shifting as a GHG strategy. Even if GHG emissions reduction were not at issue, shippers and travelers already experience substantial mode-shift pressure today from long-term high fuel prices. Growth in the rail sector highlights the critical importance of locomotive GHG emissions reduction.

We have listed some key locomotive-specific opportunities below. We note that a number of these are aimed at addressing GHG pathways from rail cars. Rail cars create very significant GHG reduction pathways for locomotives, because all of the very large energy losses from railcar components translate directly into locomotive fuel use. This is especially important when one considers that an average train has several dozen cars. We request comment on the feasibility of the ideas on this list and on other possible ways to reduce GHG emissions.

Opportunities for Rail GHG Reduction

Locomotives

- Low-friction wheel bearings
- Aerodynamic improvements
- Idle emissions control beyond AESS (such as auxiliary power units)
- Electronically-controlled pneumatic (ECP) brakes
- High-adhesion trucks (wheel assemblies)
- Global positioning system (GPS)-based speed management (to minimize braking, over-accelerations, and run-out/run-in losses at couplings)

Railcars

- Low-torque rail car wheel bearings
- Tare weight reduction
- Aerodynamic design of rail cars and between-car gaps
- Better insulated refrigeration cars

Rail Infrastructure

- Application of lubricants or friction modifiers to minimize wheel-to-track friction losses
- Higher-speed railroad crossings
- Targeted-route electrification
- Rail yard infrastructure improvements to eliminate congestion and idling

Operational

- Consist manager (automated throttling of each locomotive in a consist team for lowest overall GHG emissions)
- Optimized GPS-assisted dispatching/routing/tracking of rail cars and locomotives
- Optimized matching of locomotives with train load for every route (including optimized placement of each locomotive along the train)
- Expanded resource sharing among railroads
- Reduction of empty-car trips
- Early scrappage of higher-GHG locomotives

c. Regulatory Options for Nonroad Engines and Vehicles

There is a range of options that could be pursued under CAA section 213 to control nonroad sector GHGs. The large diversity in this sector allows for a great number of technology solutions as discussed above, while also presenting some unique challenges in developing a comprehensive, balanced, and effective regulatory program, and highlights the importance of considering multiple potential regulatory strategies. We have met similar challenges in regulating traditional air pollutants from this sector, and we request comment on the regulatory approaches discussed below and whether they would address the challenges of regulating GHGs from nonroad engines.

As discussed in our earlier section on heavy-duty vehicles, the potential regulatory approaches that we discuss here should be considered not as discrete options but as a continuum of possible approaches to address GHG emissions from this sector. Just as we have in our technology discussion, these regulatory approaches begin with the engine and then expand to included potential approaches to realize reductions through vehicle and operational changes. In approaching the discussion in this way, each step along such a path has the potential to greater regulatory complexity but also has the

[186] Comments of the Association of American Railroads on EPA's locomotive and marine engine proposal, July 2, 2007. Available in EPA docket EPA–HQ–OAR–2003–0190.

potential for greater regulatory flexibility, GHG reduction, and program benefits. For large GHG reductions in the long term we expect to give consideration to approaches that accomplish the largest reductions, but we also note that, given the long time horizons for GHG issues, we can consider a number of incremental regulatory steps along a longer path. Also, given the absence of localized effects associated with GHG emissions, EPA is interested in considering the incorporation of banking, averaging, and/or credit trading into the regulatory options discussed below.

The first regulatory approach we consider is a relatively straightforward extension of our existing criteria pollutant program for nonroad engines. In its simplest form, this approach would be an engine GHG standard that preserves the current regulatory structure for nonroad engines. Nonroad engine manufacturers are already familiar with today's certification testing and procedures. Just like the highway engine manufacturers, they have facilities, engine dynamometers, and test equipment to appropriately measure GHG emissions. Further, technologies developed to reduce GHG emissions from heavy-duty engines could be applied to the majority of diesel nonroad engines with additional development to address differences in operating conditions and engine applications in nonroad equipment. Hence, this approach would benefit from both regulatory work done to develop a heavy-duty engine GHG program and technology development for heavy-duty engines to comply with a GHG program. While we do not expect that new test cycles would be needed to effect meaningful GHG emissions control, we request comment on whether new test cycles would allow for improved control, and especially on whether there are worthwhile GHG control technologies that would not be adequately exercised and measured under the current engine test cycles and test procedures.

A second approach that would extend control opportunities beyond engine design improvements involves developing nonroad vehicle and equipment GHG standards. Changes to nonroad vehicles and equipment can offer significant opportunity for GHG emission reductions, and therefore any nonroad GHG program considered by EPA would need to evaluate the potential for reductions not just from engine changes but from vehicle and equipment changes as well. In section VI.B.2 we discussed a potential heavy-duty truck GHG standard (e.g., a gram per mile or gram per ton-mile standard). A similar option could be considered for at least some portion of nonroad vehicles and equipment. For example, a freight locomotive GHG standard could be considered on a similar mass per ton mile basis. This would be a change from our current mass per unit work approach to locomotive regulation, but section 213 of the Clean Air Act does authorize the Agency to set vehicle-based and equipment-based nonroad standards as well.

However, we are concerned that there may be significant drawbacks to widespread adoption of this application-specific standards-setting approach. For the freight locomotive example given above, a gram per ton-mile emissions standard measured over a designated track route might be a suitable way to express a GHG standard, but such a metric would not necessarily be appropriate for other applications. Instead each application could require a different unit of measure tied to the machine's mission or output— such as grams per kilogram of cuttings from a ''standard'' lawn for lawnmowers and grams per kilogram-meter of load lift for forklifts. Such application-specific standards would provide the clearest metric for GHG emission reductions. The standards would directly reflect the intended use of the equipment and would help drive equipment and engine designs that most effectively meet that need while reducing overall GHG emissions. However, the diversity of tasks performed by the hundreds of nonroad applications would lead to a diverse array of standard work units and measurement techniques in such a nonroad GHG program built on equipment-based standards. We request comments on this second regulatory approach, and in particular comments that identify specific nonroad applications that would be best served by such a nonroad vehicle-based regulatory approach.

A variation on the above-described approaches would be to maintain the relative simplicity of an engine-based standard while crediting the GHG emission reduction potential of new equipment designs. Under this option, the new technology would be evaluated by measuring GHG emissions from a piece of equipment that has the new technology while performing a standard set of typical tasks. The results would then be compared with data from the same or an identical piece of equipment, without the new technology, performing the same tasks. This approach could be carried out for a range of equipment models to help improve the statistical case for the resulting reductions. The percentage reduction in GHG emissions with and without the new equipment technology could then be applied to the GHG emissions measured in certification testing of engines used in the equipment in helping to demonstrate compliance with an engine-based GHG standard. Thus if a new technology were shown to reduce the GHG emissions of a typical piece of equipment by 20%, that 20% reduction could be applied at certification to the GHG emission results from a more traditional engine-based test procedure and engine-based standard.

In fact, a very similar approach has been adopted in EPA's recently established locomotive program (see 73 FR 25155, May 6, 2008). In this provision, credit is given to energy-saving measures based on the fact that they provide proportional reductions in the criteria pollutants. This credit takes the form of an adjustment to criteria pollutant emissions measured under the prescribed test procedure for assessing compliance with engine-based standards.

A more flexible extension of this approach would be to de-link the equipment-based GHG reduction from the compliance demonstration for the particular engine used in the same equipment. Instead the GHG difference would provide fungible credits for each piece of equipment sold with the new technology, credits that then could be used in a credit averaging and trading program. Under this concept it would be important to collect and properly weight data over an adequate range of equipment and engine models, tasks performed, and operating conditions, to ensure the credits are deserved. We request comments on the option of applying the results of equipment testing to an engine-based GHG standard and the more general concept of generating GHG emission credits from such an approach. We also request comment on whether such credit-based approaches to accounting for the many promising equipment measures are likely to obtain similar GHG reductions as the setting of equipment based standards, and on whether some combined approach involving both standards and credits may be appropriate.

There are also a number of ways to reduce GHG emissions in the nonroad sector that do not involve engine or equipment redesign. Rather, reductions can be achieved by altering the way in which the equipment is used. For example, intermodal shipping moving freight from trucks and onto lower GHG rail or marine services, provides a means of reducing these emissions for freight shipments that can accommodate the logistical constraints of intermodal shipping. Many of the operational measures with GHG-reducing potential do involve a significant technology component, perhaps even hardware changes, but they can also involve actions on the part of the equipment operator or owner that go beyond simply maintaining and not tampering with the emission controls. For example, a railroad may make the capital and operational investment in sophisticated computer technology to dispatch and schedule locomotive resources, using onboard GPS-based tracking hardware. The GHG reduction benefit, though enabled in part by the onboard hardware, is not realized without the people and equipment assigned to the dispatch center.

Credit for such operational measures could conceivably be part of a nonroad GHG control program and could be calculated and assigned using the same ''with and without'' approach to credit generation described above for equipment-based changes. However, some important implementation problems arise from the greater human element involved. This human element becomes increasingly significant as the scope of creditable measures moves further away from automatic technology-based solutions. Assigning credits to such measures must involve good correlation between the credits generated and the GHG reductions achieved in real world applications. It therefore may make sense to award these credits only after an operational measure has been implemented and verified as effective. This might necessitate that such credits have value for equipment or sources other than the equipment associated with the earning of the credit, such as in a broader credit market. This is because nonroad equipment and engines must demonstrate compliance with EPA standards before they are put into service. They therefore cannot benefit from credits created in the future unless through some sort of credit borrowing mechanism.

Once verified, however, we would expect credits reflecting these operational reductions could be banked, averaged and traded, just as much as credits derived from equipment- or engine-based measures. Verifiable GHG reductions, regardless of how generated, have equal value in addressing climate change. We also note, however, that an effective credit program, especially one with cross-sector utility, should account for the degree to which a credit-generating measure would have happened anyway, or would have happened eventually, had no EPA program existed; this is likely to be challenging. We request comment on the appropriateness of a much broader GHG credit-based program as described here.

In this section, we have laid out a range of regulatory approaches for nonroad equipment that takes us from a relatively simple extension of our existing engine-based regulatory program through equipment based standards and finally to a fairly wide open credit scheme that would in concept at least have the potential to pull in all aspects of nonroad equipment design and operation. In describing these approaches, we have noted the increasing complexity and the greater need for new mechanisms to ensure the emission reductions anticipated are real and verifiable. We seek comment on the relative merits of each of these approaches but also on the potential for each approach along the continuum to build upon the others.

3. Marine Vessels

Marine diesel engines range from very small engines used to propel sailboats, or used for auxiliary power, to large propulsion engines on ocean-going vessels. Our current marine diesel engine emission control programs distinguish between five kinds of marine diesel engines, defined in terms of displacement per cylinder. These five types include small (≤37 kW), recreational, and commercial marine engines. Commercial marine engines are divided into three categories based on per cylinder displacement: Category 1 engines are less than 5 l/cyl, Category 2 engines are from 5 l/cyl up to 30 l/cyl, and Category 3 engines are at or above 30 l/cyl. Category 3 engines are 2- or 4-stroke propulsion engines that typically use residual fuel; this fuel has high energy content but also has very high fuel sulfur levels that result in high PM emissions. Most of the other engine types are 4-stroke and can be used to provide propulsion or auxiliary power. These operate on distillate fuel although some may operate on a blend of distillate and residual fuel or even on residual fuel (for example, fuels commonly known as DMB, DMC, RMA, and RMB).

There are also a wide variety of vessels that use marine diesel engines and they can be distinguished based on where they are used. Vessels used on inland waterways and coastal routes include fishing vessels that may be used either seasonally or throughout the year, river and harbor tug boats, towboats, short- and long-distance ferries, and offshore supply and crew boats. These vessels often have Category 2 or smaller engines and operate in distillate fuels. Ocean-going vessels (OGVs) include container ships, bulk carriers, tankers, and passenger vessels and have Category 3 propulsion engines as well as some smaller auxiliary engines. As EPA deliberates on how to potentially address GHG emissions from marine vessels, we will consider the significance of the different engine, vessel, and fuel types. We invite comment on the marine specific issues that EPA should consider; in particular, we invite commenters to compare and contrast potential marine vessel solutions to our earlier discussions of highway and nonroad mobile sources and our existing marine engine criteria pollutant control programs.

a. Marine Vessel GHG Emissions

Marine engines and vessels emitted 84.2 million metric tons of CO_2 in 2006, or 3.9 percent of the total mobile source CO_2 emissions. CO_2 emissions from marine vessels are expected to increase significantly in the future, more than doubling between 2006 and 2030. The emissions inventory from marine vessels comes from operation in ports, inland waterways, and offshore. The CO_2 inventory estimates presented here refer to emissions from marine engine operation with fuel purchased in the United States.[187] OGVs departing U.S. ports with international destinations take on fuel that emits 66 percent of the marine vessel CO_2 emissions; the other 34 percent comes from smaller commercial and recreational vessels.

GHG emissions from marine vessels are dominated by CO_2 emissions which comprise approximately 94 percent of the total. Approximately 5.5 percent of the GHG emissions from marine vessels are due to HFC emissions, mainly from reefer vessels (vessels which carry refrigerated containers). Methane and nitrous oxide make up less than 1 percent of the marine vessel sector GHG emissions on a CO_2 equivalent basis. Comment is requested on the contribution of marine vessels to GHG emissions and on projections for growth in this sector.

b. Potential for GHG Reductions From Marine Vessels

There are significant opportunities to reduce GHG emissions from marine vessels through both traditional and innovative strategies. These strategies include technological improvements to engine and vessel design as well as changes in vessel operation. This

[187] U.S. EPA, ''Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006,'' April 15, 2008.

section provides an overview of these strategies, and a more detailed description is available in the public docket.[188] EPA requests comment on the advantages and drawbacks of each of the strategies described below, as well as on additional approaches for reducing greenhouse gases from marine vessels.

i. Reducing GHG Emissions Through Marine Engine Changes

GHG emissions may be reduced by increasing the efficiency of the marine engine. As discussed earlier for heavy-duty trucks, there are a number of improvements for CI engines that may be used to lower GHGs. These improvements include higher compression ratios, higher injection pressure, shorter injection periods, improved turbocharging, and electronic fuel and air management. Much of the energy produced in a CI engine is lost to the exhaust. Some of this energy can be reclaimed through the use of heat recovery systems. We request comment on the feasibility of reducing GHG emissions through better engine designs and on additional technology which could be used to achieve GHG reductions.

As discussed above, marine engines are already subject to exhaust emission standards. Many of the noxious emissions emitted by internal combustion engines may also be GHGs. These pollutants include NO_X, methane, and black carbon soot. Additionally, some strategies used to mitigate NO_X and PM emissions can also indirectly impact GHGs through their impact on fuel use—for example, use of aftertreatment rather than injection timing retard to reduce NO_X emissions. We request comment on the GHG reductions associated with HC+NO_X and PM emissions standards for these engines.

The majority of OGVs operate primarily on residual fuel, while smaller coastal vessels operate primarily on distillate fuel. Shifting more shipping operation away from residual fuel would reduce GHG emissions from the ship due to the lower carbon/hydrogen ratio in distillate fuel. Marine engines have been developed that operate on other lower carbon fuels such as natural gas and biodiesel. Because biodiesel is a renewable fuel, lifecycle GHG emissions are much lower than for operation on petroleum diesel. We request comment on these and other fuels that may be used to power marine vessels and the impact these fuels would have on lifecycle GHG emissions.

A number of innovative alternatives are under development for providing power on marine vessels. These alternative power sources include fuel cells, solar power, wind power, and even wave power. While none of these technologies are currently able to supply the total power demands of larger, ocean-going vessels, they may prove to be capable of reducing GHG emissions through auxiliary power or power-assist applications. Hybrid engine designs are used in some vessels where a bank of engines is used to drive electric motors for power generation. The advantage of this approach is that the same engines may be used both for propulsion and auxiliary needs. Another advantage is that alternative power sources could be used with a hybrid system to provide supplemental power. We request comment on the extent to which alternative power sources and hybrid designs may be applied to marine vessels to reduce greenhouse gases.

ii. Reducing GHG Emissions Through Vessel Changes

GHG emissions may be reduced by minimizing the power needed by the vessels to perform its functions. The largest power demand is generally for overcoming resistance as the vessel moves through the water but is also affected by propeller efficiency and auxiliary power needs.

Water resistance is made up of the effort to displace water and drag due to friction on the hull. The geometry of the vessel may be optimized in many ways to reduce water resistance. Ship designers have used technologies such as bulbous bows and stern flaps to help reduce water resistance from the hull of the vessel. Marine vessels typically use surface coatings to inhibit the growth of barnacles or other sea life that would increase drag on the hull. Innovative strategies for reducing hull friction include coatings with textures similar to marine animals and reducing water/hull contact by enveloping the hull with small air bubbles released from the sides and bottom of the ship.

Both the wetted surface area and amount of water displaced by the hull may be reduced by lowering the weight of the vessel. This may be accomplished through the use of lower weight materials such as aluminum or fiberglass composites or by simply using less ballast in the ship when not carrying cargo. Other options include ballast-free ship designs such as constantly flowing water through a series of pipes below the waterline or a pentamaran hull design in which the ship is constructed with a narrow hull and four sponsons which provide stability and eliminate the need for ballast water. We request comment to the extent that these approaches may be used to reduce GHGs by reducing fuel consumption from marine vessels in the future. We also request comment on other design changes that may reduce the power demand due to resistance on the vessel.

In conventional propeller designs, a number of factors must be considered including load, speed, pitch, diameter, pressure pulses, and cavitation (formation of bubbles which may damage propeller and reduce thrust). Proper maintenance of the propeller can minimize energy losses due to friction. In addition, propeller coatings are available that reduce friction on the propeller and lead to energy savings. Because of the impact of the propeller on the operation of the vessel, a number of innovative technologies have been developed to increase the efficiency of the propeller. These technologies include contra-rotating propellers, azimuth thrusters, ducted propellers, and grim vane wheels. We request comment on the GHG reductions that may be achieved through improvements in vessel propulsion efficiency, either through the approaches listed here or through other approaches.

Power is also needed to provide electricity to the ship and to operate auxiliary equipment. Power demand may be reduced through the use of less energy intensive lighting, improved electrical equipment, improved reefer systems, crew education campaigns, and automated air-conditioning systems. We request comment on the opportunities to provide auxiliary power with reduced GHG emissions.

In addition, GHG emissions may be released from leaks in air conditioning or refrigeration systems. There is a large amount of fluorinated and chlorinated hydrocarbons used in refrigeration and air-conditioning systems on ships. We request comment on the degree to which marine vessels emit fluorinated and chlorinated hydrocarbons to the atmosphere, and on measures that may be taken to mitigate these emissions.

iii. Reducing GHG Emissions Through Vessel Operational Changes

In addition to improving the design of the engine and vessel, GHG emissions may be reduced through operational measures. These operational measures include reduced speeds, improved routing and fleet planning, and shore-side power.

[188] ''Potential Technologies for GHG Reductions from Commercial Marine Vessels'', memorandum from Michael J. Samulski, U.S. EPA, to docket xx, DATE.

In general, the power demand of a vessel increases with at least the square of the speed; therefore, a 10 percent reduction in speed could result in more than a 20 percent reduction in fuel consumption, and therefore in GHG emissions. An increased number of vessels operating at slower speeds may be able to transport the same amount of cargo while producing less GHGs. In some cases, vessels operate at higher speeds than necessary simply due to inefficiencies in route planning or congestion at ports. Ship operators may need to speed up to correct for these inefficiencies. GHG reductions could be achieved through improved route planning, coordination between ports, and weather routing systems. GHG reductions may also be achieved by using larger vessels and through better fleet planning to minimize the time ships operate at less than full capacity. We request comment on the extent to which greenhouse gas emissions may be practically reduced through vessel speed reductions and improved route and fleet planning.

Many ports have shore-side power available for ships as an alternative to using onboard engines at berth. To the extent that the power sources on land are able to produce energy with lower GHG emissions than the auxiliary engines on the vessel, shore-side power may be an effective strategy for GHG reduction. In addition to more traditional power generation units, shore-side power may come from renewable fuels, nuclear power, fuel cells, windmills, hydro-power, or geothermal power. We request comment on GHG reductions that could be achieved through the use of shore-side power.

c. Regulatory Options for Marine Vessels

EPA could address GHG emissions from marine vessels using strategies from a continuum of different regulatory tools, including emission standards, vessel design standards, and strategies that incorporate a broader range of operational controls. These potential regulatory strategies are briefly described below. As is the case with other source categories, EPA is also interested in exploring the potential applicability of flexible mechanisms such as banking and credit trading. With regard to ocean-going vessels, we are also exploring the potential to address GHG emissions through the International Maritime Organization under a program that could be adopted as a new Annex to the International Convention for the Prevention of Pollution from Ships (MARPOL). Those efforts are also described below. EPA requests comment on the advantages and drawbacks of each of these regulatory approaches.

As with trucks and land-based nonroad equipment, the first regulatory approach we could consider entails setting GHG emission limits for new marine diesel engines. For engines with per cylinder displacement up to 30 liters (i.e., Category 1 and Category 2), EPA has already adopted stringent emission limits for several air pollutants that may be GHGs, including NO_X, methane (through hydrocarbon standards) and black carbon soot (through PM standards). This emission control program could be augmented by setting standards for GHG emissions that could be met through the application of the technologies described above (e.g., improved engine designs, hybrid power). We request comment regarding issues that EPA should consider in evaluating this approach and the most appropriate means to address the issues raised. We recognize that an engine-based regulatory structure would limit the potential GHG emission reductions compared to programs that include vessel technologies and crediting operational improvements. In the remainder of this section, we consider other options that would have the potential to provide greater GHG reductions by providing mechanisms to account for vessel and operational changes.

A second regulatory approach to address GHG emissions from marine vessels is to set equipment standards. As described above, these could take the form of standards that require reduced air and/or water resistance, improved propeller design, and auxiliary power optimization. Equipment standards could also address various equipment onboard vessels, such as refrigeration units. While Annex VI currently contains standards for ozone depleting substances, this type of control could be applied more broadly to U.S. vessels that are not subject to the Annex VI certification requirements.

A critical characteristic of marine vessels that must be taken into account when considering equipment standards is that not all marine vessels are designed alike for the same purpose. A particular hull design change that would lower GHGs for a tugboat may not be appropriate for a lobster vessel or an ocean-going vessel. These differences will have an impact on how an equipment standard would be expressed. We request comment on how to express equipment standards in terms of an enforceable limit, and on whether it is possible to set a general standard or if separate standards would be necessary for discrete vessel types/sizes. We also request comment on the critical components of a compliance program for an equipment standard, how it can be enforced, and at what point in the vessel construction process it should be applied.

In addition to the above, the spectrum of regulatory approaches we outline in section VI.C.2.c for nonroad engines and vehicles could potentially be applied to the marine sector as well, with corresponding GHG reductions. These would include: (1) Setting mission-based vessel standards (such as GHG gram per ton-mile shipping standards) for at least some marine applications where this can be reliably measured and administered, (2) allowing vessel changes such as lower resistance hull designs to generate credits against marine engine-based standards, (3) granting similar credits for operational measures such as vessel speed reductions, and (4) further allowing such credits to be used in wider GHG credit exchange programs. We note too that the implementation complexities for these approaches discussed in section VI.C.2.c apply in the marine sector as well, and these complexities increase as regulatory approaches move further along the continuum away from engine-based standards.

Separate from the Annex VI negotiations for more stringent NO_X and PM standards discussed above, the United States is working with the Marine Environment Protection Committee of the IMO to explore appropriate ways to reduce CO_2 emissions from ships for several years. At the most recent meeting of the Committee, in April 2008, the Member States continued their work of assessing short- and long-term GHG control strategies. A variety of options are under consideration, including all of those mentioned above. The advantage of an IMO-based program is that it could provide harmonized international standards. This is important given the global nature of vessel traffic and given that this traffic is expected to increase in the future.

4. Aircraft

In this section we discuss and seek comment on the impact of aircraft operations on GHG emissions and the potential for reductions in GHG emissions from these operations. Aircraft emissions are generated from aircraft used for public, private, and national defense purposes including air carrier commercial aircraft, air taxis, general aviation, and military aircraft.

Commercial aircraft include those used for scheduled service transporting passengers, freight, or both. Air taxis fly scheduled and for-hire service carrying passengers, freight or both, but they usually are smaller aircraft than those operated by commercial air carriers. General aviation includes most other aircraft (fixed and rotary wing) used for recreational flying, business, and personal transportation (including piston-engine aircraft fueled by aviation gasoline). Military aircraft cover a wide range of airframe designs, uses, and operating missions.

As explained previously, section 231 of the CAA directs EPA to set emission standards, test procedures, and related requirements for aircraft, if EPA finds that the relevant emissions cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare. In setting standards, EPA is to consult with FAA, particularly regarding whether changes in standards would significantly increase noise and adversely affect safety. CAA section 232 directs FAA to enforce EPA's aircraft engine emission standards, and 49 U.S.C. section 44714 directs FAA to regulate fuels used by aircraft. Historically, EPA has worked with FAA and the International Civil Aviation Organization (ICAO) in setting emission standards and related requirements. Under this approach international standards have first been adopted by ICAO, and subsequently EPA has initiated CAA rulemakings to establish domestic standards that are at least as stringent as ICAO's standards. In exercising EPA's own standard-setting authority under the CAA, we would expect to continue to work with FAA and ICAO on potential GHG emission standards, if we found that aircraft GHG emissions cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare.

Over the past 25–30 years, EPA has established aircraft emission standards covering certain criteria pollutants or their precursors and smoke; these standards do not currently regulate emissions of CO_2 and other GHGs.[189] However, provisions addressing test procedures for engine exhaust gas emissions state that the test is designed to measure various types of emissions, including CO_2, and to determine mass emissions through calculations for a simulated aircraft landing and takeoff cycle (LTO). Currently, CO_2 emission data over the LTO cycle is collected and reported.[190] Emission standards apply to engines used by essentially all commercial aircraft involved in scheduled and freight airline activity.[191]

a. GHG Emissions From Aircraft Operations

Aircraft engine emissions are composed of about 70 percent CO_2, a little less than 30 percent water vapor, and less than one percent each of NO_X, CO, sulfur oxides (SO_X), non-methane volatile organic carbons (NMVOC), particulate matter (PM), and other trace components including hazardous air pollutants (HAPs). Little or no nitrous oxide (N_2O) emissions occur from modern gas turbines. Methane (CH_4) may be emitted by gas turbines during idle and by relatively older technology engines, but recent data suggest that little or no CH_4 is emitted by more recently designed and manufactured engines.[192] By mass, CO_2 and water vapor are the major compounds emitted from aircraft operations that relate to climate change.

In 2006, EPA estimated that among U.S. transportation sources, aircraft emissions constituted about 12 percent of CO_2 emissions, and more broadly, about 12 percent of the combined emissions of CO_2, CH_4, and N_2O. Together CH_4 and N_2O aircraft emissions constituted only about 0.1 percent of the combined CO_2, CH_4, and N_2O emissions from U.S. transportation sources, and they make up about one percent of the total aircraft emissions of CO_2, CH_4, and N_2O.[193] Aircraft emissions were responsible for about 4 percent of CO_2 emissions from all U.S. sources, and about 3 percent of CO_2, CH_4, and N_2O emissions collectively. While aircraft CO_2 emissions have declined by about 6 percent between 2000 and 2006, from 2006 to 2030, the U.S. Department of Energy projects that the energy use of aircraft will increase by about 60 percent (excluding military aircraft operations).[194] Commercial aircraft make up about 83 percent of both CO_2 emissions and the combined emissions of CO_2, CH_4, and N_2O for U.S. domestic aircraft operations. In addition, U.S. domestic commercial aircraft activity represents about 24 percent of worldwide commercial aircraft CO_2 emissions. With international aircraft departures, the total U.S. CO_2 emissions from commercial aircraft are about 35 percent of the total global commercial aircraft CO_2 emissions.[195] [196] Globally, 93 percent of the fuel burn (a surrogate for CO_2) and 92 percent of NO_X emissions from commercial aircraft occur outside of the basic LTO cycle (i.e., operations nominally above 3,000 feet).[197]

The compounds emitted from aircraft that directly relate to climate change are CO_2, CH_4, N_2O and, in highly specialized applications, SF_6.[198] Aircraft also emit other compounds that are indirectly related to climate change such as NO_X, water vapor, and PM. NO_X is a precursor to cruise-altitude ozone, which is a GHG. An increase in ozone also results in increased tropospheric hydroxyl radicals (OH) which reduces ambient CH_4, thus potentially at least partially offsetting the warming effect from the increase in ozone. Water vapor and PM modify or create cloud cover, which in turn can either amplify or

[189] Our existing standards include hydrocarbon emissions and CH_4 is a hydrocarbon. If CH_4 is present in the engine exhaust, it would be measured as part of the LTO test procedure. There is not a separate CH_4 emission standard for aircraft engines.

[190] Certification information includes fuel flow rates over the different modes (and there are specified times in modes) of the LTO cycle. Utilizing this information, the ICAO Engine Emissions Databank reports kilograms of fuel used during the entire LTO cycle (see *http://www.caa.co.uk/default.aspx?catid=702&pagetype=90*).

[191] Regulated aircraft engines are used on commercial aircraft including small regional jets, single-aisle aircraft, twin-aisle aircraft, and 747s and larger aircraft.

[192] IPCC, Aviation and the Global Atmosphere, 1999, at *http://www.grida.no/climate/ipcc/aviation/index.htm*.

[193] U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006,* April 2008, USEPA #430–R–08–005, available at *http://www.epa.gov/climatechange/emissions/usinventoryreport.html*.

[194] Energy Information Administration, Annual Energy Outlook 2008, Report No.: DOE/EIA–0383 (2008), March 2008, available at *http://www.eia.doe.gov/oiaf/aeo/*. These Department of Energy projections are similar to FAA estimates (FAA, Office of Environment and Energy, Aviation and Emission: A Primer, January 2005, at pages 10 and 23, available at *http://www.faa.gov/regulations_policies/policy_guidance/envir_policy/media/aeprimer.pdf*). The FAA projections were based on FAA long-range activity forecasts that assume a constant rate of emissions from aircraft engines in conjunction with an increase in aviation operations. It does not take into account projected improvements in aircraft, aircraft engines, and operational efficiencies.

[195] FAA, System for Assessing Aviation's Global Emissions, Version 1.5, *Global Aviation Emissions Inventories for 2000 through 2004,* FAA–EE–2005–02, September 2005, available at *http://www.faa.gov/about/office_org/headquarters_offices/aep/models/sage/*.

[196] International flights are those that depart from the U.S. and arrive in a different country.

[197] FAA, System for Assessing Aviation's Global Emissions, Version 1.5, *Global Aviation Emissions Inventories for 2000 through 2004,* FAA–EE–2005–02, September 2005, at page 10, at Table 3, available at *http://www.faa.gov/about/office_org/headquarters_offices/aep/models/sage/*.

[198] SF_6 is used as an insulating medium in the radar systems of some military reconnaissance planes. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, Volume 3, Industrial Processes and Product Use, Chapter 8, Other Product Manufacture and Use, Section 8.3, Use of SF_6 and HFCs in Other Products; *http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.htm*.

dampen climate change.[199] Contrails are unique to aviation operations, and persistent contrails are of interest because they increase cloudiness.[200] The IPCC Fourth Assessment Report (2007) has characterized the level of scientific understanding as low to very low regarding the radiative forcing of contrails and aviation induced cirrus clouds.[201] EPA requests information on the climate change compounds emitted by aircraft and the scientific understanding of their climate effects, including contrail formation and persistence.

b. Potential for GHG Reductions From Aircraft Operations

There are both technological controls and operational measures potentially available to reduce GHG emissions from aircraft and aircraft operations. These are discussed below.

i. Reducing GHG Emissions Through Aircraft Engine Changes

Fuel efficiency and therefore GHG emission rates are closely linked to jet aircraft engine type (e.g., high bypass ratio) and choice of engine thermodynamic cycles (e.g., pressure and temperature ratios), but modifications in the design of the engine's combustion system can also have a substantial effect on the composition of the exhaust.[202] Turbofan engines, with their high bypass ratios and increased temperatures, introduced in the 1970s and 1980s reduced CO_2, HC, and CO emissions, but in many cases put upward pressure on NO_X emission rates. Also, a moderate increase in the engine bypass ratio (high bypass turbofan) decreases fuel burn (and CO_2) by enhancing propulsive efficiency and reduces noise by decreasing exhaust velocity, but it may lead to increased engine pressure ratio and potentially higher NO_X. [203] There is no single relationship between NO_X and CO_2 that holds for all engine types. As the temperatures and pressures in the combustors are increased to obtain better efficiency, emissions of NO_X increase, unless there is also a change in combustor technology.[204] There are interrelationships among the different emissions and noise to be considered in engine design.

The three major jet engine manufacturers in the world are General Electric (GE), Pratt and Whitney, and Rolls-Royce. All of these manufacturers supply engines to both U.S. and non-U.S. aircraft manufacturers, and their engines are installed on aircraft that operate worldwide. These three manufacturers are now (or will be in the future) producing more fuel efficient (lower GHG) engines with improved NO_X. The General Electric GEnx jet engine is being developed for the new Boeing 787, and GE's goal is to have the GEnx engine meet NO_X levels 50 percent lower than the ICAO standards approved in 2005.[205] The combustor technology GE is employing is called the Twin Annular, Pre-mixing Swirler (TAPS) combustor. In addition, the GEnx is expected to improve specific fuel consumption by 15 percent compared to the previous generation of engine technology (GE's CF6 engine).[206]

Pratt and Whitney has developed the geared turbofan technology that is expected to deliver 12 percent reduction in fuel burn while emitting half of the NO_X emissions compared to today's engines. In addition to an advanced gear system, the new engine design includes the next generation technology for advanced low NO_X (TALON). The rich-quench-lean TALON combustor utilizes advanced fuel/air atomizers and mixers, metallic liners, and advanced cooling management to decrease NO_X emissions during the LTO and high-altitude cruise operations. Flight testing of the engine is expected this year, and introduction into service is expected in 2012.[207] Mitsubishi Heavy Industries has chosen the engine for its regional jet.[208] [209]

Rolls-Royce's Trent 1000 jet engine will power the Boeing 787s on order for Virgin Atlantic airlines. The Trent 1000 powered 787 is expected to improve fuel consumption by up to 15 percent compared to the previous generation of engines (Rolls-Royce's Trent 800 engine).[210] The technology in the Trent 1000 improves the operability of the compressors, and enables the engine to run more efficiently at lower speeds. This contributes to better fuel burn, especially in descent.[211]

ii. Reducing GHG Emissions Through Aircraft Changes

Aircraft (or airframe) efficiency gains are mainly achieved through aerodynamic drag and weight reduction.[212] Most of the fuel used by aircraft is needed to overcome aerodynamic drag, since they fly at very high speeds. Reduction of aerodynamic drag can substantially improve the fuel efficiency of aircraft thus reducing GHG emissions. Aerodynamic drag can be decreased by installing add-on devices, such as film surface grooves, hybrid laminar flow technology, blended winglets, and spiroid tips, and GHG emissions can be reduced by each of these measures from 1.6 to 6 percent.

[199] IPCC, Climate Change 2007—The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the IPCC, Chapter 2, Changes in Atmospheric Constituents and in Radiative Forcing.

[200] EPA, *Aircraft Contrails Factsheet*, EPA430–F–00–005, September 2000, developed in conjunction with NASA, the National Oceanic and Atmospheric Administration (NOAA), and FAA, available at *http://www.epa.gov/otaq/aviation.htm.*

[201] IPCC, Climate Change 2007—The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the IPCC, Chapter 2, Changes in Atmospheric Constituents and in Radiative Forcing, (page 202).

[202] IPCC, Aviation and the Global Atmosphere, 1999, at Aircraft Technology and Its Relation to Emissions, at page 221, at section 7.1, available at *http://www.grida.no/climate/ipcc/aviation/index.htm.*

[203] ICCIA, Technical Design Interrelationships, Presentation by Dan Allyn, ICCAIA Chair, at Aviation and the Environment Conference, March 19, 2008, available at *http://www.airlines.org/government/environment/Aviation+and+the+Environment+Conference+Presentations.htm.*

[204] IPCC, Aviation and the Global Atmosphere, 1999, at Aircraft Technology and Its Relation to Emissions, at page 237, at section 7.5.6, available at *http://www.grida.no/climate/ipcc/aviation/index.htm.*

[205] The NO_X standards adopted at the sixth meeting of ICAO's Committee on Aviation Environmental Protection (CAEP) in February 2004 were approved by ICAO in 2005.

[206] General Electric, Press Release, *Driving GE Ecomagination with the Low-Emission GEnx Jet Engine,* July 20, 2005, available at *http://www.geae.com/aboutgeae/presscenter/genx/genx_20050720.html.*

[207] Engine Yearbook, *Pratt & Whitney changing the game with geared turbofan engine,* 2008, at page 96.

[208] Aviation, Japanese Airliner to Introduce PW's New Engine Technology, by Chris Kjelgaard, October 9, 2007, available at *http://www.aviation.com/technology/071009-pw-geared-turbofan-powering-mrj.html.*

[209] The New York Times, *A Cleaner, Leaner Jet Age Has Arrived,* by Matthew L. Wald, April 9, 2008, available at *http://www.nytimes.com/2008/04/09/technology/techspecial/09jets.html?_r=1&ex=1208491200&en=6307ad7d1372acdf&ei=5070&emc=eta1&oref=slogin.*

[210] Rolls-Royce, Trent and the environment, available at *http://www.rolls-royce.com/community/downloads/trent_env.pdf and the Rolls-Royce environmental report*, Powering a better world: Rolls-Royce and the environment, 2007, available at *http://www.rolls-royce.com/community/environment/default.jsp.*

[211] Green Car Congress, *Rolls-Royce Wins $2.6B Trent 1000 Order from Virgin Atlantic; The Two Launch Joint Environmental Initiative,* March 3, 2008, available at *http://www.greencarcongress.com/2008/03/rolls-royce-win.html.*

[212] U.S. Department of Transportation, *Best Practices Guidebook for Greenhouse Gas Reductions in Freight Transportation—Final Report,* Prepared for U.S. Department of Transportation via Center for Transportation and the Environment, Prepared by H. Christopher Frey and Po-Yao Kuo, Department of Civil, Construction, and Environmental Engineering, North Carolina State University, October 4, 2007, available at *http://www4.ncsu.edu/~frey/Frey_Kuo_071004.pdf.*

Further discussion of these devices is provided below.

—Film surface grooves: This technology is undergoing testing, and it is an adhesive-backed film with micro-grooves placed on the outer surfaces of the wings and the fuselage of the aircraft. Film surface grooves are estimated to reduce total aerodynamic drag and GHG emissions by up to 1.6 percent.

—Hybrid laminar flow technology: Contamination on the airframe surface, such as the accumulation of ice, insects or other debris, degrades laminar flow. A newly developed concept, hybrid laminar flow technology (replace turbulent air flow), integrates approaches to maintain laminar flow. This technology can reduce fuel use by 6 to 10 percent and potentially GHG emissions by 6 percent.

—Blended winglets: A blended winglet is a commercially available wing-tip device that can decrease lift-induced drag. This technology is an extension mounted at the tip of a wing. The potential decreases in both GHG emissions and fuel use are estimated to be 2 percent.

—Spiroid tip: A spiroid tip has been pilot tested and, similar to blended winglets, it is intended to reduce lift-induced drag. This technology is a spiral loop formed by joining vertical and horizontal winglets. Greenhouse gas emissions and fuel use are both potentially estimated to be decreased by 1.7 percent.

Reductions in the weight of an aircraft by utilizing light-weight materials and weight reduction of non-essential components could lead to substantial decreases in fuel use. The weight of an airframe is about 50 percent of an aircraft's gross weight. The use of advanced lighter and stronger materials in the structural components of the airframe, such as aluminum alloy, titanium alloy, and composite materials for non-load-bearing structures, can decrease airframe weight. These materials can reduce structural weight by 4 percent. The potential reduction in greenhouse gas emissions and fuel use are estimated to both be 2 percent.

iii. Reducing GHG Emissions Through Operational Changes

Rising jet fuel prices tend to drive the aviation industry to implement practices to decrease fuel usage and lower fuel usage reduces GHG emissions.[213] Indeed this has occurred in the recent past where several airlines have reduced flights and announced plans to retire older aircraft. However, such practices are voluntary, and there is no assurance that such practices would continue or not be reversed in the future. Technology developments for lighter and more aerodynamic aircraft and more efficient engines which reduce aircraft fuel consumption and thus GHG emissions are expected to improve in the future. However, technology changes take time to find their way into the fleet. Aircraft and aircraft engines operate for about 25 to 30 years.

Air traffic management and operational changes are governed by FAA. The FAA, in collaboration with other agencies, is in the process of developing the next generation air transportation system (NextGen), a key environmental goal of which is to decrease aviation's contribution to GHG emissions by reducing aviation system-induced congestion and delay and accelerating air traffic management improvements and efficiencies. As will be discussed below, measures of this type implemented together with technology changes may be a way to reduce GHG emissions in the near term. A few examples of the advanced systems/procedures and operational measures are provided below.

Reduced Vertical Separation Minimum (RSVM) allows air traffic controllers and pilots to reduce the standard required vertical separation from 2,000 feet to 1,000 feet for aircraft flying at altitudes between 29,000 and 41,000 feet. This increases the number of flight altitudes at which aircraft maximize fuel and time efficiency. RSVM has led to about a 2 percent decrease in fuel burn.[214] Continuous Descent Approach is a procedure that enables continuous descent of the aircraft on a constant slope toward landing, as opposed to a staggered or staged approach, thus allowing for a more efficient speed requiring less fuel and reducing GHG emissions. Aircraft auxiliary power units (APUs) are engine-driven generators that supply electricity and pre-conditioned cabin air for use aboard the aircraft while at the gate. Ground-based electricity sources or electrified gates combined with preconditioned air supplies can reduce APU fuel use and thus CO_2 emissions substantially. Single-engine taxiing, a practice already used by some airlines, could be utilized more broadly to reduce CO_2 emissions.[215] Fuel consumption, and thus GHG emissions, could be reduced by decreasing the aircraft weight by reducing the amount of excess fuel carried. More efficient routes and aircraft speeds would be directly beneficial to reducing full flight GHG emissions. Operational safety must be considered in the application of all of these measures.

In regard to the above three sections, we request information on potentially available technological controls (technologies for airframes, main engines, and auxiliary power units) and operational measures to reduce GHG emissions from aircraft operations. Since FAA currently administers and implements air traffic management and operational procedures, EPA would share information on these items with FAA.

Efforts are underway to potentially develop alternative fuels for aircraft in the future. Industry (manufacturers, operators and airports) and FAA established the Commercial Aviation Alternative Fuels Initiative (CAAFI) in 2006 to explore the potential use of alternative fuels for aircraft for energy security and possible environmental improvements. CAAFI's goals are to have available for certification in 2008 a 50 percent Fischer-Tropsch synthetic kerosene fuel, 2010 for 100 percent synthetic fuel, and as early as 2013 for other biofuels. However, any alternative fuel would need to be compatible with current jet fuel for commercial aircraft to prevent the need for tank and system flushing on re-fueling and to meet comprehensive performance and safety specifications. In February 2008, Boeing, General Electric, and Virgin Atlantic airlines tested a Boeing 747 that was partly powered by a biofuel made from babassu nuts and coconut oil, a first for a commercial aircraft.

EPA requests information on decreasing aircraft emissions related to climate change through the use of alternative fuels, including what is feasible in the near-term and long-term and information regarding safety, distribution and storage of fuels at airports, life-cycle impacts, and cost information. Given the Agency's work to develop a lifecycle methodology for fuels as required by the Energy Independence and Security Act, EPA also is interested in information on the lifecycle impacts of alternative fuels.

[213] According to the Energy Information Administration, jet fuel prices increased by about 140 percent from 2000 to 2007 (see *http://tonto.eia.doe.gov/dnav/pet/hist/rjetnyhA.htm.*).

[214] PARTNER, Assessment of the impact of reduced vertical separation on aircraft-related fuel burn and emissions for the domestic United States, PARTNER–COE–2007–002, November 2007, available at *web.mit.edu/aeroastro/partner/reports/rsvm-caep8.pdf.*

[215] ICAO, *Operational Opportunities to Minimize Fuel Use and Reduce Emissions,* Circular 303 AN/176, February 2004, available at *http://www.icao.int/icao/en/m_publications.html.*

c. Options To Address GHG Emissions From the Aviation Sector

In the preceding nonroad sections, we have described a continuum of regulatory approaches that take us from traditional engine standards through a range of potential approaches for vehicle standards and even potential mechanisms to credit operational changes. For commercial aircraft, although the reasons to consider such continuum are just as valid, the means to accomplish these could be simpler. We see at least two potential basic approaches for regulating aircraft GHG emissions under the CAA, engine emission standards or a fleet average standard. These approaches are discussed further below.

The first approach we can consider is setting emission standards as an extension of our current program. Under this approach we would establish, for example, CO_2 exhaust emission standards and related requirements for all newly and previously certified engines applicable in some future year and later years. These standards could potentially cover all phases of flight. Depending on timing, this first set of standards could effectively be used to either establish baseline values and/or to require reductions.

As described earlier, ICAO and EPA currently require measurement and reporting of CO_2 emissions during engine exhaust gaseous emissions testing for the current certification cycle (although the current absence of this information for other GHGs does not rule out a similar approach for those GHGs).[216] Although test procedures for measuring CO_2 are in place already and LTO cycle CO_2 data exists, test requirements to simulate full-flight emissions are a significant consideration. Further work is needed to determine how CO_2 and other GHG emissions measured over the various modes of LTO cycle might be used to as a means to estimate or simulate cruise or full-flight emissions. A method has been developed by ICAO for determining NO_X for climb/cruise operations (outside the LTO) based on LTO data, and this could be a good starting point.[217] [218] For CO_2, and potentially NO_X and other GHGs as well, the climb/cruise methods could then be codified as test procedures, and we could then establish emission standards for these GHGs. We request comments on the need to develop a new test procedure for aircraft engines and the best approach to developing such a procedure, including the viability and need for altitude simulation tests for emissions certification.

Furthermore, to drive the development of engine technology, we could pursue near- and long-term GHG exhaust emission standards. Near-term standards, which could for example apply 5 years from their promulgation, would encourage engine manufacturers to use the best currently available technology. Long-term standards could require more significant reductions in emissions beyond the near-term values. In both cases, new standards could potentially apply to both newly and previously certified engines, but possibly at different levels and implementation dates based on lead time considerations. Under this approach, we would expect that no engines would be able to be produced indefinitely if they did not meet the new standards, except possibly based on the inclusion of an emissions averaging program for GHG as discussed below.

For emission standards applied to other mobile sources, EPA has often incorporated emission averaging, banking and trading (ABT) programs to provide manufacturers more flexibility in phasing-in and phasing-out engine models as they seek to comply with emission standards. In these types of programs, the average emissions within a manufacturer's current year product line are required to meet the applicable standard, which allows a manufacturer to produce some engines with emission levels above the standard provided they are offset with some below the standard. The calculation for average compliance is usually sales, activity, and power weighted. In addition, emissions credits and debits may be generated, banked and traded with other engine manufacturers. We request comment on the approaches to engine standards for reducing GHG emissions and an engine ABT program for new GHG emission standards, including whether certain GHGs, such as CO2, are more amenable than are other GHGs to being addressed by such a program.

As part of this option, we could pursue new standards and test procedures for PM that would encompass LTO and climb/cruise operations (ICAO and EPA currently do not have test procedures or emission standards for PM from aircraft), if we find that aircraft PM emissions cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare.[219] Work has been underway for several years under the auspices of the Society of Automotive Engineers E–31 Committee, and EPA/FAA are working actively with this committee to bring forth a draft recommended test procedure. In addition, requirements could potentially be proposed and adopted using the same approach as discussed above for GHGs for near- and long-term standards and newly and already certified engines.

In the preceding nonroad sections, we have discussed several approaches or variations on approaches to include vehicle and operational controls within a GHG emission control program for nonroad equipment. In doing so, we have not discussed direct regulation of equipment or fleet operators. Instead, we have focused on approaches that would credit fleet operators for improvements in operational controls within a vehicle or engine GHG standards program. Those approaches described in section VI.C.2 could apply to aircraft GHG emissions as well, and we request comments on the potential to apply those approaches to aircraft.

As a second approach, in the case of aircraft, it may be more practical and flexible to directly regulate airline fleet average GHG emissions. Under such an approach we would set a declining fleet average GHG emission standard for each airline, based on the GHG emission characteristics of its entire fleet. This would require GHG certification emission information for all engines in the fleet from the aircraft engine manufacturers and information on hours flown and average power (e.g., thrust). Airlines would have GHG emission baselines for a given year based on the engine emission characteristics of their fleet, and beginning in a subsequent year, airlines would be required to reduce their emissions at some annual rate, at some rolling average rate, or perhaps to some prescribed lower level in a future year. This could be done as a fleet average GHG emission standard for each airline or through a surrogate measure of GHGs such as airline total fuel consumption, perhaps adjusted for flight activity in some way. This could

[216] EPA's regulations at 40 CFR 87.62 require testing at each of the following operating modes in order to determine mass emission rates: taxi/idle, takeoff, climbout, descent and approach.

[217] ICAO, CAEP/7 Report, Working Paper 68, CAEP/7–WP/68, February 2007, see *http://www.icao.int.*

[218] ICAO has deferred work on using the NO_X climb/cruise method for a certification procedure and standards since future engines (potential new technologies) may behave in a different way. There may need to be future work to consider the aircraft mission, taking into account all phases of flight and the performance of the whole aircraft.

[219] As mentioned earlier, PM modifies or creates cloud cover, which in turn can either amplify or dampen climate change. Aircraft are also a source of PM emissions that contribute to local air quality near the ground, and the public health and welfare effects from these emissions are an important consideration.

cover all domestic operations and international departures of domestic airlines. The fleet average program could potentially be implemented in the near term since it is not as reliant on lead times for technology change.

Although we might develop such a declining fleet average emissions program based on engine emissions, an operational declining fleet average program could potentially be designed to consider the whole range of engine, aircraft and operational GHG control opportunities discussed above. Under this approach compliance with a declining fleet average standard would be based not only on parameters such as engine emission rates and activity, but could also consider efficiencies gained by use of improved operational controls. It is important to note that as part of this approach, a recordkeeping and reporting system would need to be established for airlines to measure and track their annual GHG emissions. Perhaps this could be accomplished through a surrogate measure of GHGs such as airline total fuel consumption. Today each airline reports its annual fuel consumption to the Department of Transportation. We request comment on the operational fleet average GHG emission standard concept, how it could be designed and implemented, what are important program design considerations, and what are potential metrics for establishing standards and determining compliance. While we have discussed two basic concepts above, we invite comment and information on any other approaches for regulating aircraft GHG emissions.

d. Other Considerations

We are aware that the European Commission (EC) has proposed a program to cap aviation-related CO_2 emissions (cap is 100% of sector's emissions during 2004–2006). They would by 2012 include CO_2 emissions from all flights arriving at and departing from European airports, including U.S.-certified aircraft, in the European Union Emissions Trading Scheme (ETS).[220, 221] If the proposal is adopted, airlines from all countries (EU and non-EU) will be required to submit allowances to cover emissions from all such aircraft flights over the compliance period (e.g., 5 years). The EU has expressed some interest in developing a program to waive this requirement for foreign-flagged carriers (non-EU carriers) whose nations develop ''equivalent'' measures. The petitioners discussed this program, and we invite comments on it.

The 36th Session of ICAO's Assembly met in September 2007 to focus on aviation emissions related to climate change, including the use of emissions trading.[222] In response to the EC's proposed aviation program, the Assembly agreed to establish a high-level group through ICAO to develop a framework of action that nations could use to address these emissions. A report with recommendations is due to be completed before the next Assembly Session in 2010. In addition, the Assembly urged all countries to not apply an emissions trading system to other nations' air carriers except on the basis of mutual consent between those nations.[223]

To address greenhouse gas emissions, ICAO's focus currently appears to be on the continued development of guidance for market-based measures.[224] These measures include emissions trading (for CO_2), environmental levies, and voluntary measures. Emissions trading is when an overall target or cap is established and a market for carbon is set. This approach allows participants to buy and sell allowances, the price of which is established by the market. Environmental levies include taxes and charges with the objective of generating an economic incentive to decrease emissions. Voluntary measures are unilateral actions by industry or in an agreement between industry and government to decrease emissions beyond the base case. Note, for ICAO's efforts on CO_2 emission charges, it evaluated an aircraft efficiency parameter, and in early 2004 ICAO decided that there was not enough information available at the time to create a parameter that correlated properly with aircraft/engine performance.[225] However, it is important to note, that unlike EPA, ICAO has not been petitioned under applicable law to determine whether GHG emissions from aircraft may reasonably be anticipated to endanger public health or welfare or to take any action if such a finding is made. We invite information on reducing overall emissions that relate to climate change from aircraft through a cap-and-trade system or other market-based system.

Another consideration in the GHG program is the regulation of emissions from engines commonly used in general aviation aircraft. As indicated earlier, our current aircraft engine requirements apply to gas turbine engines that are mainly used by commercial aircraft, except in cases where general aviation aircraft sometimes use commercial engines. Our requirements do not currently apply to many engines used in business jets or to piston-engines used in aircraft that fall under the general aviation category, although our authority under the Clean Air Act extends to any aircraft emissions for which we make the prerequisite finding that those emissions cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare.[226] In 2006, general aviation made up about one percent of the CO_2 emissions from U.S. domestic transportation sources, and about 8 percent of CO_2 emissions from U.S. domestic aircraft operations.[227] Regulating GHG emissions from this sector of aviation would require the development of test procedures and emission standards. EPA requests comment on this matter and on any elements we should consider in potentially establishing test procedures and emission standards for these currently unregulated engines.

5. Nonroad Sector Summary

There are a number of potential approaches for reducing GHG emissions from the nonroad sector within the regulatory structure of the CAA. In considering our next steps to address GHG emissions from this sector, we seek comment on all of the issues raised in this notice along with recommendations

[220] *Commission Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community,* 2006/0304 (COD), COM(2006) 818 final, December 20, 2006, available at *http://eur-lex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexplus!prod!DocNumber&1g=en&type_doc=COMfinal&an_doc=2006&nu_doc=818.*

[221] Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community—Political agreement, December 21, 2007 available at *http://register.consilium.europa.eu/pdf/en/07/st16/st16855.en07.pdf.*

[222] ICAO, Assembly—36th Session, Report of the Executive Committee on Agenda Item 17, A36–WP/355, September 27, 2007.

[223] ICAO, Assembly—36th Session, Report of the Executive Committee on Agenda Item 17, A36–WP/355, September 27, 2007.

[224] ICAO, ICAO Environmental Report 2007, available at *http://www.icao.int/env/.*

[225] ICAO, CAEP/6 Report, February 2004, available at *http:/www.icao.int.*

[226] As specified in 40 CFR 87.10, our emission standards apply to different classes of aircraft gas turbine engines, which have a particular minimum rated output. The engine class and rated output specifications correspond to certain engine operational or use practices, but we do not, by the terms of the rule, exempt general aviation aircraft or engines as such.

[227] U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006,* April 2008, USEPA #430–R–08–005, available at *http://www.epa.gov/climatechange/emissions/usinventoryreport.html.*

on the most appropriate means to address the issues.

D. Fuels

1. Recent Actions Which Reduce GHG Impacts of Transportation Fuels

Historically under Title II of the CAA, EPA has treated vehicles, engines and fuels as a system. The interactions between the designs of vehicles and the fuels they use must be considered to assure optimum emission performance at minimum cost. While EPA continues to view its treatment of vehicles, engines and fuels as a system as appropriate, we request comment on whether it would continue to be advantageous to take this approach for the purpose of controlling GHG emissions from the transportation sector. This section describes existing authorities under the CAA for regulating the GHG emissions contribution of fuels. In this discussion, we ask for comment on the combination of authorities that would suit the goal of GHG emission reductions from transportation fuel use.

In response to CAA section 211(o) adopted as part of the Energy Policy Act of 2005 (Energy Act of 2005), EPA issued regulations implementing a Renewable Fuels Standard (RFS) program (72 FR 23900, May 1, 2007). These regulations were designed to ensure that 4.0 billion gallons of renewable fuel were used in motor vehicles beginning in 2006, gradually increasing to 7.5 billion gallons in 2012. While the primary purpose of this provision of the Energy Act of 2005 was to reduce U.S. dependence on petroleum-based fuel and promote domestic sources of energy, EPA analyzed the extent to which reductions in GHG emissions would also result from the new RFS program. Therefore, for the first time in a major rule, EPA presented estimates of the GHG impacts of replacing petroleum-based transportation fuel with fuel made from renewable feedstocks.

In December 2007, EISA revised section 211(o) to set three specific volume standards for biomass-based diesel, cellulosic biofuel, and advanced biofuel as well as a total renewable fuel standard of 36 billion gallons annually by 2022. Certain eligible fuels must also meet specific GHG performance thresholds based upon a lifecycle GHG assessment. In addition to being limited to renewable fuels, EISA puts constraints on what land sources can be used to produce the renewable fuel feedstock, requires assessment of both primary and significant secondary land use impacts as part of the required lifecycle GHG emissions assessment, and has a number of other specific provisions that affect both the design of the rule and the required analyses. EISA requires that EPA adopt rules implementing these provisions by January 2009.

The U.S. federal government is not alone in considering or pursuing fuel changes which can result in reductions of GHG emissions from the transportation sector California is moving toward adopting a low carbon fuel standard that it anticipates will result in significant reductions in GHG emissions through such actions as increasing the use of renewable fuel and requiring refiners to offset any emission increases that might result from changes in crude oil supply. Canada, the countries of the European Union, and a number of other nations are considering or in the process of requiring fuel changes as part of their strategy to reduce GHG emissions from the transportation sector.

2. GHG Reductions Under CAA Section 211(o)

The two principal CAA authorities available to EPA to regulate fuels are sections 211(c) and 211(o). As explained in previously, section 211(o), added by the Energy Act of 2005 and amended by EISA, requires refiners and other obligated parties to assure that the mandated volumes of renewable fuel are used in the transportation sector. Section 211(o) only addresses renewable fuels; other alternative fuels such as natural gas are not included nor are any requirements imposed on the petroleum-based portion of our transportation fuel pool. EPA is authorized to waive or reduce required renewable fuel volumes specified in EISA under certain circumstances, and is also authorized to establish required renewable fuel volumes after the years for which volumes are specified in the Act (2012 for biomass-based diesel and 2022 for total renewable fuel, cellulosic biofuel and advanced biofuel). One of the factors EPA is to consider in setting standards is the impact of production and use of renewable fuels on climate change. In sum, EPA has limited discretion under 211(o) to improve GHG performance of fuels.

Changes in fuel feedstock sources (for example, petroleum versus biomass) and processing technologies can have a significant impact on GHG emissions when assessed on a lifecycle basis. As analyzed in support of the RFS rules, a lifecycle approach considers the GHG emissions associated with producing a fuel and bringing it to market and then attributes those emissions to the use of that fuel. In the case of petroleum, the lifecycle would account for emissions resulting from extraction of crude oil, shipping the oil to a refiner, refining the oil into a fuel, distributing the fuel to retail markets and finally the burning the gasoline or diesel fuel in an engine. This assessment is sometimes referred to as a ''well-to-wheels'' assessment. A comparable assessment for renewable fuel would include the process of growing a feedstock such as corn, harvesting the feedstock, transferring it to a fuel production facility, turning the feedstock into a fuel, getting the renewable fuel to market and then assessing its impact on vehicle emissions. EPA presented estimates of GHG impacts as part of the assessment for the Energy Act of 2005 RFS rulemaking that increasing renewable fuel use from approximately 4 billion gallons to 7.5 billion gallons by 2012. However, as noted below, the methodology used in that RFS rulemaking did not consider a number of relevant issues.

The 7.5 billion gallons of renewable fuel required by the Energy Act of 2005 program represents a relatively small portion of the total transportation fuel pool projected to be used in 2012 (add figure as % of energy). The much larger 36 billion gallons of renewable fuel required by EISA for 2022 would be expected to displace a much larger portion of the petroleum-based fuel used in transportation and would similarly be expected to have a greater impact on GHG emissions. Comments on the RFS proposal suggested improvements to the lifecycle assessment used in that rule. For instance, the RFS analysis did not fully consider the impact of land use changes both domestically and abroad that would likely result from increased demand for corn and soybeans as feedstock for ethanol and biodiesel production in the U.S. EPA largely agreed with these comments but was not able to incorporate a more thorough assessment of land use impacts and other enhancements in its lifecycle emissions modeling in time. We are undertaking such a lifecycle assessment as we develop the proposal to implement EISA fuel mandates. Because this updated lifecycle assessment will incorporate more factors and the latest data, it will undoubtedly change the estimates of GHG reductions included in the Energy Act 2005 RFS package.

EISA recognizes the importance of distinguishing between renewable fuels on the basis of their impact on lifecycle GHG emissions. Nevertheless, EISA stops short of directly comparing and crediting each fuel on the basis of its estimated impact on GHG emissions. For example, while requiring a minimum of 60% GHG emission reduction for cellulosic biomass fuel compared to the petroleum-based fuel displaced, EISA does not distinguish among the multiple pathways for producing cellulosic biofuel even though these pathways might differ significantly in their lifecycle GHG emission performance. It may be that the least costly fuels meeting the cellulosic biofuel GHG performance threshold will be produced which may not be the fuels with the greatest GHG benefit or even the greatest GHG benefit when considering cost (e.g., GHG reduction per dollar cost). The same consideration applies to other fuels and pathways. Without further delineating fuels on the basis of their lifecycle GHG impact, no incentive is provided for production of particular fuels which would minimize lifecycle GHG emissions within the EISA fuel categories.

We request comment on the importance of distinguishing fuels beyond the categories established in EISA and how an alternative program might further encourage the development and use of low GHG fuels. We also request comment on the ability (including considerations of uncertainty and the measurement of both direct and indirect emissions associated with the production of fuels) of lifecycle analysis to estimate the GHG emissions of a particular fuel produced and used for transportation and how EPA should delineate fuels (e.g., on the basis of feedstock, production technology, etc.). EPA notes that a certain level of aggregation in the delineation of fuels may be necessary, but that the greater the aggregation in the categories of fuels, the fewer incentives exist for changes in behavior that would result in reductions of GHG emissions. EPA asks for comment on this idea as well as how and whether methods for estimating lifecycle values for use in a regulatory program can take into account the dynamic nature of the market. EPA also requests comment on the relative efficacy of a lifecycle-based regulatory approach versus a price-based (e.g., carbon tax or cap and trade) approach to incentivize the multitude of actors whose decisions collectively determine the GHG emissions associated with the production, distribution and use of transportation fuels. Finally, we request comment on the ability to determine lifecycle GHG performance for fuels and fuel feedstocks that are produced outside the U.S.

EISA addresses impacts of renewable fuels other than GHG impacts. Section 203 of EISA directs that the National Academy of Sciences be asked to consider the impacts on producers of feed grains, livestock, and food and food products, energy producers, individuals and entities interested in issues relating to conservation, the environment and nutrition, users and consumers of renewable fuels, and others potentially impacted. Section 204 directs EPA to lead a study on environmental issues, including air and water quality, resource conservation and the growth and use of cultivated invasive or noxious plants. We request comment on what impacts other than GHG impacts should be considered as part of a potential fuels GHG regulation and how such other impacts should be reflected in any policy decisions associated with the rule. These impacts could include the potential impacts on food prices and supplies.

Programs under section 211(o) are subject to further limitations. Limited to renewable fuels, these programs do not consider other alternative fuels such as coal-to-liquids fuel that could be part of the transportation fuel pool and could impact the lifecycle GHG performance of the fuel pool. Additionally, EISA's GHG performance requirements are focused on the renewable fuels, not the petroleum-based fuel being replaced. Under EISA, the GHG performance of renewable fuels is tied to a 2005 baseline for petroleum fuel. No provision is included for considering how the GHG impacts of the petroleum-based fuel pool might change over time, either for the purpose of determining the comparative performance for threshold compliance of renewable fuels or for assessing the impact of the petroleum fuel itself on transportation fuel GHG emissions. Thus, for example, there is no opportunity under EISA to recognize and credit improvements in refinery operation which might improve the lifecycle GHG performance of the petroleum-based portion of the transportation fuel pool. Comments are requested on the importance of lowering GHG emissions from transportation fuels via the inclusion of alternative, non-renewable fuels in a GHG regulatory program as well as the petroleum portion of the fuel pool, thus providing opportunity to reflect improvements in refinery practices.

Finally while the current RFS and anticipated EISA programs will tend to improve the GHG performance of the transportation fuel pool compared to a business as usual case, they would not in any way cap the GHG emissions due to the use of fuels. In fact, under both programs, the total amount of fuel consumed and thus the total amount of GHG emissions from those fuels can both increase. We note that other lifecycle fuel standard programs being developed such as those in California, Canada, and Europe, while also taking into account the GHG emissions reduction potential from petroleum fuels, do not cap the emissions from the total fuel pool; the GHG per gallon of transportation fuel consumed may decrease but the total gallons consumed are not constrained such that the total GHG emissions from fuel may continue to grow. We request comment on setting a GHG control program covering all transportation fuels used in the United States which would also cap the total emissions from these transportation fuels.

Elsewhere in this notice, comments are solicited on the potential for regulating GHG emissions from stationary sources which could include petroleum refineries and renewable and alternative fuel production facilities. EPA recognizes the potential for overlapping incentives to control emissions at fuel production facilities. We request comment on the implications of using a lifecycle approach in the regulation of GHG emissions from fuels which would include refinery and other fuel production facilities while potentially also directly regulating such stationary source emission under an additional control program. Recognizing that the use of biomass could also be a control option for stationary sources seeking to reduce their lifecycle GHG impacts, EPA requests comment on the implications of using biomass for transportation fuel in potential competition as an energy source in stationary source applications.

3. Option for Considering GHG Fuel Regulation Under CAA Section 211(c)

Section 211(c)(1) of the CAA has historically been the primary authority used by EPA to regulate fuels. It provides EPA with authority to ''control or prohibit the manufacture, introduction into commerce, offering for sale, or sale of any fuel or fuel additive for use in a motor vehicle, motor vehicle engine, or nonroad engine of nonroad vehicle [(A)] if in the judgment of the Administrator any emission product of such fuel or fuel additive causes or contributes to air pollution or water pollution (including any degradation in the quality of groundwater) which may reasonably be anticipated to endanger public health or welfare.'' Section 211(c)(2) specifies that EPA must consider all available relevant medical and scientific information, including consideration of other technologically or economically feasible means of achieving vehicle emission standards under CAA section 202 before controlling a fuel under section 211(c)(1)(A). A prerequisite to action under 211(c)(1) is an EPA finding that a fuel or fuel additive, or emission product of a fuel or fuel additive, causes or contributes to air or water pollution that may reasonably be anticipated to endanger public health or welfare. Issues related to an endangerment finding are discussed in section V of this advance notice.

EPA asks for comment on whether section 211(c) could be read as providing EPA a broader scope of authority to establish a new GHG fuel program than section 211(o). Specifically, EPA asks for comment on whether section 211(c)(1)(A) could allow EPA to start the program as soon as appropriate in light of our analysis and similarly cover the time period most appropriate; whether it could allow a program that would encourage the use of both renewable and alternative fuels with beneficial GHG emissions impacts and discourage those fuels with relatively detrimental GHG impacts; and whether it could allow EPA to establish requirements for all fuels (gasoline, diesel, renewables, alternative and synthetic fuel, etc.) used in both highway and nonroad vehicles and engines. EPA requests comment on whether the flexibilities under section 211(c) allow it to consider a broad set of options for controlling GHG emissions through fuels, including those that solely regulate the final point of emissions such as tailpipe emissions rather than also controlling the emissions at the fuel production facility through a lifecycle approach.

Typically EPA has acted through CAA section 211(c) to prohibit the use of certain additives (e.g., lead) in fuel, to control the level of a component of fuel to reduce harmful vehicle emissions (e.g., sulfur, benzene), or to place a limit on tailpipe emissions of a pollutant (e.g., the reformulated gasoline standards for volatile organic compounds and toxics emissions performance). While multiple approaches may be available to regulate GHG emissions under section 211(c), one option could require refiners and importers of gasoline and diesel meet a GHG performance standard based on reducing their lifecycle GHG emissions of the fuel they import or produce. They would comply with this performance standard by ensuring the use of alternative and/or renewable fuels that have lower lifecycle GHG emissions than the gasoline and diesel they displace and through selection of lower petroleum sources that also reduce the lifecycle GHG performance of petroleum-based fuel. EPA asks comment on whether section 211(c) could authorize such an approach because it would be a control on the sale or manufacture of a fuel that addresses the emissions of GHGs from the transportation fuels that would be the subject the endangerment finding discussed in section V. Comments are requested on this interpretation of 211(c) authority.

As pointed out above, neither the Energy Act of 2005 RFS program nor the forthcoming program under EISA directly addresses the varying GHG emission reduction potential of each fuel type and production pathway. EPA asks comment on whether it could have the authority under CAA section 211(c) to design and implement a program that includes not only renewable fuels but other alternative fuels, considers the GHG emissions from the petroleum portion of the fuel pool and reflects differences in fuel production not captured by the GHG thresholds established under EISA, including differences in technology at the fuel production facility. We request comment on the factors EPA should consider in developing a GHG fuel control program under section 211(c) and how including such factors could serve to encourage the use of low GHG-emitting practices and technology.

We note that the RFS and the forthcoming EISA programs require refiners and other obligated parties to meet specified volume standards and that these programs are anticipated to continue. We request comment on the impacts and opportunities of implementing both a GHG program under 211(c) and volume mandates under 211(o).

EPA seeks comment on the potential for reducing GHG emissions from transportation fuel over and above those reductions that could be achieved by RFS and the anticipated EISA requirements. Although EPA has not completed its analysis of the GHG emission reductions expected under the combined RFS and EISA programs, EPA seeks comment on how it might structure a program that could reduce GHG emissions from transportation fuel over and above those reductions that could be achieved by the RFS and anticipated EISA requirements.

VII. Stationary Source Authorities and Potential Options for Regulating Greenhouse Gases Under the Clean Air Act

In this section, we explore three major pathways that the CAA provides for regulating stationary sources, as well as other stationary source authorities of the Act, and their potential applicability to GHGs. The three pathways include NAAQS and implementation plans (sections 107–110 and related provisions); performance standards for new and existing stationary sources (section 111); and hazardous air pollutant standards for stationary sources (section 112).[228] Special provisions for regulating solid waste incinerators are contained in section 129.

We also review the implications of regulating GHGs under Act's programs for preconstruction permitting of new emissions sources, with emphasis on the PSD program under Part C of the Act. These programs require permits and emission controls for major new sources and modifications of existing major sources. The permitting discussion closes by examining the implications of requiring operating permits under Title V for major sources of GHGs. Finally, we describe four different types of market-oriented regulatory designs that (in addition to other forms of regulation) could be considered for programs to reduce GHG emissions from stationary sources to the extent permissible under the CAA: cap-and-trade, rate-based emissions trading, emissions fees, and a hybrid approach.

For each potential pathway of stationary source regulation, this notice discusses the following basic questions:

- What does the section require?
- What sources would be affected if GHGs were regulated under this authority?
- What would be the key milestones and implementation timeline?
- What are key considerations regarding use of this authority for GHGs and how could potential issues be addressed?
- What possible implications would use of this authority for GHGs have for other CAA programs?

In discussing these questions, EPA considers the President's core principles and other policy design principles enumerated in Section III.F.1. EPA seeks comment on the advantages and disadvantages of alternative regulatory authorities in light of those policy design principles. EPA further invites comments on the following aspects of each CAA stationary source authority:

- How much flexibility does the CAA section provide for implementing its requirements? For example, can EPA set compliance dates that reflect the global

[228] As explained in this section, the NAAQS pathway is not solely a stationary source regulatory authority; plans for implementating the NAAQS can involve regulation of stationary and mobile sources.

and long-lived nature of GHGs and that allow time for technological advances and new technology deployment?

- To what extent would the section allow for consideration of the costs and economic impacts of regulating GHGs? For example, would the section provide opportunities for sending a price signal, such as through cap and trade programs (with or without cost containment mechanisms) and emission fees.
- To what extent can each section account for the international aspects of GHG emissions, atmospheric concentrations, and emission impacts, including ways for potentially addressing international pollutant transport and emission leakage?
- How does each section address the assessment of available technologies, and to what extent could the section promote or require the advancement of technology?
- To what extent does the section allow for the ability to prioritize regulation of significant emitting sectors and sources?
- To what extent could each authority be adapted to GHG regulation without compromising the Act's effectiveness in regulating traditional air pollutants?

Finally, for each regulatory authority, EPA requests comment on a range of program-specific issues identified in the discussion below. EPA also requests comment on whether there are specific statutory limitations that would best be addressed by new legislation. Additional information concerning potential CAA regulation of stationary source GHGs may be found in the Stationary Source Technical Support Document (Stationary Source TSD) placed in the docket for this notice.

A. National Ambient Air Quality Standards (NAAQS)

1. What Are the Requirements for Setting and Implementing NAAQS?

a. Section 108: Listing Pollutant(s) and Issuing Air Quality Criteria

Section 108(a)(1) establishes three criteria for listing air pollutants to be regulated through NAAQS. Specifically, section 108(a)(1) states that: EPA ''shall from time to time * * * list * * * each air pollutant—

(A) emissions of which, in [the Administrator's] judgment, cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare;

(B) the presence of which in the ambient air results from numerous or diverse mobile or stationary sources; and

(C) for which air quality criteria had not been issued before the date of enactment of the Clean Air Amendments of 1970, but for which [the Administrator] plans to issue air quality criteria under this section.''

In determining whether a pollutant meets these criteria, EPA must consider a number of issues, including many of those discussed in section IV above regarding an endangerment finding. As discussed there, in the context of the ICTA petition remand, EPA is considering defining the ''air pollution'' as the elevated current and future concentration of six GHGs (CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6). Also in that context, EPA is considering alternative definitions of ''air pollutant'' as the group of GHGs or each individual GHG for purposes of the ''cause or contribute'' determination.

In considering the potential listing of GHGs under section 108, EPA solicits input on appropriate definitions of both the ''air pollution'' and the ''air pollutants.'' With regard to section 108, it is important to note that EPA has clear precedents for listing related compounds as groups rather than as individual pollutants. For example, photochemical oxidants, oxides of nitrogen, and particulate matter all comprise multiple compounds, but the listing under section 108 is for the group of compounds, not the individual elements of the group. The Agency is soliciting comment on the relevance of these precedents for GHGs. In addition, as discussed later, there would be increased complexity in setting NAAQS for individual GHGs than for GHGs as a group. We are particularly interested in comments on how to apply the terms ''air pollution'' and/or ''air pollutants'' under sections 108 and 109 in the context of GHGs, and the implications of taking consistent or different approaches under other Titles or sections of the Act.

A positive endangerment finding for GHGs under section 202(a) or other sections of the CAA could have significant and direct impacts on EPA's consideration of the first two criteria for listing the pollutant(s) under section 108, as explained in section IV.B.2 of this notice. The third criterion for listing under section 108, however, may be unrelated to the issues involved in any motor vehicle or other endangerment finding. Moreover, this third criterion could provide EPA discretion to decide whether to list those pollutants under section 108 for purposes of regulating them via the NAAQS.[229] EPA requests comment on the effect of a positive finding of endangerment for GHGs under section 202(a) of the Act on potential listing of the pollutant(s) under section 108.

Section 108 also requires that once a pollutant is listed, EPA issue ''air quality criteria'' encompassing ''all identifiable effects on public health or welfare,'' including interactions between the pollutant and other types of pollutants in the atmosphere. We are interested in commenters' views on whether and how developing air quality criteria for GHGs would differ from developing such criteria for other pollutants such as ozone and particular matter, given the long-lived nature of GHGs and the breadth of impacts and other special issues involved with global climate change. EPA also invites comment on the extent to which it would be appropriate to use the most recent IPCC reports, including the chapters focusing on North America, and the U.S. government Climate Change Science Program synthesis reports as scientific assessments that could serve as an important source or as the primary basis for the Agency's issuance of ''air quality criteria.''

Finally, section 108 requires EPA to issue information on air pollution control techniques at the same time it issues air quality criteria. This would include information on the cost of installation and operation, energy requirements, emission reduction benefits, and environmental impacts of these techniques. Generally, the Agency defers this obligation until the time a standard is actually issued. As required under Executive Order 12866, EPA must issue a Regulatory Impact Analysis (RIA) for major rulemaking actions, and it is in this context that EPA has previously described the scope and effectiveness of available pollution control techniques. EPA requests comment on whether this approach is appropriate in the case of GHGs.

b. Section 109: Standard-Setting

Section 109 requires that the Administrator establish NAAQS for any air pollutant for which air quality criteria are issued under section 108. Both the air quality criteria and the standards are to be reviewed and, as appropriate, revised by the Administrator, every five years. These decisions are to be informed by an

[229] With respect to the third criterion, while there is a decision of U.S. Court of Appeals for the Second Circuit to the contrary, *NRDC* v. *Train*, 545 F.2d 320 (2nd Cir. 1978), EPA notes that that decision was rendered prior to the Supreme Court's decision in *Chevron* v. *Natural Resources Defense Council*, 467 U.S. 837 (1984). Thus, a proper and reasonable question to ask is whether this criterion affords EPA discretion to decide whether it is appropriate to apply the NAAQS structure to a global air pollution problem like GHGs.

independent scientific review committee, a role which has been fulfilled by the Clean Air Scientific Advisory Committee (CASAC) of EPA's Science Advisory Board. The committee is charged with reviewing both the air quality criteria for the pollutant(s) and the standards, and recommending any revisions deemed appropriate.

The statute specifically provides that primary NAAQS ''shall be ambient air quality standards the attainment and maintenance of which in the judgment of the Administrator, based on such criteria and allowing an adequate margin of safety, are requisite to protect the public health,'' including the health of sensitive groups. The requirement that primary standards provide an adequate margin of safety was intended to address uncertainties associated with inconclusive scientific and technical information available at the time of standard setting. It was also intended to provide a reasonable degree of protection against hazards that research has not yet identified. *Lead Industries Association* v. *EPA*, 647 F.2d 1130, 1154 (DC Cir 1980), *cert. denied*, 449 U.S. 1042 (1980); *American Petroleum Institute* v. *Costle*, 665 F.2d 1176, 1186 (DC Cir 1981), *cert. denied*, 455 U.S. 1034 (1982). The selection of any particular approach to providing an adequate margin of safety is a policy choice left specifically to the Administrator's judgment. *Lead Industries Association* v. *EPA*, 647 F.2d at 1161–62.

With regard to secondary NAAQS, the statute provides that these standards ''specify a level of air quality the attainment and maintenance of which in the judgment of the Administrator * * * is requisite to protect the public welfare from any known or anticipated adverse effects associated with the presence of such air pollutant in the ambient air.'' Welfare effects as defined in CAA section 302(h) include, but are not limited to, ''effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being.''

One of the central issues posed by potential regulation of GHGs through the NAAQS is the nature of the health and environmental effects to be addressed by the standards and, thus, what effects should be addressed when considering a primary (public health) standard and what effects should be addressed when considering a secondary (public welfare) standard. This issue has implications for whether it would be appropriate to establish a primary standard as well as a secondary standard for these pollutants. As discussed above in section V, the direct effects of GHG emissions appear to be principally or exclusively welfare-related. GHGs are unlike other current NAAQS pollutants in that direct exposure to GHGs at current or projected ambient levels appears to have no known adverse effects on human health. Rather, the health impacts associated with ambient GHG concentrations are a result of the changes in climate at the global, regional, and local levels, which trigger myriad ecological and meteorological changes that can adversely affect public health (e.g., increased viability or altered geographical range of pests or diseases; increased frequency or severity of severe weather events including heat waves) (see section V above). The effects on human health are thus indirect impacts resulting from these ecological and meteorological changes, which are effects on welfare. This raises the question of whether it is more appropriate to address these health effects as part of our consideration of the welfare effects of GHGs when setting a secondary NAAQS rather than a primary NAAQS. Control of GHGs would then occur through implementation of the secondary NAAQS rather than the primary NAAQS. EPA invites comment on whether and how these indirect human health impacts should be addressed in the context of setting a primary or a secondary NAAQS.

Past experience suggests EPA may have discretion to decline to set either a primary or a secondary standard for a pollutant if the evidence shows that there are no relevant adverse effects at or near current ambient concentrations, and therefore that no standard would be requisite to protect public health or welfare. In 1985, for example, EPA determined that it was appropriate to revoke the secondary standard for carbon monoxide (CO) after a review of the scientific evidence indicated that there was no evidence of known or anticipated adverse welfare effects associated with CO at or near ambient levels. 50 FR 37484, 37494 (September 13, 1985). This decision was reaffirmed by the Agency in the 1994 CO NAAQS review, and there remains only a primary standard for this pollutant. EPA requests comment on whether it would be necessary and/or appropriate for the Agency to establish both primary and secondary NAAQS for GHGs if those pollutants were listed under section 108.

It is also important to consider how a NAAQS for GHGs would interface with existing NAAQS for other pollutants, particularly oxides of nitrogen (NO_X) and ozone (O3), as well as particulate matter. EPA's approach in other NAAQS reviews has been to consider climate impacts associated with any pollutant as part of the welfare impacts evaluated for that pollutant in setting secondary standards for the pollutant. If separate NAAQS were established for GHGs, EPA would likely address the climate impacts of each specific GHG in the NAAQS for GHGs, and would not need to address the climate impacts of that GHG when addressing other NAAQS, thus avoiding duplication of effort.

In considering the application of section 109 to GHGs and whether it would be appropriate to regulate GHGs through the NAAQS, EPA must evaluate a number of other standard-setting issues, as discussed below.

i. Level

For potential GHG standards, EPA would face special challenges in determining the level of the NAAQS. As noted above, the primary standard must be ''requisite to protect public health with an adequate margin of safety'' and the secondary standard ''requisite to protect public welfare against any known or anticipated adverse effects.'' EPA's task is to establish standards that are neither more nor less stringent than necessary for the purposes of protecting public health or welfare. *Whitman* v. *American Trucking Associations*, 531 U.S. 457, 473. Under established legal interpretation, the costs of implementation associated with various potential levels cannot be factored into setting a primary or secondary standard.[230] Any determinations by the EPA Administrator regarding the appropriate level (and other elements of) of a NAAQS for GHGs must based on the available scientific evidence of adverse public health and/or public welfare impacts, without consideration of the costs of implementation.

EPA expects it would be difficult to determine what levels and other elements of NAAQS would meet these criteria for GHGs, given that the full effects associated with elevated atmospheric concentrations of these

[230] The Supreme Court has confirmed EPA's long-standing interpretation and ruled that ''[t]he text of § 109(b), interpreted in its statutory and historical context and with appreciation for its importance to the CAA as a whole, unambiguously bars cost considerations from the NAAQS-setting process.'' The court also noted that consideration of costs occurs in the state's formulation of the implementation plan with the aid of EPA cost data. *Whitman* v. *American Trucking Associations*, 531 U.S. at 472.

pollutants occur over a long period of time and there are significant uncertainties associated with the health or welfare impacts at any given concentration. The delayed nature of effects and the complex feedback loops associated with global climate change would require EPA to consider both the current effects and the future effects associated with current ambient concentrations. In making a determination of what standard is sufficient but not more stringent than necessary, EPA would also have to grapple with significant scientific uncertainty. As with other NAAQS, however, the iterative nature of the 5-year review cycle means the standards could be revised as appropriate in light of new scientific information as it becomes available. EPA requests comment on the scientific, technical, and policy challenges of determining appropriate levels for NAAQS for GHG pollutants, for both primary and secondary standards.

As with all pollutants for which EPA establishes NAAQS, EPA would need to evaluate what constitutes an ''adverse'' impact in the climate context. EPA notes that the 1992 UNFCCC calls for the avoidance of ''dangerous anthropogenic interference with the climate system.'' However, it is possible that the criteria for setting a NAAQS may call for protection against risks and effects that are less egregious than ''dangerous interference.'' Furthermore, international agreement has not been reached on either the metric (e.g., atmospheric concentrations of the six major directly emitted anthropogenic GHGs, radiative forcing, global average temperature increase) or the level at which dangerous interference would occur. EPA requests comment on whether it would be appropriate, given the unique attributes of GHGs and the significant contribution to total atmospheric GHG contributions from emissions emanating outside the United States, to establish a level for a GHG NAAQS based on an internationally agreed-upon target GHG level, considering legal and policy factors.

Another key question is the geographical extent of the human health and welfare effects that should be taken into consideration in determining what level and other elements of a standard would provide the appropriate protection. The pollutants already subject to NAAQS are typically local and/or regional in nature, so the standards are designed to limit ambient concentrations of pollutants associated with emissions typically originating in and affecting various parts of the United States. In assessing what standard is requisite to protect either public health or welfare, EPA has focused in the past on analyzing and addressing the impacts in the United States. It may be appropriate to interpret the Act as requiring standards that are requisite for the protection of U.S. public health and welfare. However, atmospheric concentrations of GHGs are relatively uniform around the globe, the impacts of climate change are global in nature, and these effects, as described in section V, may be unequally distributed around the world. The severity of impacts in the U.S. might differ from the severity of impacts in the rest of the world. In light of these factors, EPA invites comment on whether it would be appropriate to consider adverse effects on human health and welfare occurring outside the U.S. Specifically, we invite comment on whether, and if so, on what legal basis, it would be appropriate for EPA to consider impacts occurring outside the U.S. when those impacts, either in the short or long term, may reasonably be anticipated to have an adverse effect on health or welfare in the U.S.

As noted briefly above, if each GHG is listed as a separate pollutant under section 108, rather than as a group or category of pollutants, then EPA arguably would have to establish separate NAAQS for each listed GHG. This scenario raises significant challenges for determining which level of any particular standard is appropriate, especially as the science of global climate change is generally focused on the total radiative impact of the combined concentration of GHGs in the atmosphere. Since for any one pollutant, the standard that is requisite to protect public health with an adequate margin of safety or public welfare from known or anticipated adverse effects is highly dependent upon the concentration of other GHGs in the atmosphere, it would be difficult to establish independent standards for any of the six principal GHGs. EPA requests comments on possible approaches for determining appropriate levels for GHG NAAQS if these pollutants are listed individually under section 108.

ii. Indicator

If each GHG is listed as an individual pollutant under section 108, the atmospheric concentration of each pollutant could be measured separately, and establishing an indicator for each pollutant would be straightforward. However, if GHGs are listed as a group, it would be more challenging to determine the appropriate indicator for use in measuring ambient air quality in comparison to a GHG NAAQS. One approach could be to measure the total atmospheric concentration of a group of GHGs on a CO_2 equivalent basis, by assessing their total radiative forcing (measured in W/m^2).[231] Radiative forcing is a measure of the heating effect caused by the buildup of the GHGs in the atmosphere. Estimating CO_2-equivalent atmospheric concentrations, however, would not be a simple matter of multiplying emissions times their respective GWP values. Rather, the heating effect (radiative forcing) due to concentrations of each individual GHG would have to be estimated to define CO_2-equivalent concentrations. EPA invites comment on the extent to which radiative forcing could be an effective metric for capturing the heating effect of all GHGs in a group (or for each GHG individually). For example, in the year 2005 global atmospheric CO_2 concentrations were 379 parts per million (ppm), but the CO_2-equivalent concentration of all long-lived GHGs was 455 ppm. This approach would not require EPA to specify the allowable level of any particular GHG, alone or in relation to the concentration of other GHGs present in the atmosphere.

A second option would be to select one GHG as the indicator for the larger group of pollutants intended to be controlled under the standard. This kind of indicator approach is currently used in regulating photochemical oxidants, for which ozone is the indicator, and oxides of nitrogen, for which NO_2 has been used as an indicator. There are several reasons, however, that this approach may not be appropriate for GHGs. For example, in the instances noted above, the indicator species is directly related to the other pollutants in the group, either through common precursors or similar chemical composition, and there is a basis for expecting that control of the indicator compound will lead to the appropriate degree of control for the other compounds in the listed pollutant. In the case of GHGs, it would be more difficult to select one species as the indicator for the larger group, given that the GHGs are distinct in origin, chemical composition, and radiative forcing, and will require different control strategies. Furthermore, this approach raises an issue regarding whether states would have the appropriate incentive to address all pollutants within the group. For example, there could be a focus on controlling the single indicator species at the expense of other species also associated with the adverse effects from

[231] See footnote 13 for an explanation of CO_2 equivalency.

which the standard(s) are designed to offer protection.

EPA seeks comment on the merits and drawbacks of these various approaches, as well as suggestions for other possible approaches, to defining an indicator for measuring allowable concentrations of GHGs in the atmosphere.

c. Section 107: Area Designations

After EPA establishes or revises a NAAQS, the CAA requires EPA and the states to begin taking steps to ensure that the new or revised NAAQS are met. The first step is to identify areas of the country that do not meet the new or revised NAAQS. This applies to both the primary and secondary NAAQS. EPA is required to identify each area of the country as ''attainment,'' ''nonattainment,'' or ''unclassifiable.'' [232]

For a GHG NAAQS, the designations given to areas would depend on the level of the NAAQS and the availability of ambient data to make informed decisions for each area. For GHGs, in contrast to current NAAQS pollutants, it would likely make sense to conduct the air quality assessment at the national scale rather than at a more localized scale. All of the potential indicators discussed above for measuring ambient concentrations of GHGs for purposes of a NAAQS involve globally averaged metrics. Therefore, the ambient concentrations measured across all locations within the U.S. for purposes of comparison to the level of the standard would not vary, and all areas of the country would have the same designation—that is, the entire U.S. would be designated either attainment or non-attainment, depending on the level of the NAAQS compared to observed GHG ambient concentrations.

If, in making decisions about the appropriate level of the GHG NAAQS, EPA were to determine that current ambient concentrations are not sufficient to cause known or anticipated adverse impacts on human health or welfare now or in the future, then it is possible that the NAAQS would be set at some level higher than current ambient concentrations. In that case, the entire country would likely be designated nonattainment. If, on the other hand, EPA were to set the NAAQS at a level above current ambient concentrations, the entire country would likely be designated attainment.

d. Section 110: State and Federal Implementation Plans

i. State Implementation Plans

The CAA assigns important roles to EPA, states, and tribal governments in implementing NAAQS and in ensuring visibility protection in Class I areas. States have the primary responsibility for developing and implementing state implementation plans (SIPs). A SIP is the compilation of authorities, regulations, control programs, and other measures that a state uses to carry out its responsibilities under the CAA to attain, maintain, and enforce the NAAQS and visibility protection goals, and to prevent significant deterioration of air quality in areas meeting the standard. Additional specifics on SIP requirements are contained in other parts of the CAA.

EPA assists states and tribes in their efforts to clean the air by promulgating national emissions standards for mobile sources and selected categories of stationary sources. Also, EPA assists the states in developing their plans by providing technical tools, assistance, and guidance, including information on potentially applicable emissions control measures.

Historically, the pollutants addressed by the SIP program have been local and regional pollutants rather than globally mixed pollutants like GHGs. The SIP development process, because it relies in large part on individual states, is not designed to result in a uniform national program of emissions controls.

(1) Generic Requirements for All SIPs

This section discusses the specific CAA requirements states must address when implementing any new or revised NAAQS.[233]

Under section 110(a)(1) and (2) of the CAA, all states are required to submit plans to provide for the implementation, maintenance, and enforcement of any new or revised NAAQS. Section 110(a)(1) and (2) require states to address basic program elements, including requirements for emissions inventories, monitoring, and modeling, among other things. These requirements apply to all areas of the state regardless of whether those areas are designated nonattainment for the NAAQS.

In general, every state is required to submit to EPA within 3 years of the promulgation of any new or revised NAAQS a SIP demonstrating that these basic program elements are properly addressed. Subsections (A) through (M) of section 110(a)(2) enumerate the elements that a state's program must contain. See the Stationary Source TSD for this list.

Other statutory requirements for state implementation plans vary depending on whether an area is in nonattainment or attainment. There are four specific scenarios that could hypothetically apply, depending on whether a primary or a secondary standard, or both, are established, and on the level(s) set for those standards. Because we are proposing no scientific determinations in this notice, our discussion of NAAQS implementation addresses all four of these scenarios.

(2) Scenario 1: Primary GHG Standard With Country in Nonattainment

If the entire country were designated nonattainment for a primary GHG NAAQS, each state would be required to develop and submit a SIP that provided for attainment and met the other specific requirements of Part D of Title I of the Act by the specified deadline.

Requirements for the general contents of a nonattainment area plan are set forth in section 172 of the CAA. Section 172(c) specifies that SIPs must, among other things: [234]

- Include all Reasonably Available Control Measures (RACM) (including, at a minimum, emissions reductions obtained through adoption of Reasonably Available Control Technology (RACT)) and provide for attainment of the NAAQS;
- Provide for Reasonable Further Progress (RFP), which means reasonable interim progress toward attainment;
- Include an emissions inventory;
- Require permits for the construction and operation of major new or modified stationary sources, known as

[232] CAA Section 107(d)(1) requires EPA to establish a deadline for states to submit recommendations for area designations that is no later than one year after promulgation of the new or revised NAAQS. Section 107(d)(1) also directs states to recommend appropriate area boundaries. A nonattainment area must consist of that area that does not meet the new or revised NAAQS, and the area that contributes to ambient air quality in a nearby area that does not meet the new or revised NAAQS. Thus, a key factor in setting boundaries for nonattainment areas is determining the geographic extent of nearby source areas contributing to the nonattainment problem. EPA then reviews the states' recommendations, collects and assesses additional information as appropriate, and issues final designations no later than 2 years following the date EPA promulgated the new or revised NAAQS. EPA may take one additional year (meaning final designations can be up to 3 years after promulgation of new or revised NAAQS) if the Administrator has insufficient information to promulgate the designations. Whether or not a state or a Tribe provides a recommendation, EPA must promulgate the designation that it deems appropriate.

[233] The visibility protection program required by CAA sections 169A and 169B, and as implemented through state compliance with EPA's 1999 Regional Haze Rule, will only be raised again here in this section of the ANPR in the context of a framework for implementing a secondary GHG NAAQS.

[234] For additional information about nonattainment area planning requirements, please see the Technical Support Document.

''nonattainment new source review'' (see also section 173 of the Act and section VII.E. of this notice);

- Contain contingency measures that are to be implemented in the event the air quality standard is not met by the area's attainment deadline; and
- Meet the applicable provisions of section 110(a)(2) of the CAA related to the general implementation of a new or revised NAAQS.

In addition, all nonattainment areas must meet requirements of section 176(c) known as ''general conformity'' and ''transportation conformity.'' [235] In brief, general conformity requires the federal government only to provide financial assistance, issue a permit or approve an activity that conforms to an approved SIP for a NAAQS. Transportation conformity requires metropolitan planning organizations and the U.S. Department of Transportation only to approve or fund transportation plans, programs and projects that conform to an approved SIP for a NAAQS. For the scenario of the country in nonattainment with a GHG NAAQS, these requirements would apply nationwide one year after the effective date of EPA's nonattainment designations.

For nonattainment areas, SIPs must provide for attainment of the primary NAAQS as expeditiously as practicable, but no later than 5 years from the effective date of the nonattainment designation for the area—or no later than 10 years if EPA finds additional time is needed considering the severity of nonattainment and the availability and feasibility of pollution control measures.

At the outset, it would appear to be an inescapable conclusion that the maximum 10-year horizon for attaining the primary NAAQS would be ill-suited to GHGs. The long atmospheric lifetime of the six major emitted GHGs means that atmospheric concentrations will not quickly respond to emissions reduction measures (with the possible exception of methane, which has an atmospheric lifetime of approximately a decade). In addition, in the absence of substantial cuts in worldwide emissions, worldwide concentrations of GHGs would continue to increase despite any U.S. emission control efforts. Thus, despite active control efforts to meet a NAAQS, the entire U.S. would remain in nonattainment for an unknown number of years. If States were unable to develop plans demonstrating attainment by the required date, the result would be long-term application of sanctions, nationwide (e.g., more stringent offset requirements and restrictions on highway funding), as well as restrictions on approvals of transportation projects and programs related to transportation conformity. EPA is currently evaluating the extent to which section 179B might provide relief to states in this circumstance. As further explained below, section 179B is a waiver provision providing for SIP approval under certain circumstances when international emissions affect a U.S. nonattainment area.

In addition to submitting plans providing for attainment within the state, each state would be required to submit, within 3 years of NAAQS promulgation, a plan under section 110(a)(2)(D) prohibiting emissions that would significantly contribute to nonattainment in another state. EPA requests comments on what approaches could be utilized for purposes of addressing this requirement as well as the general matter of controlling GHGs to meet a NAAQS.

Impact of section 179B on nonattainment requirements: States may use section 179B of the CAA to acknowledge the impact of emissions from international sources that may contribute to violations of a NAAQS. Section 179B provides that EPA shall approve a SIP for a nonattainment area if: (1) The SIP meets all applicable requirements of the CAA; and (2) the submitting state can satisfactorily demonstrate that ''but for emissions emanating from outside of the United States,'' the area would attain and maintain the applicable NAAQS. EPA has historically evaluated these ''but for'' demonstrations on a case-by-case basis, based on the individual circumstances and the data provided by the submitting state. These data might include ambient air quality monitoring data, modeling scenarios, emissions inventory data, and meteorological or satellite data. In the case of GHGs, however, where global emissions impact all areas within the United States, the federal government may be best suited for establishing whether a ''but for'' demonstration can be made for the entire country.

If a ''but for'' conclusion is affirmed, section 179B would allow EPA to approve a SIP that did not demonstrate attainment or maintenance of the relevant NAAQS. Section 179B does not provide authority to exclude monitoring data influenced by international transport from regulatory determinations related to an area's status as an attainment or nonattainment area. Thus, even if EPA approves a section 179B ''but for'' demonstration for an area, the area would continue to be designated as nonattainment and subject to certain applicable nonattainment area requirements, including nonattainment new source review, conformity, and other measures prescribed for nonattainment areas by the CAA. EPA requests comment on the practical effect of application of section 179B on the global problem of GHG emissions and on the potential for controls based on the attainment plan requirement and other requirements directly related to the attainment requirement, including the reasonable further progress requirement and the RACM requirement.[236]

(3) Scenario 2: Secondary Standard With Country in Nonattainment (No Primary Standard)

As noted above in the NAAQS standard-setting discussion, depending on the nature and bases of any endangerment finding under section 108, EPA may be able to consider setting only a secondary NAAQS for GHGs and not also a primary NAAQS.

In general, the same nonattainment requirements that apply to SIPs for a primary standard apply for a secondary standard, including nonattainment new source review and the other programs listed under the Scenario 1 subsection above.

A notable difference in nonattainment requirements for primary and secondary standards is the time allowed for attainment. Under a secondary standard, state plans must achieve attainment as expeditiously as practicable, but there is no statutory maximum date for attainment. The general requirement to attain as expeditiously as practicable includes consideration of required controls, including ''reasonably available control measures.'' These requirements do allow for consideration of cost. What would constitute ''as expeditiously as practicable'' would be determined based on the entire set of facts and circumstances at issue. EPA requests comment on how to interpret

[235] These requirements also apply to ''maintenance areas''—former nonattainment areas that have met the standard and been redesignated according to a formal EPA determination.

[236] EPA has interpreted RACM as emissions reducing measures that are technically and economically feasible, and considered collectively would advance the nonattainment area's attainment date by at least one year. RACT has been interpreted in two different ways, depending on the applicable statutory requirements. In the case of ozone, RACT consists of measures that are technically and economically feasible, without regard to whether the measures would result in earlier attainment. In recent rules on PM2.5, EPA interpreted RACT for PM2.5 as essentially the same as RACM, with RACT referring to the stationary source component of RACM, which applies to all types of sources.

the requirement that state plans demonstrate that attainment will be achieved ''as expeditiously as practicable'' in the context of a secondary NAAQS for GHGs.

Potential implementation approach based on regional haze model: For a secondary GHG NAAQS with no prescribed attainment date, EPA requests comment on the concept of implementing a GHG secondary NAAQS standard in a way roughly analogous to an approach used in the long-term regional visibility program, known as the regional haze program. This program is based on a goal of achieving natural visibility conditions in our nation's parks and wilderness areas (Class I areas) by 2064. The program requires states to develop reasonable progress goals every 10 years and implement emissions control programs to achieve those goals, ultimately achieving the 2064 natural condition goal in each Class I area. At the midpoint of every 10-year period, states must assess the progress being made and take corrective action if necessary to maintain reasonable progress toward the 10-year progress milestone.

The regional haze program's model for goal planning, control strategy development, and control strategy implementation could offer a possible framework for achieving a GHG secondary NAAQS. This framework potentially could be designed to address the RACM, RACT and Reasonable Further Progress requirements, as well as the attainment planning requirement. This framework may also provide a mechanism for implementing a nationwide GHG emissions cap and trade program adopted and implemented through state plans. However, EPA recognizes that the global nature of GHGs and their persistence in the atmosphere make an approach based on ''reasonable'' progress more difficult to implement than in the case of regional haze. For example, despite domestic emissions reductions, it might not be possible to discern improvement in atmospheric concentrations of GHGs due to their relatively long atmospheric lifetimes or to growth in emissions from other countries which could eclipse reductions made in the U.S. We note that using this framework would not provide relief from any of the applicable nonattainment area requirements of the Act. EPA requests comment on whether, and if so how, the regional haze approach could be adapted for use in the GHG context.

(4) Scenarios 3 and 4: Primary and/or Secondary Standard With Country in Attainment

If a primary or secondary GHG NAAQS were set at a level higher than ambient GHG levels at the time of designations, then the country would be in attainment. (See preceding section on NAAQS standard-setting for discussion of this issue.) In this case, a much shorter list of requirements would apply than if the country were in nonattainment.

SIPs would be required to include PSD programs for GHGs, which would require preconstruction permitting of new major sources and significant modifications to existing major sources. (See section VII.D on PSD.)

EPA has identified two other requirements that potentially could apply, both of which could provide authority for a nationwide cap-and-trade program implemented at the state level. First, section 110(a)(1) requires states to submit a SIP providing for ''implementation, maintenance, and enforcement'' of primary and secondary NAAQS. Under the scenario of a GHG NAAQS with the country in attainment, where states may need more than PSD/NSR to maintain attainment, EPA could consider using this provision to require SIPs to provide for maintenance of air quality consistent with the GHG standard. This requirement could be implemented through a nationwide cap-and-trade program designed at the federal level and adopted by individual states in their SIPs, a program similar but broader in scope than existing programs such as the more limited NO_X SIP Call regional cap-and-trade system for EGUs and selected industrial source categories. If a state failed to submit an adequate maintenance SIP, EPA would be required to develop and implement a federal implementation plan for that state. EPA could design the FIP to enable the state to participate in a nationwide cap-and-trade system.

Second, section 110(a)(2)(D) requires SIPs to prohibit emissions that would interfere with maintenance of the standard by other states. Because GHGs are globally well-mixed, it may be that GHGs emitted from any state could be found to interfere with maintenance of a GHG NAAQS in every other state. In the past, EPA has issued rules that have resulted in states adopting interstate cap-and-trade programs (e.g., the Clean Air Interstate Rule) implemented through SIPs to address the requirements of this provision. In the case of GHGs, this authority could potentially support a nationwide cap-and-trade program for GHGs, adopted through SIPs. If a state failed to submit its section 110(a)(2)(D) SIP, EPA would be required to develop and implement a FIP for that state. EPA could design the FIP to enable the state to participate voluntarily in a nationwide cap-and-trade system. We request comment on the suitability of adopting either of these approaches under section 110(a).

ii. Additional CAA Provisions Affecting SIP Obligations and FIPs

(1) Section 179(a)

The CAA requires states to submit SIPs to EPA for review, and EPA must approve or disapprove them based on whether the state plan or component meets the Act's requirements. An EPA finding that a state has failed to submit a nonattainment plan or plan component, or an EPA disapproval of such a plan because it does not meet the requirements of the Act, would start a ''sanctions clock'' under section 179(a). This means that sanctions would apply in the state if the deficiencies are not corrected within prescribed deadlines. These sanctions include additional requirements for major new sources (18 months after the finding of failure) and restrictions on federal highway funds (6 months after the offset sanction).[237] EPA must promulgate a FIP for the deficient component of the SIP if the state's plan component is not approved within 2 years of EPA's finding or disapproval action. In the case of GHGs, it is possible that EPA could design the FIP to enable the state to participate in a nationwide cap-and-trade system.

(2) Section 115

CAA section 115 creates a mechanism through which EPA can require states to amend their SIPs to address international transport issues. It is designed to protect public health and welfare in another country from air pollution emitted in the U.S. provided the U.S. is given essentially reciprocal rights with respect to prevention and control of air pollution originating in the other country. The Administrator could exercise his authority under this provision if EPA were to promulgate a NAAQS for GHG.

To act under section 115, the Administrator would need to make a finding that, based on information from any duly constituted international agency, he has reason to believe that air pollutants (GHGs) emitted in the U.S. causes or contributes to air pollution which may reasonably be anticipated to endanger public health or welfare in a foreign country. Upon making such a finding, the Administrator would give

[237] 40 CFR 52.31.

formal notification to the Governor of the state (or in this case potentially all of the states) where GHGs originate. A finding under this section has the same regulatory consequences as a finding that the state's existing SIP is inadequate to attain the NAAQS or otherwise meet the requirements of the Act. This notification would require the notified states to modify their SIPs to prevent or eliminate the endangerment.

Addressing GHGs under this authority could allow some flexibility in program design, subject to limitations of the SIP development process. Section 115 could not be used to require states to incorporate into their SIPs measures unrelated to attainment or maintenance of a NAAQS. A factor to consider is that this section of the Act only applies where countries that suffer possible endangerment give reciprocal rights to the U.S. However, reciprocity with one or more affected countries may be sufficient to trigger section 115. We request comment on the efficacy of using section 115 as a mechanism to facilitate more effective regulation of GHGs through a NAAQS.

2. What Sources Would Be Affected?

Sections 108 and 109 impose no controls directly on sources, but instead establish the air quality benchmarks that control requirements would be designed to meet. The precise nature of these controls would be determined through federal and state programs, as established via SIPs and, for states failing to submit an approvable plan, FIPs. Considering that GHGs are emitted by a wide array of sources, it is likely that NAAQS implementation would result in controls on numerous stationary and mobile sources through sections 110 and 172.

The federal government could have less flexibility under the NAAQS approach to target control efforts toward particular groups of existing stationary sources. Under the traditional SIP approach, emissions controls on specific source categories would flow from independent state-level decisions, and could result in a patchwork of regulations requiring different types and levels of controls in different states. However, the SIP approach could also be adapted for use in a more coordinated strategy. As mentioned above, EPA has in the past issued rules that have resulted in states adopting limited interstate cap-and-trade programs (e.g., NO_X SIP Call and the Clean Air Interstate Rule) implemented through state SIPs. Furthermore, the federal government would also have flexibility to design a national control program in the event that states did not adopt the required programs and EPA were required to promulgate a FIP.

EPA requests comment on whether and how the different implementation provisions within the NAAQS program could be adapted to be most suitable for application to control GHGs.

3. What Would Be the Key Milestones and Implementation Timeline?

The key milestones that would apply if EPA were to regulate GHGs as a NAAQS pollutant include: listing the pollutant(s); issuing air quality criteria; issuing information on air pollution control techniques; proposing primary and secondary NAAQS for the pollutants; issuing final standards; designating areas; development of SIPs/FIPs; and application of control measures.

EPA has discretion with regard to the date of listing of a pollutant under section 108. The statute does not prescribe any specific deadline for listing, instead stating that EPA ''shall from time to time * * * list * * * each air pollutant'' that EPA judges meets the three criteria discussed above. This could provide the Agency some latitude in determining the precise timing of any listing.

Once a pollutant is listed, the CAA specifies a very ambitious timeline for issuing the initial NAAQS for the pollutant. Section 108 allows 12 months between date of listing and issuance of air quality criteria for the pollutant(s). Since these criteria are intended to encompass ''all identifiable effects on public health or welfare,'' it would be difficult to meet this timeline in the case of GHGs. In 1970, when the NAAQS program was first established under the CAA, air quality criteria either were in development or had already been issued for a variety of pollutants, and the process involved consideration of a much smaller body of science than is now available. Therefore, the 12-month period allotted for the initial issuance of air quality criteria appeared reasonable.[238] However, based on recent NAAQS reviews for ozone, particulate matter, lead, and other pollutants, it now generally takes several years for the Agency to complete the thorough scientific assessment necessary to issue air quality criteria.

Given the complexity of global climate change science, and the vast amount of research that would be relevant to the Agency's scientific assessment, EPA anticipates this task would be particularly time consuming in the case of GHGs, though relying on synthesis reports such as the Intergovernmental Panel on Climate Change's Fourth Assessment Report and various reports of the U.S. Climate Change Science Program could help expedite the process. The challenge of completing a thorough scientific assessment for GHGs could result in a significant delay in listing the pollutant(s) under section 108, since EPA would likely choose to list GHGs only when the scientific assessment had progressed sufficiently to enable the Agency to meet the statutory requirement to issue ''air quality criteria'' within one year of listing, and to meet the tight rulemaking timeframe, discussed below. To the extent that EPA addresses GHGs through this CAA mechanism, EPA requests comments on the issuance of ''air quality criteria'' following listing, as well as the adequacy of the available scientific literature.

Under section 109, EPA must propose NAAQS for any newly listed pollutant at the same time it issues air quality criteria under section 108, and must finalize those standards within 90 days after proposal. Thus, from the date of listing a pollutant(s) under section 108, the Agency has only 12 months to propose standards, and only 3 additional months to issue final NAAQS for the pollutant(s). This tight timeframe would be particularly challenging in the case of GHGs, for which review and synthesis of an enormous body of literature would be required before a proposal could be issued. Furthermore, it is important to note that while subsequent NAAQS reviews of existing standards are required on a revolving 5-year cycle, EPA has found it challenging to meet even this extended schedule, which generally allows 9–12 months between issuance of the air quality criteria and proposal and an additional 6 months or more for issuance of final standards.

Once a new standard has been established, the CAA allows EPA to establish a deadline for states to submit designation recommendations that is no later than one year after promulgation of the new or revised NAAQS. EPA then reviews the states' recommendations, collects and assesses additional information as appropriate, and issues final designations no later than 2 years following the date EPA promulgated the new or revised NAAQS. EPA may take up to one additional year if the Administrator has insufficient

[238] For each air pollutant for which air quality criteria had already been issued prior to enactment of the Clean Air Act Amendments of 1970, section 109(a)(1) actually required EPA to issue proposed NAAQS within 30 days of enactment and to finalize those standards within 90 days of publication of the proposal. This included carbon monoxide, ozone, particulate matter, hydrocarbons, and sulfur oxides.

information to promulgate the designations, which could push the date of final designations out to three years after promulgation of a new GHG NAAQS.

The timeline for SIP submittal and implementation of control requirements depends an area's designation status (attainment, nonattainment, unclassifiable) and whether there is only a secondary NAAQS, or both a primary and a secondary standard. These various scenarios are described above. As a first step, regardless of attainment status of level of the standard, states must submit infrastructure SIPs to EPA within 3 years of the promulgation of any new or revised NAAQS. These SIPs demonstrate that certain basic program elements (including emissions inventories, monitoring, and modeling) are properly addressed. Areas that are designated attainment would face a much shorter list of requirements, which are discussed above in the context of, Scenarios 3 and 4.

For areas designated nonattainment with a primary standard, states must submit nonattainment SIPs no more than 3 years after the effective date of designations, and must reach attainment no later than 5 years after the effective date designations. EPA can extend the attainment deadline by up to an additional 5 years—i.e., to no later than 10 years after the effective date of designations, if EPA finds additional time is needed considering the severity of nonattainment and the availability and feasibility of pollution control measures.

As noted above, the maximum 10-year horizon for attaining the primary NAAQS is ill-suited to pollutants such as GHGs with long atmospheric residence times. It is probable that, despite active control efforts, the entire U.S. would remain in nonattainment for an indefinite number of years if the level of a NAAQS were set at or below current atmospheric concentrations; whether attainment would ever be reached would depend on the timing and stringency of GHG control measures implemented on a global basis.

For areas designated nonattainment with a secondary standard only, the attainment schedule could be significantly longer. The CAA requires that state plans under a secondary standard must provide for reaching attainment as expeditiously as practicable, but there is no statutory maximum date for attainment (e.g., up to 10 years). EPA requests comment on the suitability of adapting this approach for use in the GHG context, and specifically, on the schedule that could reasonably be considered as ''expeditious as practicable.'' We also request comment on how global emissions should be taken into consideration in this context.

EPA requests comment on whether the avenues discussed in this notice, or alternative approaches, could facilitate schedule adjustments that would better enable use of the NAAQS approach for regulating GHGs.

4. What Are Key Considerations Regarding Use of This Authority for GHGs?

a. Possible Cost and Emissions Impacts

Listing GHGs as pollutants under section 108 and setting NAAQS under section 109 would have no direct cost or emissions impacts. However, these actions would trigger further federal actions, including designations under section 107, and state or federal actions through SIPs or FIPs developed under section 110 and other provisions in title I of the CAA. Thus, the listing of GHGs as NAAQS pollutants would likely lead to the adoption of a substantial control program affecting sources across the nation.

Because establishing NAAQS for a pollutant sets in motion a broad and prescriptive implementation process that could affect a wide array of stationary and mobile sources, it is likely to entail substantial costs. The magnitude of these costs would depend, in part, on the relative reliance on technologies which are not yet suitable for commercial application or which have not yet been developed. Though this problem affects other pollutants, it is more acute in the case of GHGs. The timing and nature of controls instituted, and thus the costs, would depend to a significant extent on an area's designation status and whether EPA set only a secondary NAAQS (with a longer implementation time horizon), or a primary standard as well (with a more rapid and rigid compliance schedule, allowing less time for technological advances and efficiency improvements). The standard set and the nature of GHGs could also determine whether it is feasible to attain a NAAQS in the near-term, or how costly attainment could be over a longer term.

One important aspect of the NAAQS approach is that the standards themselves (both primary and secondary) are established without consideration of these costs. EPA requests comment on the suitability of establishing regulations to limit atmospheric concentrations of GHGs through a statutory mechanism that prohibits consideration of the costs such regulations might entail. EPA also requests comment on the extent to which various implementation mechanisms in Title I are available for addressing such costs.

As mentioned above, CAA section 108 requires EPA to issue information on air pollution control techniques at the same time it issues air quality criteria. This would include information on the cost of installation and operation, energy requirements, emission reduction benefits, and environmental impacts. Generally, the Agency fulfills this obligation at the time a standard is issued; as required under Executive Order 12866, EPA must issue an RIA for major rulemaking actions. A NAAQS RIA provides an illustrative analysis of control options available to reduce emissions and ambient concentrations of the regulated pollutant(s); evaluates the costs of these controls; and estimates the human health and environmental benefits likely to accrue from the improved air quality resulting from the standards.

As required by EO 12866 and guidance from OMB, the analysis generally compares control options and estimated costs and benefits of multiple, specific standard options under consideration. While EPA recognizes the cost estimates for future GHG control technologies would potentially place more reliance on yet-to-be-developed options, the precedent exists for consideration of future, unknown controls. EPA requests comment on whether there are important distinctions between GHGs and previously regulated criteria pollutants that would make it appropriate in the case of a new NAAQS for GHG(s) to issue a separate air pollution control techniques document earlier in the process, specifically in conjunction with the air quality criteria as required by section 108, or whether such information is more useful if tailored to specific standard options under consideration, as in the RIA.

b. Technology Development and Leakage

Two of the policy design considerations noted in section III.F.1 include the potential to promote technology development and to address potential concerns about shifting emissions to other countries. The NAAQS establish standards based on ambient concentrations that must be attained and maintained everywhere, and are implemented through SIPs that establish emissions budgets consistent with meeting the standards. The limited emissions budget encourages state and local areas and affected sources to work together to identify least-cost emissions controls to meet their SIP obligations and reduce ambient concentrations of the regulated pollutant(s). The NAAQS requirements help create market demand for technologies that can assist in meeting air quality standards at the least cost. As discussed in Section III.C of this notice, this process has encouraged significant technological innovation. EPA requests comment on the extent to which the NAAQS can be an effective mechanism for encouraging technological innovation and development of least-cost controls for GHG emissions.

The 10-year maximum timeline for attaining a primary NAAQS would allow some time for development and deployment of emerging technologies, but longer timelines available under other forms of the NAAQS would provide greater flexibility to provide continuous incentives over a longer time period for major technology advances, and more time to deploy new technologies that are developed. EPA requests comment on the extent to which a GHG NAAQS could reasonably be expected to advance new control technologies, and on what timeframe.

With respect to the leakage issue, establishing a primary NAAQS could lead to high costs among affected industries unless a viable approach is identified to limit the control burden on U.S. sources. Because the standards themselves are set without consideration of cost or availability of control technologies, and because states would be required to adopt a plan to attain a primary standard within 10 years of designation, the NAAQS approach might offer less flexibility to delay emissions reductions in the absence of effective control technologies or when costs are prohibitive. This consideration may be particularly relevant in the case of GHGs, where highly efficient control technologies or mitigation options are currently limited, and where critical new control strategies, such as carbon capture and storage, are still in the early stages of development. In these instances, industries that are unable to locate cost-effective control strategies may consider relocating to non-regulated locations, resulting in significant emissions leakage.

We request comment on the cost-effectiveness of utilizing a NAAQS approach to regulating GHGs, and on the extent to which this approach might be expected to result in emissions leakage, especially as compared to other potential regulatory approaches outlined in this notice.

c. Summary of Opportunities and Challenges Afforded by NAAQS Pathway

Regulating GHGs through a NAAQS offers certain opportunities; however, there are also significant technological, legal and program design challenges that would tend to limit the appropriateness of the NAAQS program.

NAAQS are based purely on preventing adverse health and environmental impacts, rather than on considerations of cost, feasibility, or availability of technology. Our expectation is that the NAAQS approach would establish a goal tied to actual ambient concentrations of GHGs. A NAAQS would call for assessment of potential control strategies for a broad array of sources, rather than focusing only on emissions reductions from a specified (but potentially limited) list of sources. The NAAQS approach would allow for some flexibility in the design of control strategies and requirements, including the possibility of a cap-and-trade approach, and might spur significant technological innovation. It would provide a mechanism for reducing GHG emissions from current sources and limiting the growth of emissions from new sources. If the facts supported adopting only a secondary standard, this would somewhat reduce the specific obligations on states, and would allow a suitably extended timeline for achieving the emissions reductions necessary to stabilize and then reduce ambient GHG concentrations.

Though such an approach has the potential to be effective in reducing emissions, there would be a number of obstacles to overcome. Chief among these is that if worldwide (non-U.S.) emissons were to continue increasing, global concentrations of GHGs would continue to increase despite U.S. emission control efforts, and the NAAQS would be unachievable (depending on the level of the standards) even if U.S. emissions were reduced to zero. Unless viable legal approaches could be identified for limiting the control burden on U.S. sources, such as by defining a U.S. share of the emissions reductions needed to attain a NAAQS, the NAAQS approach would result in an expensive program. It would not achieve the adopted GHG NAAQS due to foreign emissions growth, although U.S. emissions reductions would be achieved. If the result of a NAAQS were stringent unilateral controls for vulnerable industries, this would encourage emissions leakage in the absence of comparable control efforts abroad.

Especially if the Agency were to set a primary as well as a secondary standard, a NAAQS would trigger a relatively rigid implementation apparatus, limiting the Agency's flexibility to target cost-effective emissions reductions and to shift the burden of control requirements among different industries based on the availability of new technological approaches. The lack of flexibility allowed under the CAA for many of the NAAQS implementation requirements—especially those affecting areas designated nonattainment with a primary standard—makes them difficult to adapt effectively for application in the GHG context. For example, it would be challenging to apply requirements for transportation conformity under a GHG NAAQS, or for states to develop attainment demonstration SIPs. As discussed in section IV.E, a nonattainment new source review program requiring for GHGs would dramatically expand the scope of the preconstruction permitting program to include smaller sources and new types of sources such as apartment buildings with natural gas heat, unless EPA were successful in applying legal theories that justify deviating from statutory language. This would pose substantial administrative feasibility and cost issues. While implementation of an attainment-level NAAQS would involve fewer specific requirements, this avenue would only apply if the standard set by EPA under section 109 resulted in attainment designations. Section 109 calls for standards to be set based on science-based criteria, which exclude consideration of the cost or efficiency of the implementation requirements in determining the level of the standard.

We note that while the NAAQS implementation system is state-based, legislative proposals have focused on establishing federally administered national cap-and-trade strategies to address the global climate problem.

In closing, we request comment on our assessment of NAAQS approaches, and on how the NAAQS approach compares to other potential CAA approaches in light of the policy principles enunciated in section III.F.1.

5. Possible Implications for Other CAA Provisions

Listing a pollutant under section 108(a)(1) would preclude listing under section 112 or regulation under section 111(d), but would not preclude listing and regulation under section 111(a)–(c) New Source Performance Standards (NSPS) provisions as described below. Similarly, regulation of GHGs under section 111(a)–(c) NSPS provisions, as discussed further in other sections of today's notice, would not preclude regulation of those pollutants through a NAAQS, although controls implemented through these provisions might influence the Agency's perspective on the appropriateness of establishing air quality criteria for GHGs. EPA requests comment on the extent to which regulatory action under section 111 could be considered in the context of exercising authority under section 108 relevant to GHGs.

B. Standards of Performance for New and Existing Sources

CAA section 111 provides EPA with authority to set national performance standards for stationary sources. There are two alternative pathways for using section 111 to regulate GHGs—as part of an implementation program for a GHG NAAQS or as a freestanding program.

- In the event of a GHG NAAQS, section 111 authorizes EPA to set emissions performance standards for new and modified sources but not for unmodified existing sources.
- In the absence of a GHG NAAQS, section 111 offers the potential for an independent, comprehensive program for regulating most stationary sources of GHGs, except to the extent GHG emissions are regulated under section 112

Section 111 provides for consideration of cost, and allows substantial discretion regarding the types and size of sources regulated. As with most other CAA authorities, however, establishment of a section 111 standard for any source category of GHGs would trigger preconstruction permitting requirements for all types of GHG major sources under the PSD program.

The Stationary Source TSD for this ANPR identifies some specific industry sectors that EPA has evaluated for their emissions of multiple pollutants, including GHGs. EPA requests comment on this analysis. In addition, EPA requests comment on GHG emissions from these and all other categories and subcategories that have been subject to section 111 standards and on the relative costs that could be associated with employing certain identified control technology or practices affecting GHG emissions, including any positive or negative impacts on the emissions of traditional pollutants.

1. What Does Section 111 Require?

Section 111 establishes two distinct mechanisms for controlling emissions of air pollutants from stationary sources. Section 111(b) provides authority for EPA to promulgate New Source Performance Standards (NSPS) which may be issued regardless of whether there is a NAAQS for the pollutant being regulated, but apply only to new and modified sources. Once EPA has elected to set an NSPS for new and modified sources in a given source category, section 111(d) calls for regulation of existing sources with certain exceptions explained below. Taken together, the section 111 provisions could allow significant flexibility in regulation that may not be available under other CAA Title I provisions.

a. Section 111(b) New Source Performance Standards

Section 111(b) of the CAA requires EPA to establish emission standards for any category of new and modified stationary sources that the Administrator, in his judgment, finds ''causes, or contributes significantly to, air pollution which may reasonably be anticipated to endanger public health or welfare.'' EPA has previously made endangerment findings under this section for more than 60 stationary source categories and subcategories that are now subject to NSPS.[239] An endangerment finding would be a prerequisite for listing additional source categories under section 111(b), but is not required to regulate GHGs from source categories that have already been listed.

For listed source categories, EPA must establish ''standards of performance'' that apply to sources that are constructed, modified or reconstructed after EPA proposes the NSPS for the relevant source category.[240] However, EPA has significant discretion to define the source categories, determine the pollutants for which standards should be developed, identify the facilities within each source category to be covered, and set the level of the standards. In addition, EPA believes that the NSPS program is flexible enough to allow the use of certain market-oriented mechanisms to regulate emissions, as discussed below.

As implemented over many years by EPA, the NSPS program has established standards that do not necessarily set emission limits for all pollutants or even all regulated pollutants emitted by sources within the relevant source category. Rather, the NSPS generally focus on specific pollutants of concern for a particular source category. Air pollutants currently regulated through section 111(b) include the criteria pollutants listed under section 108 and certain additional pollutants. These additional pollutants are acid mist, fluorides, hydrogen sulfide in acid gas, total reduced sulfur, and landfill gas. EPA has discretion to revise an existing NSPS to add standards for pollutants not currently regulated for that source category, but has interpreted the section to not require such a result when an NSPS is reviewed pursuant to section 111(b)(1)(B). That section requires EPA to review and, if appropriate, revise NSPS every eight years unless the Agency determines that such review is not appropriate in light of readily available information on the efficacy of the standard.

Further, in contrast to other provisions in the CAA which require regulation of all sources above specific size thresholds, section 111 gives EPA significant discretion to identify the facilities within a source category that should be regulated. To define the affected facilities, EPA can use size thresholds for regulation and create subcategories based on source type, class or size. Emission limits also may be established either for equipment within a facility or for an entire facility.

EPA also has significant discretion to determine the appropriate level for the standards. Section 111(a)(1) provides that NSPS are to ''reflect the degree of emission limitation achievable through the application of the best system of emission reduction which (taking into account the cost of achieving such reduction and any nonair quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated.'' This level of control is commonly referred to as best demonstrated technology (BDT). In determining BDT, we typically conduct a technology review that identifies what emission reduction systems exist and how much they reduce air pollution in practice. This allows us to identify potential emission limits. Next, we evaluate each limit in conjunction with costs, secondary air benefits (or disbenefits) resulting from energy

[239] EPA has developed NSPS for more than 70 source categories and subcategories. However, endangerment findings apply to the categories as a whole, while subcategories within them have been established for purposes of creating standards that distinguish among sizes, types, and classes of sources.

[240] Specific statutory and regulatory provisions define what constitutes a modification or reconstruction of a facility. 40 CFR 60.14 provides that an existing facility is modified, and therefore subject to an NSPS, if it undergoes ''any physical change in the method of operation . . . which increases the amount of any air pollutant emitted by such source or which results in the emission of any air pollutant not previously emitted.'' 40 CFR 60.15, in turn, provides that a facility is reconstructed if components are replaced at an existing facility to such an extent that the capital cost of the new equipment/components exceed 50 percent of what is believed to be the cost of a completely new facility.

requirements, and non-air quality impacts such as solid waste generation. The resultant standard is commonly a numerical emissions limit, expressed as a performance level (i.e., a rate-based standard). While such standards are based on the effectiveness of one or more specific technological systems of emissions control, unless certain conditions are met, EPA may not prescribe a particular technological system that must be used to comply with a NSPS. Rather, sources remain free to elect whatever combination of measures will achieve equivalent or greater control of emissions.

It is important to note that under section 111, the systems on which a standard is based need only be ''adequately demonstrated'' in EPA's view such that it would be reasonable to apply them to the regulated category. The systems, and corresponding emission rates, need not be actually in use or achieved in practice at potentially regulated sources or even at a commercial scale. Further, EPA believes that if a technology is ''adequately demonstrated'' for use at a date in the future, EPA could establish a future-year standard based on that technology. This would allow EPA to develop two- or multi-phased standards with more stringent limits in future years that take into account and promote the development of technology.

Costs are also considered in evaluating the appropriate standard of performance for each category or subcategory. We generally compare control options and estimated costs and emission impacts of multiple, specific emission standard options under consideration. As part of this analysis, we consider numerous factors relating to the potential cost of the regulation, including industry organization and market structure; control options available to reduce emissions of the regulated pollutant(s); and costs of these controls. Frequently, much of this information is presented in the Regulatory Impact Analysis (RIA) that is required for all major rulemaking actions.

b. Section 111(d) Emissions Guidelines for Existing Sources

Section 111(d) requires regulation of existing sources in specific circumstances. Specifically, where EPA establishes a NSPS for a pollutant, a section 111(d) standard is required for existing sources in the regulated source category except in two circumstances. First, section 111(d) prohibits regulation of a NAAQS pollutant under that section. Second, ''where a source category is being regulated under section 112, a section 111(d) standard of performance cannot be established to address any HAP listed under 112(b) that may be emitted from that particular source category.'' [241]

Section 111(d) also uses a different regulatory mechanism to regulate existing sources than section 111(b) uses for new and modified sources in a source category. Instead of giving EPA direct authority to set national standards applicable to existing sources in the source category, section 111(d) provides that EPA shall establish a procedure for states to issue performance standards for existing sources in that source category. Under the 111(d) mechanism, EPA first develops regulations known as ''emission guidelines.'' These may be issued at the same time or after an NSPS for the source category is promulgated. Although called ''guidelines,'' they establish binding requirements that states are required to address when they develop plans to regulate the existing sources in their jurisdictions. These state plans are similar to state implementation plans and must be submitted to EPA for approval. Historically, EPA has issued model standards for existing sources that could then be adopted by states. Under this approach, creating an interstate trading system would require adoption of compatible state rules promoted by EPA rules and guidance. In the event that a state does not adopt and submit a plan, EPA has authority to then issue a federal plan covering affected sources.

Section 111(d) guidelines, like NSPS standards, must reflect the emission reduction achievable through the application of BDT. However, both the statute and EPA's regulations implementing section 111(d) recognize that existing sources may not always have the capability to achieve the same levels of control at reasonable cost as new sources. The statute and EPA's regulations in 40 CFR 60.24 permit states and EPA to set less stringent standards or longer compliance schedules for existing sources where warranted considering cost of control; useful life of the facilities; location or process design at a particular facility; physical impossibility of installing necessary control equipment; or other factors making less stringent limits or longer compliance schedules appropriate.

2. What Sources Could Be Affected?

Section 111 has been used to regulate emissions of traditional and nontraditional air pollutants from a broad spectrum of stationary source categories. EPA has already promulgated NSPS for more than 70 source categories and subcategoriesand we could add GHG emission standards, as appropriate, to the standards for existing source categories.[242] EPA has begun a review of the existing NSPS source categories to determine whether it would be appropriate to regulate GHG emissions from sources in each category. In addition, EPA is in the process of responding to a remand from the D.C. Circuit requiring it to consider whether to add standards for GHGs to the NSPS for utility boilers, and EPA has received suggestions that it would be appropriate to add such standards to the NSPS for Portland cement kilns.[243]

To determine whether regulation of GHGs is appropriate for existing categories, we must evaluate whether it is reasonable to do so given the magnitude of emissions and availability of controls, considering the costs of control. Decisions in this regard could be influenced by several factors, including the magnitude of the GHG emissions from a source category; the potency of the particular GHG emitted; whether emissions are continuous, seasonal or intermittent; the availability of information regarding the category's GHG emissions; and whether regulating GHG emissions from the source category would be beneficial. EPA requests comment on the extent to which these factors should, if at all, influence EPA's decisions whether to add standards to existing NSPS and what additional factors should be taken into consideration. EPA also requests

[241] *See* 70 FR 15994, 16029–32 (Mar. 29, 2005).

[242] Some of the existing source categories are very broad, comprising an entire industrial process such as steel making, while others are narrowly defined as a single piece of equipment within a broader production process. Examples of source categories subject to NSPS are fossil fuel-fired boilers, incinerators, sulfuric acid plants, petroleum refineries, lead smelters, and equipment leaks of VOCs in the synthetic organic chemicals manufacturing industry. A complete list of the NSPS source categories is found at 40 CFR part 60.

[243] The NSPS for Petroleum Refineries were recently amended, resulting in the promulgation of new Subpart Ja. These performance standards include emission limitations and work practice standards for fluid catalytic cracking units, fluid coking units, delayed coking units, fuel gas combustion devices, and sulfur recovery plants. As such, they regulate criteria pollutant emissions from the processes that are also responsible for most of the refinery GHG emissions. During the public comment period for Subpart Ja, we received several comments in favor of developing new source performance standards to address GHG emissions from refineries. However, we declined to adopt standards for GHG emissions in that rulemaking, in part because while doing so was within our discretion, we believed that it was important to fully consider the implications for programs under other parts of the CAA before electing to regulate GHG under section 111. This is a fundamental purpose for today's notice and request for comments.

comment on which of the previously regulated categories might be appropriate for GHG regulation and on the information on which such judgments might be based.

To inform the public of EPA's analytical work to date, we have provided descriptions of key industrial sectors, their GHG emissions, and information that we have collected to date on GHG control options for those sectors in the Stationary Source TSD in the docket for today's notice. It is important to note that, as described further in the technical support materials, many near-term technologies or techniques for reducing GHG, e.g., energy efficiency or process efficiency improvements, are relatively cost effective and achieve modest emission reductions when compared with the potential of some add-on control techniques. Other controls may become available in the future whose costs and emission reduction effectiveness may differ substantially from what is discussed here today. The Stationary Source TSD also discusses various mechanisms, such as cap-and-trade programs or emissions averaging approaches across facilities or industries, that can help reduce costs of reducing emissions. EPA requests comment on the availability and extent of its legal authority for such mechanisms.

In addition to regulating GHGs from previously listed source categories, section 111 provides discretionary authority to list new source categories, or reformulate listed source categories, for purposes of regulating of GHG emissions. For example, such categories could include sources of emissions covered by existing NSPS source categories as well as sources not currently covered by any NSPS. One option available to EPA is the reorganization of source categories for purposes of GHG regulation. In creating new categories to be used for regulation of GHGs, EPA could consider factors unique to GHG emissions. For example, EPA could take into account concerns about emissions leakage (discussed in section III.F.5 of this notice), and structure categories to minimize opportunities for shifting emissions to other source categories. EPA could also explore how the rearrangement of source categories could facilitate netting arrangements through which a more broadly defined ''source'' could avoid triggering an GHG NSPS by off-setting its increased GHG emissions.[244] In addition, EPA could structure categories to take into account possible reductions from improvements at non-emitting parts of the plants, for example, by creating source categories that cover all equipment at particular plants, instead of using categories that cover only specific types of equipment at a plant. EPA invites comment on whether such rearrangement would be appropriate and what type of rearrangement would be desirable. We also solicit information on how rearrangement could facilitate netting and how we might structure such netting.

An alternative, or complementary, scenario would be to create larger ''super-categories'' covering major groupings of stationary sources of GHG emissions. For example, it might be possible to create process-based categories (*i.e.,* all sources emitting CO_2 through a stack as a result of combustion processes) or vertically integrated categories which take more of a life-cycle approach to the control of GHG emissions and reduce the possibility of leakage of GHG reductions to other parts of the economy or other geographic regions.[245] The creation of such ''super-categories'' might provide additional opportunities for the development of innovative control mechanisms such as cap-and-trade programs covering multiple industry sectors. In light of these considerations, EPA requests comment on whether the creation of such ''super categories'' would be appropriate and what categories would be most useful for regulating GHGs.

Under either option, EPA possesses authority to distinguish among classes, types and sizes of sources within existing categories for purposes of regulating GHG emissions. For example, we have at times distinguished between new and modified/reconstructed sources when setting the standards. This may be appropriate, for instance, when a particular new technology may readily be incorporated into a new installation, but it may be technically infeasible or unreasonably costly to retrofit this technology to an existing facility undergoing modification or reconstruction. Alternatively, we have distinguished among sources within a category, for instance fossil fuel-fired boilers, for which we have subcategorized on the basis of fuel types (*e.g.*, coal, oil, natural gas). EPA requests comment on what considerations are relevant to determining whether it is appropriate and reasonable to establish subcategories for regulation under section 111.

3. What Are Possible Key Milestones and Implementation Timelines?

a. Priority Setting Among Source Categories

If EPA were to pursue section 111 regulation of GHGs, timetables for regulation would depend upon how EPA prioritized among source categories to determine which categories should be regulated first. In the near term, it may be possible to address GHGs under section 111 in a limited fashion by establishing control requirements for new and existing sources in some number of existing source categories, while information is developed on other source categories. Actions under other portions of the CAA may involve longer lead times to develop and implement, so that standards under section 111 for certain source categories could provide for emission reductions in the interim. We have begun to examine source categories subject to existing NSPS and other standards to consider how we might determine priorities among them for review and revisions, and whether GHGs could be addressed for specific sectors in a more coordinated, multi-pollutant fashion. EPA requests comment on the availability of its legal authority, if any, to prioritize among source categories in the event that regulation under section 111 was pursued.

Under a ''prioritization'' approach, EPA could seek to revise standards earliest for those categories offering the greatest potential for significant reductions in the emissions of covered pollutants, and either deferring action or determining that no further action is necessary or appropriate at this time for other categories. This conclusion could be based, for example, on the lack of significant improvements in technology since the last NSPS review or the fact that no new sources are considered to be likely in the foreseeable future.

Another possibility might be to schedule and structure the review and revision of standards for source categories to account for the fact that, in addition to the need to address GHG emissions, they may be subject to multiple standards for different pollutants under several sections of the CAA. Such standards may often be subject currently to different review

[244] We recognize that the Court in *Asarco Inc.* v. *EPA*, 578 F.2d 326 (D.C. Cir. 1978) struck down an NSPS provision that allowed netting. The provision at issue there, however, permitted netting between sources, not within a source. *See Alabama Power* v. *EPA*, 636 F.2d 323, 401–02 (D.C. Cir. 1980).

[245] For instance, a ''super-category'' could be created encompassing all aspects of the production, processing, and consumption of petroleum fuels, or to regulate the production and consumption of fossil fuels for heat and power, addressing all aspects of emissions-producing activity within a sector, including fuel production, consumption, and energy conservation.

timetables resulting from when these standards were last established or revised. In addition, as discussed in section III.D of today's notice, they may have the potential for positive or negative interactions with one another and with opportunities for the control of GHG emissions.

Still another approach might consider the impacts of future reduction opportunities or enacted legislation so that standards under section 111 might focus initially on source categories for which near-term benefits might result largely from efficiency improvements which do not result in ''stranded capital,'' or investment in systems that will be superseded by more effective systems that we determine will be available at some specific future date. Alternatively, standards could focus on those sectors of the economy which will not likely be subject to controls being addressed in enacted legislation.

We request comment on EPA's available legal authority, if any, to defer action with respect to any ''class'' of section 111 source categories or subcategories as well as how and under what circumstances EPA could also consider such approaches to the identification of source categories for standards to address GHGs. Assuming the existence of adequate authority, what, if any, additional criteria should be considered in our priority-setting analysis efforts? In considering such sector- or multi-pollutant-based approaches, we further request comment on the extent to which we could establish new or revised source categories which better accommodate these approaches, or whether we are bound by existing source categories and their definitions.

b. Timetables for Promulgation and Implementation

In our experience, collecting and analyzing information regarding available control technologies, resulting emission reductions, and cost effectiveness can take up to several years for a source category. However, this time period can be shortened to 1½ to 2 years when information is readily available or is presented to the Agency in a form that facilitates efficient consideration. With respect to GHGs, there has been significant effort devoted to identifying and evaluating ways to reduce emissions within sectors such as the electricity generating industry, and we are aware of the potential for GHG reductions through energy efficiency and other means within other industries. However, for many others, technologies for reducing GHG emissions have not yet been identified or evaluated by EPA. EPA requests comment on whether and how the availability of current information should be considered when considering regulation under section 111.

As is the case with traditional pollutants, any new or revised NSPS for new and modified sources of GHGs under section 111(b) would be developed through a notice and comment rulemaking process and would be effective upon promulgation. As noted previously, EPA is also required to review, and if appropriate revise, existing NSPS every 8 years unless the Administrator determines that ''such review is not appropriate in light of readily available information on the efficacy of such standard.'' Standards for pollutants not regulated by the existing NSPS may be added concurrent with the 8-year review, but such additions are not part of that review process.

Any section 111(d) emission guidelines associated with the revised NSPS standards would be promulgated either along with or after the NSPS. States are generally required to submit the required state plans containing the standards of performance applicable to existing sources in their jurisdictions within 9 months of EPA's promulgation of the guidelines.

In the case of existing sources regulated under section 111(d), affected sources are typically provided up to 3 years to comply with any resulting requirements; however, states have flexibility to provide longer or shorter compliance timeframes based on a number of source-specific factors. In addition, where we determine that a technology has been adequately demonstrated to be available for use by some particular future date, we believe it is possible to establish timeframes for compliance that reflect this finding.[246]

No explicit 8-year review requirement exists with regard to section 111(d) standards for existing sources. Nonetheless, it also may be appropriate to require existing source plans to periodically revise their control strategies to reflect changes in available technologies and standards over time, particularly where the existing limitations were based on more limited controls at the time they were established. EPA requests comment on its authority and the advisability of such periodic updating with respect to the possible control of GHG.

The CAA and EPA's regulations implementing section 111(d) permit states to consider a number of factors when determining the level of stringency of controls, but do not establish a bright line test when stricter requirements for existing sources are warranted. Many of these sources may also be subject to requirements for the control of other non-section 111(d) pollutants as part of implementation plans to attain and maintain NAAQS for one or more pollutants, and in some cases, these provisions may result in more stringent coincidental control of section 111(d) pollutants. We request comment on how and when we should evaluate, review, and revise as appropriate any section 111(d) standards that might be established in the future for GHGs.

[246] See *Portland Cement Association* v. *EPA*, 486 F.2d 275 (D.C. Cir. 1973).

4. What Are the Key Considerations Regarding Use of This Authority To Regulate GHGs?

a. Key Attributes and Limitations of Section 111

As noted above, section 111 possesses certain flexible attributes that may be useful in tailoring emissions standards to address GHG emissions. Yet, regulation under this section also has important limitations. This section of today's notice briefly summarizes these attributes and limitations. We request comment on how these attributes and limitations relate to the policy design considerations set forth in section III.F.1.

Program scope: Section 111 provides EPA with authority to regulate GHG emissions from stationary source categories, but does not require EPA to regulate GHGs emitted by all source categories or even all listed source categories. EPA has flexibility to identify the source categories for which it is appropriate to establish GHG limits. For example, EPA could decide to set GHG limits for those source categories with the largest GHG emissions and reduction opportunities. EPA could postpone or decline to set GHG limits for source categories for which emissions contributions may be small or for which no effective means of reducing emissions exist, currently or within the reasonably foreseeable future. EPA also could consider traditional air pollutants as well as GHGs in setting its overall priorities for the NSPS program.

Source size: Section 111 does not require regulation of all sources above a certain size. Instead, EPA has discretion to use rational emission thresholds to identify which facilities within a source category are covered by NSPS standards.

Consideration of cost: Section 111 explicitly directs EPA to take ''into account the cost of achieving'' emission reductions, as well as other nonair quality, health and environmental impact and energy requirements.'' This gives EPA significant flexibility to determine of appropriate levels of control, and can be an important source of distinctions between requirements for new sources and those for modified or reconstructed sources.

Potential for emissions trading: As EPA has interpreted the NSPS requirements in the past with respect to certain air pollutants, we believe that the NSPS program could use emissions trading, including cap-and-trade programs and rate-based regulations that allow emissions trading, to achieve GHG emission reductions. EPA believes such programs are consistent with the statutory requirements because they satisfy the three substantive components of the section 111(a)(1) definition of ''standard of performance''—(1) a standard for emissions of air pollutants; that (2) reflects that degree of emission limitation available''; and (3) ''constitutes the best system of emission reduction.'' A cap-and-trade program can constitute a ''standard for emissions of air pollutants'' because it is a system created by EPA for control of emissions. The use of emissions budgets does not make the system less of a ''standard'' since the budgets must be met regardless of the methodology used to allocate allowances to specific sources. Further, any such system would be based on our assessment of the overall degree of emission reduction available for the source category and our analysis of the available systems of emission reductions. EPA could select a market-oriented mechanism as the ''standard of performance'' if these analyses (including cost analyses) indicate that the system would ''reflect the degree of emission limitation achievable'' and ''constitute the best system of emission reduction.'' EPA also believes that trading among new and existing sources could be permitted, and could offer, at least in some cases, cost efficiencies.[247] EPA also believes that because of the potential cost savings, it might be possible for the Agency to consider deeper reductions through a cap-and-trade program that allowed trading among sources in various source categories relative to other systems of emission reduction. We request comment on the extent of EPA's available legal authority in this area as well as the attributes such a program must possess to qualify as a standard of performance under section 111.

Potential for declining performance standards: EPA believes that section 111 authority may be used to set both single-phase performance standards based upon current technology and to set two-phased or multi-phased standards with more stringent limits in future years. Future-year limits may permissibly be based on technologies that, at the time of the rulemaking, we find adequately demonstrated to be available for use at some specified future date. Alternatively, it may be possible to establish a goal based on future availability of a technology and to revise the standard to reflect technological advancements at appropriate intervals, such as the 8-year review cycles. We believe these concepts could be applied to standards for new and modified sources, as well as to standards for existing sources under section 111(d). In addition, this concept could be coupled with emissions trading.

We recognize that various legal issues and questions concerning legal authority may be involved in setting standards based on technology only adequately demonstrated for use at a future date. For example, there might be greater uncertainty regarding the cost of technology for such standards than for standards based only on technology that is already commercially demonstrated at the time of promulgation. In the Clean Air Mercury Rule (CAMR), which was vacated by the D.C. Circuit on other grounds, EPA interpreted section 111 to allow a two-phased ''standard of performance'' to reduce mercury emissions from existing sources. The compliance date for the more stringent second phase was 2018. EPA believed that it had greater flexibility to set such a standard for existing sources under section 111(d) because these standards, in contrast to section 111(b) standards for new sources, are not subject to the requirements of section 111(e). Section 111(e) makes unlawful to operate any new source in violation of a standard of performance after its effective date. EPA requests comment on this interpretation. We also request comment on the circumstances under which the requirements of section 111(e) would be satisfied by a standard requiring compliance with the initial requirements of a multi-phase standard. More generally, EPA seeks comment on its legal authority in this matter as well as the legal and factual conditions that must be satisfied to support a multi-phase standard with future-year standards based on technology adequately demonstrated for use by that future date. EPA also seeks comment on how far into the future multi-phase standards could extend and the degree of certainty with which EPA must make its determinations of availability for future use, considering the section 111 standard setting language.

Technology development: Section 111 also contains a waiver provision that can be used to encourage the development of innovative technologies, as described below.

Standards tied to available technology: The fact that section 111 requirements are based upon a demonstration of the availability of control technology could limit the amount of reductions achievable through section 111 regulations to demonstrably feasible and cost-effective levels. If a given level of overall emission reduction is determined to be necessary and that level exceeds what is currently demonstrated to be feasible now or by some future date, then section 111 may not provide adequate authority by itself to achieve needed reductions. Although section 111 provides certain opportunities and incentives for technology development, this feature may make it more difficult to set ''stretch goals'' without other companion mechanisms.

In light of these considerations, we request comment on whether and to what extent section 111 provides an appropriate means for regulating GHG emissions.

b. Additional Considerations

We also request comment on the questions presented below which relate to the manner in which EPA could or should exercise its authority under this section to regulate GHGs.

i. What Regulatory Mechanisms Are Available?

As noted above, NSPS standards and 111(d) emission guidelines most commonly establish numerical emission standards expressed as a performance level. Such rate-based limits, however, are not the only mechanisms that could be used to regulate GHGs.

Efficiency Standards: We believe that most reductions in stationary GHG emissions may occur initially as the result of increased energy efficiency, process efficiency improvements, recovery and beneficial use of process gases, and certain raw material and product changes that could reduce inputs of carbon or other GHG-

[247] In the Clean Air Mercury Rule we concluded that new sources needed to comply with a unit specific control requirement in addition to participating in the trading program. We solicit comment on whether section 111 requires such controls for new sources or if it would be sufficient for them to participate in a trading program or other market based mechanism without this restriction. While not ensuring an equally stringent level of control at each new source, the latter approach would be expected to achieve the same total emissions reductions at a lower overall compliance cost.

generating materials. Such emission reductions may range in the near term (e.g., 5–10 years) from 1 to 10%. Thus, it could be possible to utilize NSPS standards to ensure reductions from efficiency improvements are obtained. For such standards to be effective, they likely would generally need to apply to the entire facility, not just specific equipment at the facility. EPA requests comment on the availability of its legal authority in this area and whether and when it might be appropriate to establish efficiency standards for source categories as a way of reducing GHG emissions.

Plant-wide standards: EPA also believes there may be benefits to developing plant-wide or company-wide standards for GHG emissions. Section 111, however, requires each affected facility to comply with the standard. EPA believes that it could redefine the affected facility for certain categories, for purposes of GHG regulation only, to include an entire plant. EPA also requests comment on whether it would be consistent with the statutory requirements to establish company-wide limits.

Work practice standards: In some circumstances, it may not be possible to identify a specific performance level for sources in a particular category; however, section 111(h) permits promulgation of design, equipment, work practice, or operational standards but allows such standards to be established only in specific circumstances. Specifically, it provides that where we determine ''that (A) a pollutant or pollutants cannot be emitted through a conveyance designed and constructed to emit or capture such pollutant, or that any requirement for, or use of, such a conveyance would be inconsistent with any Federal, State, or local law, or (B) the application of measurement methodology to a particular class of sources is not practicable due to technological or economic limitations,'' we may establish a ''design, equipment, work practice, or operational standard, or combination thereof, which reflects the best technological system of continuous mission reduction which . . . has been adequately demonstrated.'' EPA requests comment on the circumstances under which the section 111(h) criteria would be satisfied and when, and for which source categories, work practice standards could be appropriate standards to control GHGs.

Market-oriented regulatory mechanisms: As mentioned above, EPA believes that market-oriented regulatory approaches including emissions trading are worthy of consideration for applying NSPS to GHG emissions. Several market-oriented regulatory mechanisms are discussed in section VII.G of today's notice. EPA requests comment on which of these mechanisms are consistent with the section 111 definition of a ''standard of performance.''

ii. Request for Comment on Section 111 Regulatory Approaches

This notice and the Stationary Source TSD describe possible approaches for using section 111 to reduce GHG emissions, in general and in regard to particular source categories. We request comment on the following specific questions regarding potential regulatory approaches under section 111:

- What are the overall advantages and disadvantages of the regulatory approaches discussed above, in light of the policy design considerations in section III.F.1? Please describe in detail any approaches not discussed in today's notice that you think we should consider.
- What are the industry-specific advantages and disadvantages of the regulatory approaches discussed above and in the TSD?

In developing section 111 standards for a particular source category (e.g., refineries, cement plants, industrial commercial boilers, electric generating plants, etc.) we are requesting source category-specific comments on the following additional issues:

- What data are available, or would need to be collected, to support the development of performance standards, either by process, subcategory, or for the facility?
- Should the standards be different for new and existing sources, either in terms of the systems for emission reductions on which they should be based and/or on the regulatory structure and implementing mechanisms for such standards?
- To what extent, if any, should the standards be technology-forcing for existing sources?
- Should the standards require additional reductions over time? To what extent would such reductions be consistent with the authority and purpose of section 111, and how should they be designed and carried out to ensure consistency?

iii. What Reductions Could Be Achieved From Efficiency Improvements at Existing Sources?

Recognizing that existing sources do not have as much flexibility in the levels of control that may realistically be achieved at a new source, a section 111(d) standard regulating GHG from existing sources would at this time most likely focus on currently available measures to increase the energy efficiency at the facility, thereby reducing GHG emissions. Examples of typical measures that promote energy efficiency include the use of cleaner fuels and equipment replacement or process improvements which reduce energy consumption. How well a measure, or combination of measures, will reduce GHG emissions at an individual facility will vary. A review of available literature suggests a range of improvements for various industry sectors that may be achievable through energy and process efficiency improvements, and some representative examples are summarized below. This information is illustrative, and does not represent any final technical determination by the agency as to what emission reduction requirements might be appropriate to require from the source categories discussed below.

For example, reductions in emissions of GHG from cement plants would most likely occur from fuel efficiency and electric energy efficiency measures as well as raw material and product changes that reduce the amount of CO_2 generated per ton of cement produced. There are numerous efficiency measures generally accepted by much of the U.S. industry, and many of these measures have been adopted in recent cement plant improvements. Such measures may directly reduce GHG emissions by cement plants, or they may indirectly reduce GHG emissions at sources of power generation due to reduced electrical energy requirements. The range of effectiveness of the individual measures in reducing GHG is from less than 1% to 10%.[248] Benchmarking and other studies have demonstrated a technical potential for up to 40% improvement in energy efficiency for a new cement plant using the most efficient technologies compared to older plants using wet kilns.

A number of opportunities may exist within refineries to increase energy efficiency by optimizing utilities, fired heaters, heat exchangers, motors, and process designs. Competitive benchmarking data indicate that most petroleum refineries can economically improve energy efficiency by 10 to 20%.[249] Therefore, we would expect that a new refinery could be designed to be at least 20% more efficient than an existing one.

[248] U.S. EPA (2008), Air Pollution Controls and Efficiency Improvement Measures for Cement Kiln. Final Report.

[249] Energy Efficiency Improvement and Cost Saving Opportunities for Petroleum Refineries, LBNL, 2005.

In the case of industrial boilers, measures applied to individual facilities could result in energy savings and GHG reductions on the order of 1% to 10%. Replacing an existing boiler with a combined heat and power plant could improve the energy efficiently of an existing plant by 10% to 33%.

Existing coal-fired power plants can reduce their fuel consumption (reduce heat rate) and reduce CO_2 emissions by performing well known modifications and upgrades to plant systems. Heat rate reductions of up to 10% may be feasible through various efficiency improvements at individual coal units, depending on site specific conditions. Because of plant age and other physical limitations, the potential average heat rate reduction for the coal fleet would likely not exceed about 5%. The existing fleet operates at an average net efficiency of about 33%. If the corresponding coal fleet average net heat rate were reduced by 5% via efficiency improvements, a potential 5% reduction in CO_2 emissions could be obtained as well.

As older, less efficient coal power plants are retired, their capacity may be replaced with new, more efficient coal-fired units. A new, fully proven supercritical coal plant design can operate at a heat rate 10–15% below the current coal fleet average, and therefore produce 10–15% less GHG than the average existing coal plant. Future more advanced ultra-supercritical plant designs with efficiencies above 40% would have heat rates that are 20–25% or more below the current coal fleet average, and therefore produce that much less GHG than the average existing coal plant.

Technology to capture and geologically sequester CO_2 is the subject of ongoing projects in the U.S. and other countries and is a promising technology.[250] The electric power sector will most likely be the largest potential market for carbon capture and sequestration (CCS) technologies, with the potential to reduce CO_2 by approximately 80–90% at an individual plant.[251] It may become possible to apply CCS to some portion of the existing coal-fired fleet by retrofit to achieve significant CO_2 reductions. Other facilities that might be able to use CCS include refineries, chemical manufacturing plants, ethanol production facilities, cement kilns and steel mills. As advances in GHG reduction technologies continue, section 111(d) standards would be expected to consider and reflect those advances over time. We solicit comment on the criteria EPA should use to evaluate whether CCS technology is adequately demonstrated to be available for the electric power and other industrial sectors, including the key milestones and timelines associated with the wide-spread use of the technology.

iv. What Are the Possible Effects of Section 111 With Respect to Innovation?

As noted previously, whatever path may be pursued with respect to the control of GHG through the CAA or other authority, we believe it is likely that most early reductions in stationary GHG emissions may occur as the result of increased energy efficiency, process efficiency improvements, recovery and beneficial use of process gases, and certain raw material and product changes that could reduce inputs of carbon or other GHG-generating materials. Clearly, more fundamental technological changes will be needed to achieve deeper reductions in stationary source GHG emissions over time. We request general comments on how to create an environment in which new, more innovative approaches may be encouraged pursuant to section 111, or other CAA or non-CAA authority.

Waiver authority under section 111(j) would be useful as one element of broader policies to encourage development of innovative technologies. Section 111(j) authorizes the Administrator to waive the NSPS requirements applicable to a source if he determines that the innovative technology the source proposes to use will operate effectively and is likely to achieve greater emission reductions, or at least equivalent reductions but at lower cost. Also, the Administrator must determine that the proposed system has not yet been adequately demonstrated (i.e. it is still an innovative technology), but that it will not cause or contribute to an unreasonable risk to public health, welfare, or safety in its operation, function, or malfunction. These waivers can be given for up to 7 years, or 4 years from the date that a source commences operation, whichever is earlier.

We believe that effective GHG reduction techniques for many source categories potentially subject to NSPS may at this time be limited and that additional research and development will be necessary before these controls are demonstrated to be effective. We ask for comment on how the use of innovative technology waivers could conceivably be used to foster the development of additional approaches for GHG reductions.

5. Possible Implications for Other CAA Provisions

Regulation of GHGs under a section 111 standard for any industry would trigger preconstruction permitting requirements for all types of GHG sources under the PSD program. NSPS are also incorporated into operating permits issued under Title V of the CAA. The consequences of triggering and the options for addressing these permitting requirements are addressed in detail in section VII.D of this notice.

Whether GHGs were regulated individually or as a group in NSPS standards would affect the definition of regulated pollutant for stationary sources subject to preconstruction permitting under the PSD program. Conversely, while the section 111 mechanisms are relatively independent of other CAA programs, NSPS decision-making as a practical matter would need to consider the pollutant definitions adopted under other CAA authorities. It would be advantageous to maintain consistency regarding the GHG pollutants subject to regulation elsewhere in the Act to avoid the potential for PSD review requirements for individual GHGs as well as for groups of the same GHGs.

In considering the impact that decisions to list pollutants under other authorities of the CAA might have on our use of section 111 authority, we note that some industries have processes that emit more than one GHG and a potential may exist among some of these industries to control emissions of one GHG in ways that may increase emissions of others (e.g., collecting methane emissions and combusting them to produce heat and/or energy, resulting in emissions of CO_2.) While an overall reduction in GHGs may occur, as well as a reduction in global warming potential, whether GHGs are regulated as a class of compounds or as individual constituents could have implications for the degree of flexibility and for the outcome of any regulatory decisions. More specifically, if we were to regulate GHGs as a group, then standards under section 111 might establish an overall level of performance that could accommodate increases in emissions of some gases together with reductions in others, so long as the overall performance target was met. If we were to regulate individual GHGs, then we may be less able to establish less stringent requirements for the control of some gases, while setting more stringent requirements for others. The extent to which we may be able to do so depends

[250] See *http://www.netl.doe.gov/technologies/carbon_seq/partnerships/partnerships.html* for more information about the Regional Carbon Sequestration Partnerships in the United States.

[251] IPCC Special Report on Carbon Dixoide Capture and Storage, 2005, pp.3, 22.

on the significance of the emissions of each gas from the source category in question as well as the feasibility and cost-effectiveness of controlling each. One result of this lessened flexibility may be the preclusion of certain approaches that could yield greater net reduction in GHG emissions. For this reason, we request comments on (1) the extent to which we are limited in our flexibility to regulate GHG as a class if listed individually under other CAA authorities, and (2) whether regulation under section 111 should treat GHG emissions as a class for determining the appropriate systems for emissions reduction and resulting standards.

Finally, we note that our authority to promulgate 111(d) standards for existing sources depends on the two restrictions noted above. First, section 111(d) prohibits regulation of a NAAQS pollutant under that section. Second, ''where a source category is being regulated under section 112, a section 111(d) standard of performance cannot be established to address any HAP listed under 112(b) that may be emitted from that particular source category.'' If we were to promulgate a section 111(d) emission standard and then subsequently take action under sections 108 or 112 such that we could not promulgate a section 111(d) standard had we not already done so, the continued validity of the section 111(d) regulations might become unclear. We request comment on the extent, if any, to which the requirements of section 111(d) plans would, or could, remain in force under such circumstances.

C. National Emission Standards for Hazardous Air Pollutants

Along with the NAAQS system and section 111 standards, section 112 is one of the three main regulatory pathways under the CAA for stationary sources. Section 112 is the portion of the Act that Congress designed for controlling hazardous air pollutant emissions from these sources, including toxic pollutants with localized or more geographically widespread effects. This focus is reflected in the statutory provisions, which, for example, require EPA to regulate sources with relatively small amounts of emissions. In comparison to section 111, section 112 provides substantially less discretion to EPA concerning the size and types of sources to regulate, and is specific about when EPA may and may not consider cost.

This section explores the implications if EPA were to list GHGs as hazardous air pollutants under section 112.

1. What Does Section 112 Require?

a. Overview

Section 112 contains a list of hazardous air pollutants (HAPs) for regulation. EPA can add or delete pollutants from the list consistent with certain criteria described below.

EPA must list for regulation all categories of major sources that emit one or more of the HAPs listed in the statute or added to the list by EPA. A major source is defined as a source that emits or has the potential to emit 10 tons per year or more of any one HAP or 25 tons per year of any combination of HAPs.

For each major source category, EPA must develop national emission standards for hazardous air pollutants (NESHAP). Standards are required for existing and new major sources. The statute requires the standards to reflect ''the maximum degree of reduction in HAP emissions that is achievable, taking into consideration the cost of achieving the emission reduction, any nonair quality health and environmental impacts, and energy requirements.'' This level of control is commonly referred to as maximum achievable control technology, or MACT.

The statute also provides authority for EPA to list and regulate smaller ''area'' sources of HAPs. For those sources EPA can establish either MACT or less stringent ''generally available control technologies or management practices''.

Section 112(d)(6), requires a review of these technology-based standards every 8 years and requires that they be revised ''as necessary taking into account developments in practices, processes and control technologies.'' Additionally, EPA under section 112(f)(2)(C) must reevaluate MACT standards within 8 years of their issuance to determine whether MACT is sufficient to protect public health with an ample margin of safety and prevent adverse environmental effects. If not, EPA must promulgate more stringent regulations to address any such ''residual risk''.

b. How Are Pollutants and Source Categories Listed for Regulation Under Section 112?

Section 112(b)(1) includes an initial list of more than 180 HAPs. Section 112(b)(2) requires EPA to periodically review the initial HAP list and outlines criteria to be applied in deciding whether to add or delete particular pollutants.

A pollutant may be added to the list because of either human health effects or adverse environmental effects. With regard to adverse human health effects, the provision allows listing of pollutants ''including, but not limited to, substances which are known to be, or may reasonably be anticipated to be, carcinogenic, mutagenic, teratogenic, neurotoxic, which cause reproductive dysfunction, or which are acutely or chronically toxic.'' An adverse environmental effect is defined as ''any significant and widespread adverse effect, which may reasonably be anticipated, to wildlife, aquatic life, or other natural resources, including adverse impacts on populations of endangered or threatened species or significant degradation of environmental quality over broad areas.'' Section 112(b)(2) provides that ''no substance, practice, process or activity regulated under [the Clean Air Act's stratospheric ozone protection program] shall be subject to regulation under this section solely due to its adverse effects on the environment.'' Thus, section 112 may not be used to regulate certain chlorofluorocarbons and other ozone-depleting substances, their sources, or activities related to their production and use to address climate change unless we establish that such regulations are necessary to address human health effects in addition to any adverse environmental impacts. See section 602 of the Clean Air Act for a partial list of these substances.

Section 112(b)(3) of the Act establishes general requirements for petitioning EPA to modify the HAP list by adding or deleting a substance. Although the Administrator may add or delete a substance on his own initiative, if a party petitions the Agency to add or delete a substance, the burden historically has been on the petitioner to include sufficient information to support the requested addition or deletion under the substantive criteria set forth in CAA section 112(b)(3)(B) and (C). The Administrator must either grant or deny a petition within 18 months of receipt of a complete petition.

The effects and findings described in section 112 are different from other sections of the CAA addressing endangerment of public health discussed in previous sections of today's notice. Given the nature of the effects identified in section 112(b)(2), we request comment on whether the health and environmental effects attributable to GHG fall within the scope of this section. We also request comment on direct and indirect GHG emissions from existing source categories currently subject to regulation under section 112, any assessment of the relative costs of regulating GHG under the authority of section 112, and any co-benefits or co-detriments with regard to controlling GHG and the emissions of HAP.

The source categories to be regulated under section 112 are determined based on the list of HAP. Section 112(c) requires EPA to publish a list of all categories and subcategories of major sources of one or more of the listed pollutants, and to periodically review and update that list. In doing this, EPA also is required to list each category or subcategory of area sources which the Administrator finds presents a threat of adverse effects to human health or the environment (by such sources individually or in the aggregate) warranting regulation under section 112.

c. How Is MACT Determined?

In essence, MACT standards are intended to ensure that all major sources of HAP emissions achieve the level of control already being achieved by the better controlled and lower emitting sources in each category. This approach provides assurance to citizens that each major source of toxic air pollution will be required to effectively control its emissions. At the same time, this approach provides assurances that facilities that employ cleaner processes and good emissions controls are not disadvantaged relative to competitors with poorer controls.

MACT is determined separately for new and existing sources. For existing sources, MACT standards must be at least as stringent as the average emissions limitation achieved by the best performing 12 percent of sources in the category or subcategory (or the best performing five sources for source categories with less than 30 sources). This level is called the ''MACT floor.'' For new or reconstructed sources, MACT standards must be at least as stringent as the control level achieved in practice by the best controlled similar source.[252] EPA also must consider more stringent ''beyond-the-floor'' control options for MACT. When considering beyond-the-floor options, EPA must consider not only the maximum degree of reduction in emissions of the HAP, but also costs, energy requirements and non-air quality health environmental impacts of imposing such requirements.

MACT standards may require the application of measures, processes, methods, systems, or techniques including, but not limited to, (1) reducing the volume of, or eliminating emissions of, such pollutants through process changes, substitution of materials, or other modifications; (2) enclosing systems or processes to eliminate emissions; (3) collecting, capturing, or treating such pollutants when released from a process, stack, storage or fugitive emissions point; (4) design, equipment, work practice, or operational standards (including requirements for operator training or certification) as provided in subsection (h); or (5) a combination of the above. (See section 112(d)(2) of the Act.)

For area sources, CAA section 112(d)(5) provides that the standards may reflect generally available control technology or management practices (GACT) in lieu of MACT.

d. What Is Required To Address Any Residual Risk?

Section 112(f)(2) of the CAA requires us to determine for each section 112(d) source category whether the MACT standards protect public health with an ample margin of safety. If the MACT standards for a HAP ''classified as a known, probable, or possible human carcinogen do not reduce lifetime excess cancer risks to the individual most exposed to emissions from a source in the category or subcategory to less than 1-in-1-million,'' EPA must promulgate residual risk standards for the source category (or subcategory) as necessary to protect public health with an ample margin of safety. EPA must also adopt more stringent standards if needed to prevent an adverse environmental effect, but must consider cost, energy, safety, and other relevant factors in doing so. EPA solicits comments on the extent to which these programs could apply with respect to the possible regulation of sources of GHG under section 112, including the relevance of any carcinogenic effects of individual GHG.

2. What Sources Would Be Affected if GHGs Were Regulated Under This Authority?

If GHGs were listed as HAP, EPA would be required to regulate a very large number of new and existing stationary sources, including smaller sources than if alternative CAA authorities were used to regulate GHG. This is the result of three key requirements. First, the section 112(a) major sources thresholds of 10 tons for a single HAP and 25 for any combination of HAPs would mean that very small GHG emitters would be considered major sources. Second, section 112(c) requires EPA to list all categories of major sources. Third, section 112(d) requires EPA to issue MACT standards for all listed categories.

We believe that most significant stationary source categories of GHG emissions have already been listed under section 112 (although the 10-ton threshold in the case of GHGs would be expected to bring in additional categories such as furnaces in buildings, as explained below). To date we have adopted standards for over 170 categories and subcategories of major and area sources. This is a significantly greater number than the categories for which we have adopted NSPS because under section 112 we must establish standards for *all* listed categories, whereas section 111 requires that we identify and regulate only those source categories that contribute ''significantly'' to air pollution endangering public health and welfare.

3. What Are the Key Milestones and Expected Timeline if Section 112 Were Used for GHG Controls?

One possible timetable for addressing GHG under this part of the Act would be to incorporate GHG emission control requirements concurrent with the mandatory 8-year technology reviews for each category, collecting information on emissions and control technologies at the time the existing MACT standards are reviewed to determine whether revisions are needed. If we were to list new source categories under section 112, EPA would be required to adopt MACT standards for those categories within 2 years of the date of category listing.

EPA must require existing sources to comply within 3 years of a standard's promulgation, although states and EPA are authorized in certain circumstances to extend the period of compliance by one additional year. Most new sources must comply as soon as a section 112 standard is issued; however, there is an exception where the final rule is more stringent than the proposal.

Because of the more detailed requirements for identifying appropriate levels of control to establish a level for MACT, significantly more information on the best performing sources is needed under section 112 than under section 111, making the development of such standards within 2 years after listing a source category difficult. We request comment on this and other approaches for addressing GHG under section 112, both for categories already listed for regulation and for any that might appropriately be added to the section 112 source category list if we were to elect to regulate GHGs under this section.

4. What Are the Key Considerations Regarding Use of This Authority for GHGs (and How Could Potential Issues Be Addressed)?

A key consideration in evaluating use of section 112 for GHG regulation is that

[252] See CAA section 112(d)(3).

the statutory provisions appear to allow EPA little flexibility regarding either the source categories to be regulated or the size of sources to regulate. As described above, EPA would be required to regulate a very large number of new and existing stationary sources, including smaller sources than if alternative CAA authorities were used to regulate GHG. For example, in calculating CO2 emissions based on fossil-fuel consumption, we believe that small commercial or institutional establishments and facilities with natural gas-fired furnaces would exceed this major source threshold; indeed, a large single-family residence could exceed this threshold if all appliances consumed natural gas. EPA requests comment on the requirement to establish standards for all sources under section 112 relevant to GHG emissions and whether any statutory flexibility is or is not available with respect to this requirement and GHGs.

A section 112 approach for GHGs would require EPA to issue a large number of standards based on assessments for each source category. Determining MACT based on the best-controlled 12 percent of similar sources for each category would present a difficult challenge, owing to our current lack of information about GHG control by such sources and the effort required to obtain sufficient information to establish a permissible level of performance.

GHG regulation under section 112 would likely be less cost effective than under some CAA authorities, in part because section 112 was designed to ensure a MACT level of control by each major source, and thus provides little flexibility for market-oriented approaches. Given the structure and past implementation of section 112, this section may not provide EPA with authority to allow emissions trading among facilities or averaging across emitting equipment in different source categories. This is because the statutory terms of section 112 provide that emission standards must be established for sources within ''each category'' and those standards must be no less stringent than the ''floor,'' or the level of performance achieved by the best-performing sources within that category. Each source in the category must then achieve control at least to this floor level. Trading would allow sources to emit above the floor. In addition, it may not be possible to assess individual source fence line risk for section 112(f) residual risk purposes if the sources did not each have fixed limits. Finally, the section 112 program is in part designed to protect the population in the vicinity of each facility, which trading could undermine (in contrast to an ambient standard). Given the global nature of GHGs and the lack of direct health effects from such emissions at ambient levels, EPA requests comments on the extent to which the CAA could be interpreted to grant flexibility to consider such alternative implementation mechanisms, and what, if any, limitations should be considered appropriate in conjunction with them.

Another reason that section 112 regulation of GHGs would be expected to be less cost effective than other approaches is that the statute limits consideration of cost in setting MACT standards. As described above, the statute sets minimum stringency levels, or ''floors,'' for new and existing source standards. Cost can only be considered in determining whether to require standards to be more stringent than the floor level.

A further consideration is that the short compliance timetables—immediate for most new sources, and within 3–4 years for existing sources—appear to preclude setting longer compliance timeframes to allow for emerging GHG technologies to be further developed or commercialized.

5. What Are the Possible Implications for Other Provisions of the Clean Air Act?

As provided under section 112(b)(6), pollutants regulated under section 112 of the Act are exempt from regulation under the PSD program. Also, a section 111(d) standard of performance for existing sources cannot be established to address any HAP listed under section 112(b) that that is emitted from a source category regulated under section 112.[253]

If EPA were to list GHGs under section 108 of the CAA for purposes of establishing NAAQS, we would be prevented by section 112(b)(2) from listing and regulating them as HAPs under this section of the Act. However, it is less clear that the reverse is true; that is, if a pollutant were first listed under section 112 and then EPA decided to list and regulate it under section 108, the statute does not clearly say whether that is permissible, or whether EPA would then have to remove the pollutant from the section 112 pollutant list. We request comment on the extent to which this apparent ambiguity in the Act poses an issue regarding possible avenues for regulating GHG and if so, how it should be addressed.

[253] It is important to note that many sources may be subject to standards under both section 111 and 112; however these standards establish requirements for the control of different pollutants.

In light of the foregoing, we request comment on the appropriateness of section 112 as a mechanism for regulating stationary source emissions of GHGs under the CAA. If commenters believe use of section 112 would be appropriate, we further request comments on which GHGs should be considered, what additional sources of emissions should be listed and regulated, and how MACT should be determined for GHG emission sources.

D. Solid Waste Combustion Standards

1. What Does Section 129 Require?

Section 129 of the CAA requires EPA to set performance standards under section 111 to control emissions from solid waste incineration units of at least 9 specific air pollutants. It directs EPA to develop standards which include emission limitations and other requirements for new units and guidelines and other requirements applicable to existing units.

Section 129 directs EPA to set standards for ''each category'' of such units, including those that combust municipal, hospital, medical, infectious, commercial, or industrial waste, and ''other categories'' of solid waste incineration units, irrespective of size. The pollutants to be addressed by these standards include the NAAQS pollutants particulate matter (total and fine), sulfur dioxide, oxides of nitrogen, carbon monoxide, and lead; and the hazardous air pollutants hydrogen chloride, cadmium, mercury, and dioxins and dibenzofurans. EPA is authorized to regulate additional pollutants under these provisions, but section 129 includes no endangerment test or other criteria for determining when it is appropriate to do so.

Although the emission standards called for by section 129 are to be established pursuant to section 111, the degree of control required under those standards more closely resembles that of section 112(d). For new sources the level of control is required to be no less stringent than that of the best performing similar source, while for existing sources the level of control is to be no less stringent than the average of the top 12% of best-performing sources. For both new and existing source standards, beyond these ''floor'' levels EPA must consider the cost of achieving resulting emission reductions and any non-air quality health and environmental impacts and energy requirements in determining what is achievable for units within each category. The performance standards must be reviewed every 5 years. Additionally, for those pollutants that are listed under section 112 as a HAP, EPA must reevaluate the standards in accordance with section 112(f) to determine whether they are sufficient to protect public health with an ample margin of safety and prevent adverse environmental effects, and must promulgate more stringent regulations if necessary to address any such ''residual risk.'' Thus, for this particular class of source categories, section 129 merges important elements of both sections 111 and 112.

EPA has established standards for a variety of solid waste incinerator categories and is in the process of developing additional standards and revising others.[254] In the absence of statutory criteria for determining whether and under what circumstances EPA should regulate additional pollutants under this section of the CAA, we request comment on whether emissions of GHG could fall within the scope of this section. We also request comment on direct and indirect GHG emissions from existing source categories currently subject to regulation under section 129, any assessment of the relative costs of regulating GHGs under the authority of section 129, and any co-benefits or co-detriments with regard to controlling GHG and the emissions of pollutants specifically listed for regulation under section 129.

2. What Sources Would Be Affected if GHGs Were Regulated Under This Authority?

Standards required by section 129 are applicable to ''any facility which combusts any solid waste material from commercial or industrial establishments or the general public (including single and multiple residences, hotels, and motels).'' Thus the provisions of this section are limited to a specific type of emission source, although there are many such units in existence that are subject to regulation. To date we have adopted standards for five categories of incinerators and are currently in the process of developing revised standards on remand for several of these categories, which may involve the inclusion of several additional subcategories of incineration units. We anticipate that when completed these rules will establish standards of performance for as many as five hundred or more units.

Because section 129 does not require, but authorizes EPA to establish requirements for other air pollutants, we request comment on whether and for what categories or subcategories of incinerators EPA could address GHG emissions control requirements.

a. How Are Control Requirements Determined?

As noted above, the control requirements for sources regulated under section 129 are similar to the MACT standards mandated under section 112(d). However, whereas section 112(d)(3) provides that standards are to be based on the best performing sources ''for which the Administrator has emissions information,'' section 129 contains no such limitation. Consequently, it appears that EPA is obligated to obtain information from all potentially affected sources in order to determine the appropriate level of control.

Section 129(a)(2) provides authority for EPA to distinguish among classes, types, and sizes of units within a category in establishing standards. This provision is similar to authorities provided in sections 111(b)(2) and 112(b)(2). Because section 129 directs that EPA establish standards for affected source categories under sections 111(b) and (d), we believe that the provisions governing the creation of design, equipment, work practice, or operational standards are also available for standards required by section 129. For existing sources, we believe that provisions for consideration of remaining useful life and other related factors are relevant to EPA and States when determining the requirements and schedules for compliance for individual affected sources.

b. What Is Required To Address Any Residual Risk?

For each of the air pollutants named in section 129 that are listed as HAP under section 112, section 129 requires EPA to evaluate and address any residual risk remaining after controls established under the initial emission standards.[255] In so doing, it requires EPA to determine for each affected source category whether the performance standards protect public health with an ample margin of safety. EPA must also adopt more stringent standards if needed to prevent an adverse environmental effect, but must consider cost, energy, safety, and other relevant factors in doing so.

Section 129(h)(3) limits residual risk assessments and any subsequent resulting regulations to ''the pollutants listed under subsection (a)(4) of this section and no others.'' Consequently, if EPA were to regulated GHG emissions from incineration units under section 129, we would not be required to conduct additional residual risk determinations.

3. What Are the Key Milestones and Expected Timeline if Section 129 Were Used for GHG Controls?

As stated above, we have adopted rules governing emissions from certain categories of solid waste incineration units and are in the process of revising or establishing new standards for others. Thus if we were to elect to regulate GHG emissions under section 129, a question arises concerning how to incorporate new requirements for those categories for which standards have already been established. One possible timetable for addressing GHG under this part of the Act would be to incorporate GHG emission control requirements concurrent with the mandatory 5-year reviews for each previously-regulated category, collecting information on emissions and control technologies at the time the existing standards are reviewed to determine whether revisions are needed. Because of the more detailed requirements for identifying appropriate levels of control to establish a level for these categories of sources, significantly more information on the best performing sources is needed under section 129 than even under section 112 (because of the absence of limitations for this analysis to those sources ''for which the Administrator has information''), making the development of such standards a more time-consuming effort. In the event that we were to elect to regulate GHGd under this section, we request comment on this and other approaches for addressing GHGd under section 129, both for categories already regulated and for any for which standards are currently under development.

4. What Are the Key Considerations Regarding Use of This Authority for GHGs (and How Could Potential Issues Be Addressed)?

If we were to elect to regulate GHG emissions from solid waste incinerators under section 129, then we would need to establish standards for at least some number of categories of such sources. We request comment on the availability of authority to establish requirements

[254] Rules have been promulgated for large and small municipal waste combustors; medical waste incinerators; other solid waste incinerators; and commercial, institutional, and industrial solid waste incinerators. EPA is also currently reevaluating and revising certain standards under section 129 in response to decisions by the U.S. Court of Appeals for the D.C. Circuit.

[255] Section 129(h)(3) provides that for purposes of considering residual risk the standards under section 129(a) and section 111 applicable to categories of solid waste incineration units are to be ''deemed standards under section 112(d)(2).''

for controlling GHG emissions from subcategories of incineration units based on size, type or class, as provided under section 111, and to exclude from regulation other categories or subcategories.

Given the structure of section 129 and its hybrid approach to the use of authorities under sections 111 and 112, we question whether this section provides EPA with available authority to establish alternative compliance approaches, such as emissions trading or averaging across sources within a category. This is because the statutory terms of section 129 provide that emission standards must be established for sources within ‘‘each category’’ and those standards must be no less stringent than the level of performance achieved by the best-performing sources within that category. Each source in the category must then achieve control at least to this level. Trading would allow sources to emit above the floor. As a practical matter, given that requirements for control of specifically-listed pollutants may preclude trading for those pollutants, and given that many of the controls applicable to those pollutants would be the same as or similar to those that would be applicable to GHGs, we believe that trading options would likely be infeasible with respect to GHG control requirements. However, EPA requests comments on the extent to which the CAA could be interpreted to grant flexibility to consider such alternative implementation mechanisms, to what extent, and what, if any, limitations should be considered appropriate in conjunction with them.

5. What Are the Possible Implications for Other Provisions of the Clean Air Act?

Section 129 recognizes that many incineration units may also be subject to prevention of significant deterioration or nonattainment new source review requirements. It addresses potentially conflicting outcomes of control determinations under those programs by providing that ‘‘no requirement of an applicable implementation plan . . . may be used to weaken the standards in effect under this section.’’

If EPA were to list GHGs under section 108 for purposes of establishing NAAQS, we would not be prevented from regulating them under this section of the Act as well. If EPA were to list GHG under section 112, a potential conflict arises in that section 112 establishes major and area source emissions thresholds, providing for standards of different stringency for each, and requires analysis of residual risk for major sources regulated under that section of the Act. We request comments on how such apparent conflicts could be reconciled if we were to elect to regulate emissions of GHGs from solid waste incineration units under section 129.

In light of the foregoing, we request comment on the appropriateness of section 129 as a mechanism for regulating incineration unit emissions of GHGs under the CAA. If commenters believe that use of section 129 would be appropriate, we further request comments on which GHGs should be considered, what source categories or subcategories should be regulated, and how appropriate control requirements should be determined for new and existing GHG emission sources.

E. Preconstruction Permits Under the New Source Review (NSR) Program

1. What Are the Clean Air Act Provisions Describing the NSR Program?

Under what is known as the New Source Review (NSR) program, the CAA requires the owners and operators of large stationary sources of air pollution to obtain construction permits prior to building or modifying such a facility. The program is subdivided into the Prevention of Significant Deterioration (PSD) and nonattainment NSR (NNSR) programs, either of which may be applicable depending on the air quality for a particular pollutant in the location of the source subject to permitting.

The PSD program, set forth in Part C of Title I of the CAA, applies in areas that are in attainment with the NAAQS (or are unclassifiable) and has the following five goals and purposes:

- To protect public health and welfare from air pollution beyond that which is addressed by the attainment and maintenance of NAAQS;
- To protect specially designated areas such as national parks and wilderness areas from the effects of air pollution;
- To assure that economic growth will occur in a manner consistent with the preservation of existing clean air resources;
- To assure emissions in one state will not interfere with another state’s PSD plan; and
- To assure that any decision to permit increased air pollution is made only after evaluating the consequences of the decision and after opportunities for informed public participation.

The main element of the PSD program is the requirement that a PSD permit be obtained prior to construction of any new ‘‘major emitting facility’’ or any new ‘‘major modification.’’ Before a source can receive approval to construct under PSD, the source and its permitting authority (usually a state or local air pollution control agency, but sometimes EPA) must follow certain procedural steps, and the permit must contain certain substantive requirements. The most important procedural step is providing an opportunity for the public to comment when a permitting authority proposes to issue a permit.

The PSD program primarily applies to all pollutants for which a NAAQS is promulgated, but some of the substantive requirements of the PSD program also apply to regulated pollutants for which there is no NAAQS (except that there is an explicit statutory exemption from PSD for HAPs).[256] Since there is currently no NAAQS for GHGs and GHGs are not otherwise subject to regulation under the CAA, the PSD program is not currently applicable to GHGs.[257] However, as discussed in section IV of this notice, it is possible that EPA actions under other parts of the CAA could make GHGs pollutants subject to regulation under the Act and thus subject to one or more parts of the PSD program.

If EPA were to promulgate a rule establishing limitations on GHG emissions from mobile sources or stationary sources without promulgating a NAAQS for GHGs, the PSD requirement of greatest relevance would be the requirement that a permit contain emissions limits that reflect the Best Available Control Technology (BACT). BACT is defined as the maximum achievable degree of emissions reduction for a given pollutant (determined by the permitting authority on a case-by-case basis), taking into account energy, environmental, and economic impacts. BACT may include add-on controls, but also includes application of inherently lower-polluting production processes and other available methods and techniques for control. BACT cannot be less stringent than any applicable NSPS.

Since emission control requirements will likely have the most direct impact on new or modified stationary sources subject to PSD, our focus in this notice is on the BACT requirement. However, we are also interested in stakeholder input on the extent to which we should

[256] CAA section 112(b)(6).

[257] In the Energy Independence and Security Act of 2007 (EISA), Congress provided that regulation of GHGs under CAA section 211(o) would not automatically result in regulation of GHGs under other CAA provisions. Because of this provision, EISA does not impact the interrelationship of other provisions of the CAA, and we only reference the HAP exception in the text.

evaluate other substantive PSD program elements which would be affected by any possible EPA action to regulate GHGs under other parts of the Act. These include the requirements to evaluate, in consultation with the appropriate Federal Land Manager (FLM), the potential impact of proposed construction on the Air Quality Related Values of any affected ''Class I area'' (national parks, wilderness areas, etc.) and additional impacts analysis.[258]

If EPA were to promulgate a NAAQS for GHGs, because of the relatively uniform concentration of GHGs, we expect that the entire country would be in nonattainment or attainment of the NAAQS. The preconstruction permitting requirements that apply would depend on whether the country is designated as nonattainment or attainment for the GHG emissions that would increase as a result of a project being constructed.

If the entire country is designated attainment, and PSD applies, the adoption of a NAAQS would trigger air quality analysis requirements that are in addition to all the requirements described above. For example, under CAA section 165(a)(3), permit applicants have to conduct modeling to determine whether they cause or contribute to a NAAQS violation. Following promulgation of a NAAQS, EPA may also promulgate a PSD increment for GHGs, which would require additional analysis for each new and modified source subject to PSD.[259] However, this notice does not address in detail the PSD elements that relate to increments.

Under a GHG NAAQS with the country in nonattainment, the nonattainment NSR permitting program would be triggered nationally. The nonattainment NSR program requirements are contained in section 173 of the Act. Like PSD, they apply to new and modified major stationary sources, but they contain significantly different requirements from the PSD program. A key difference is the requirement that the emissions increases from the new or modified source in a nonattainment area must be offset by reductions in existing emissions from the same nonattainment area or a contributing upwind nonattainment area of equal or higher nonattainment classification. The offsetting emissions reductions must be at least equal to the proposed increase and must be consistent with a SIP that assures the nonattainment area is making reasonable progress toward attainment.[260] Another key difference is that instead of BACT, sources subject to nonattainment NSR must comply with the Lowest Achievable Emission Rate (LAER), which is the most stringent emission limitation that is (1) contained in any SIP for that type of source, or (2) achieved in practice for sources of the same type as the proposed source.[261] Notably, if the rate is achievable, LAER does not allow for consideration of costs or of the other factors that BACT does. While LAER and offsets are likely of greatest significance for GHG regulation under nonattainment NSR, there are additional requirements for nonattainment NSR that would also apply. The additional requirements include the alternatives analysis requirement; the requirement that source owners and operators demonstrate statewide compliance with the Act; and the prohibition against permit issuance if the SIP is not being adequately implemented.

For simplicity, the remainder of this notice describing affected sources, impacts, and possible tailoring generally focuses on PSD, raising issues specific to nonattainment NSR where applicable.

2. What Sources Would Be Affected if GHGs Were Regulated Under NSR?

A PSD permit is required for the construction or modification of ''major emitting facilities,'' which are commonly referred to as ''major sources.'' A ''major emitting facility'' is generally any source that emits or has the potential to emit 250 tons per year (tpy) of a regulated NSR pollutant.[262] [263] A source that belongs to one of several specifically identified source categories is considered a major source if it emits or has the potential to emit 100 tpy of a regulated NSR pollutant.[264] Also, for nonattainment NSR, the major source threshold is at most 100 tpy, and is less in some nonattainment areas, depending on the pollutant and the nonattainment classification.

A ''major modification'' is any physical change or change in the method of operation of a major source which significantly increases the amount of emissions of any regulated NSR pollutant. EPA defines what emissions levels of a pollutant are ''significant'' through regulation, and the defined significance levels range from 0.3 tpy for lead to 100 tpy for CO. Currently there is no defined significance level for GHGs (either individually or as a group) because they are not regulated NSR pollutants, and thus, were GHGs to become regulated, the significance threshold would be zero. Note that, when determining whether a facility is ''major,'' a source need not count fugitive emissions (i.e., emissions which may not reasonably be vented through stacks, vents, etc.) unless it is in a listed category.

As noted in section IV, GHGs are not currently subject to regulation under the Act, and therefore are not regulated NSR pollutants. However, if GHG emissions become subject to regulation under any of the stationary or mobile source authorities discussed above (except sections 112 and 211(o)), GHGs could become regulated NSR pollutants. Many types of new GHG sources and GHG-increasing modifications that have not heretofore been subject to PSD would become subject to PSD permitting requirements. This is particularly true for CO_2 because, as noted in section III, the mass CO_2 emissions from many source types are orders of magnitude greater than for currently regulated pollutants. Thus, many types of new small fuel-combusting equipment could become newly subject to the PSD program if CO_2 becomes a regulated NSR pollutant. As discussed below in the section on potential to emit, the extent to which such equipment would become subject to PSD would depend upon whether, for each type of equipment, its maximum capacity considering its physical and operational design would involve constant year-round operation or some lesser amount of operation. For example, the calculated size of a natural gas-fired furnace that has a potential to emit 250 tpy of CO_2, if year-round operation (8760 hours per year) were assumed—would be only 0.49 MMBTU/hr, which is comparable to the size of a very small commercial furnace. In practice, a furnace like this would likely operate far less than year round and its actual emissions would be well below 250 tpy. For example, such a furnace, if used for

[258] As codified at 40 CFR 51.166(o), the owner or operator shall provide an analysis of the impairment to visibility, soils, and vegetation that would occur as a result of the source or modification and general commercial, residential, industrial, and other growth associated with the source or modification.

[259] PSD increments are air quality levels which represent an allowable deterioration in air quality as compared to the existing air quality level on a certain baseline date for a given area.

[260] CAA section 173(a)(1); limitations on offsets are set forth in section 173(c).

[261] CAA section 173(a); LAER is defined in section 171(3)(A).

[262] 42 U.S.C. 7569(1). The PSD regulations use the term ''major stationary source.'' 40 CFR 51.166(b)(1) The definition of ''regulated NSR pollutant'' is at 40 CFR 51.166(b)(49).

[263] ''Potential-to-emit'', or PTE, is defined as the maximum capacity of a source to emit any air pollutant under its physical and operational design.

[264] These specific sources include major industrial categories such as petroleum refining, fossil-fuel fired steam electric plants, chemical process plants, and 24 other categories. The full list of 100 tpy major sources is promulgated at 40 CFR 51.166(b)(1)(i)(a).

space heating, might only be burning gas for about 1000 hours per year, meaning that it would need to be sized at over 4 MMBTU/hr—a size more comparable to a small industrial furnace—to actually emit 250 tons of CO_2. For sources such as these, the interpretation of the term ''potential to emit'' and the availability of streamlined mechanisms for smaller sources to limit their potential to emit would determine whether they would be considered ''major'' for GHG emissions under PSD.

For sources already major for other pollutants, it is likely that many more changes made by the source would also qualify as major modifications and become subject to PSD as well, unless potential approaches (including those discussed below) for raising applicability thresholds were implemented. Relatively small changes in energy use that cause criteria pollutant emissions too small to trigger PSD would newly trigger PSD at such facilities because such changes would likely result in greater CO_2 increases. For example, consider a hypothetical 500 MW electric utility boiler firing a bituminous coal that is well-controlled for traditional pollutants. Such a boiler, operating more than 7000 hours per year (out of a possible 8760), can emit approximately 4 million tons of CO_2 per year, or more than 580 tons per hour. Assuming a 100 tpy significance level (rather than the current zero level for GHGs), any change resulting in just 10 additional minutes of utilization over the course of a year at such a source would be enough to result in an increase of 100 tons and potentially subject the change to PSD. By contrast, to be considered a modification for NO_X, the same change would require approximately 36 additional hours of operation assuming that the hypothetical source had a low-NO_X burner, and 90 additional hours of operation assuming that the source also employed a selective catalytic reduction add-on control device.

Once a source is major for any NSR regulated pollutant, PSD applies to significant increases of any other regulated pollutant, so significant increases of GHGs would become newly subject to PSD at sources that are now major for other regulated pollutants. Similarly, significant increases of other pollutants would become subject to PSD if they occur at sources previously considered minor, but which become classified as major sources for GHG emissions.

Currently, EPA estimates that EPA, state, and local permitting authorities issue approximately 200–300 PSD permits nationally each year for construction of new major sources and major modifications at existing major sources. Under existing major source thresholds, we estimate that if CO_2 becomes a regulated NSR pollutant (either as an individual GHG or as a group of GHGs), the number of PSD permits required to be issued each year would increase by more than a factor of 10 (*i.e.* more than 2000–3000 permits per year), unless action were taken to limit the scope of the PSD program under one or more of the legal theories described below. The additional permits would generally be issued to smaller industrial sources, as well as large office and residential buildings, hotels, large retail establishments, and similar facilities. These facilities consist primarily of equipment that combusts fuels of various kinds and release their exhaust gases through a stack or vent. Few of these additional permits would be for source categories (such as agriculture) where emissions are ''fugitive,'' because, as noted above, fugitive emissions do not count toward determining if a source is a major source except in a limited number of categories of large sources.

Because EPA and states have generally not collected emissions information on sources this small, our estimate of the number of additional permits relies on limited available information and engineering judgment, and is uncertain. Our estimate of the number of additional permits is also not comprehensive. First, it does not include permits that would be required for modifications to existing major GHG sources because the number of these is more difficult to estimate.[265] Nonetheless, we anticipate that, for modifications, coverage of GHGs would increase because the larger universe of major sources will bring in additional sources at which modifications could occur and because for ''traditional'' major sources, many more types of small modifications that were minor for traditional pollutants could become major due to increases in GHG emissions that exceed the significance levels. Second, EPA's estimate is uncertain because it is based on actual emissions, and thus excludes a potentially very large number of sources that would be major if they operated at their full potential-to-emit (PTE) (i.e. they emitted at a level that reflects the maximum capacity to emit under their physical and operational design), but which in practice do not. Such sources could be defined as major sources without an enforceable limitation on their PTE, but for the purposes of this estimate, we assume they have options for limiting their PTE and avoiding classification as a major source. (Nonetheless, there are important considerations in creating such PTE limits, as discussed below). Third, this estimate does not specifically account for CO_2 from sources other than combustion sources. While we know there are sources with significant non-combustion emissions of GHGs, there are relatively few of these compared to the sources with major amounts of combustion CO_2. These non-combustion sources would likely be major for combustion CO_2 in any event, and many of these are likely already major for other pollutants, though GHG regulation would likely mean increases in the number of major modifications at such sources.

We request any available information that would allow us to better characterize the number and types of sources and modifications that would become subject to the PSD program if CO_2 becomes a regulated NSR pollutant. As discussed below, we are particularly interested in information that would allow us to analyze the effects of different major source thresholds and significance levels.

Finally, we note that our estimates above are for CO_2. As described above in section IV, there are implications to regulating additional GHGs as pollutants, or GHGs in the aggregate. Our estimates of PSD program impacts do not include consideration of GHGs other than CO_2 because we expect that at the vast majority of these sources CO_2 will be the dominant pollutant. We ask for comment on whether there are large categories of potentially newly regulated PSD sources for individual GHGs besides CO_2. We also ask for comment on the effects of aggregating GHGs for PSD applicability. Aggregating GHGs could bring additional sources into PSD to the extent that other GHGs are present and would add enough to a source's PTE to make it a major source. On the other hand, under the netting provisions of the CAA, it may be easier to facilitate interpollutant netting if GHGs are aggregated (e.g., a source using netting to avoid PSD for a CO_2 increase based on methane decreases at the same source).

[265] Among other things, any estimate of modifications must take into account the netting provisions of NSR, in which sources can avoid NSR if the increase of pollutant emissions from a project is below the significance level for that pollutant, after taking into account other increases and decreases of emissions that are contemporaneous with the project.

3. What Are the Key Milestones and Expected Timeline if the PSD Program Were Used for GHG Controls?

Because PSD applies to all regulated pollutants except HAP, EPA's interpretation of the Act is that PSD program requirements would become applicable immediately upon the effective date of the first regulation requiring GHG control under the Act.[266] While existing PSD permits would remain unaffected, from that point forward, each new major source of GHGs and each major modification at an existing major source that significantly increases GHGs would need to get a PSD permit before beginning construction. Control requirements could take effect as the first new and modified sources obtain their permits and complete construction of the permitted projects. Because of the case-by-case nature of the PSD permitting decisions, the complexity of the PSD permitting requirements, and the time needed to complete the PSD permitting process, it can take several months to receive a simple PSD permit, and more than a year to receive a permit for a complex facility. We ask for comment on whether there are additional timeline considerations not noted here.

4. What Are Key Considerations Regarding Application of the PSD Program to GHGs (and How Could Potential Issues Be Addressed?)

a. Program Scope

As noted above, regulating GHGs under the PSD program has the potential to dramatically expand the number of sources required to obtain PSD permits, unless action is taken to limit the scope of the program, as described below. Since major source thresholds were enacted before this assessment of the application of the PSD program to GHGs, it is reasonable to expect that Congress could consider legislative alterations to account for the different aspects of GHGs versus traditional air pollutants noted above (e.g., the relatively uniform atmospheric concentrations of GHGs versus more localized effects of traditional pollutants.) Possible ways to limit the scope of the program without legislation are described later in this section.

In the absence of such action, we would expect (assuming a 250 tpy major source threshold, or 100 tpy for statutorily specified source categories) at least an order-of-magnitude increase in the number of new sources required to obtain PSD permits, and an expansion of the program to numerous smaller sources not previously subject to it. While such sources may emit amounts of GHGs that exceed statutory thresholds, they have relatively small emissions of non-GHG pollutants (such that they have not been regulated under PSD, and many have not been regulated under any CAA program).[267] Regulating GHGs under the PSD program would also cause a large increase in the number of modifications at existing sources that would be required to obtain PSD permits. Such modifications may occur at existing sources that have been long regulated as major for other pollutants, or at existing sources that become classified as major solely due to their GHG emissions.

Permitting smaller sources and modifications is generally less effective due to the fact that, while there are still administrative costs borne by the source and permitting authority, the environmental benefit of each permit is generally less than what results from permitting a larger source. Congress excluded smaller sources from PSD by adopting 100 and 250 tpy major source cutoffs in 1977 when PSD was enacted, and EPA rules have long excluded smaller sources and modifications from the program. This cutoff would not exclude many smaller sources of GHGs because the mass emissions (i.e., tons per year) of the relevant GHG may be substantially higher than the mass emissions of traditional pollutants for the same process or activity. Thus, while existing cutoffs for traditional pollutants capture a relatively modest number of new and modified sources per year, applying those same major source levels to CO_2, and possibly for other GHG, would capture a very large number of sources, many of which are comparatively smaller in size when compared to ''traditional'' sources. Similarly, for modifications, the current absence of a significance level, or the future adoption of a significance level that is below the current major source thresholds, would subject numerous small changes to PSD permitting requirements.

b. Potential Program Benefits

In the past, EPA has recognized that the PSD program can achieve significant emissions benefits over time as emissions increases from new major sources and major modifications are minimized through application of state-of-the-art technology.[268] As a result, other programs designed to reduce emissions are not compromised by growth in new emissions from PSD sources. Further emissions benefits are achieved when sources limit or reduce emissions to avoid PSD applicability.

A rationale for new source review since its inception has been that it is generally more effective and less expensive to engineer and install controls at the time a source (or major modification) is being designed and built, as BACT does, rather than retrofitting controls absent other construction.[269] In addition, the BACT determination process requires consideration of new emissions reduction technologies, which provides an ongoing incentive to developers of these technologies. There is the potential for avoiding or reducing GHG emissions if ''traditional'' sources begin to install abatement technologies for GHGs as they do for traditional pollutants. On the other hand, as discussed in section III,F, some suggest that regulations that apply stringent requirements to new sources and ''grandfather'' existing sources may create incentives to keep older and inefficient sources in use longer than otherwise would occur, diminishing the incentive for technological innovation and diffusion and reducing the environmental effectiveness and cost effectiveness of the regulation. Others believe that economic factors other than these regulatory differences tend to drive business decisions on when to build new capacity. EPA examined the effect of new source review on utilities and refineries in a 2002 report, as described in section III.F.4 of this notice.[270]

[266] Because PSD is implemented in many areas by states under EPA-approved state regulations, there may be a lag time in a small number of states if their PSD regulations are written in such a way that revision of the regulations (and EPA approval) would be required to give the state authority to issue permits for GHGs. However this would not be the case for EPA's own regulations or for any state delegated to implement EPA regulations on our behalf.

[267] Some fraction of these small sources are regulated, at least in some areas, by SIPs and state minor source permit programs under section 110 of the CAA.

[268] See, for example, Section II of ''NSR Improvements: Supplemental Analysis of the Environmental Impact of the 2002 Final NSR Improvement Rules,'' U.S. EPA, November 21, 2002.

[269] Critics of this rationale suggest that under a market-oriented system covering both new and existing sources, source owners would be best placed to decide whether it is economic to place state-of-the-art controls on new sources.

[270] See U.S. EPA, ''New Source Review: Report to the President, June 2002.'' As noted in section III.F of this notice, the report concluded (pp. 30–31) that, for existing sources, ''[c]redible examples were presented of cases in which uncertainty about the exemption for routine activities has resulted in delay or resulted in the cancellation of projects which sources say are done for purposes of maintaining and improving the reliability,

EPA has not performed an analysis of the GHG emissions that might be avoided or reduced under PSD preconstruction permitting, nor of possible increases through unintended incentives. Such an analysis would necessarily involve new analysis of potential BACT technologies, considering costs and other factors, for GHGs emitted by numerous sectors. The PSD program, through the BACT requirement, might result in installation of such technologies as CCS, or the incorporation of other CO_2 reducing technologies, such as more efficient combustion processes.[271] However, it is not possible at this time to estimate these effects in light of the uncertainty surrounding the future trends in construction at new and modified sources, demonstration of commercial availability of various GHG control technology options, their control effectiveness, costs, and the aforementioned incentives to keep existing sources in operation and avoid modifying them. We ask for comment on the nature (and to the extent possible, the magnitude) of the potential effects of PSD on GHG emissions, and whether these effects vary between new and existing sources.

Regarding the potentially large universe of smaller sources and modifications that could become newly subject to BACT, as described above, there are large uncertainties about the potential benefits of applying BACT requirements to GHG emissions from such sources. Individual emission reduction benefits from such sources would be smaller; however, the cumulative effect could theoretically be large because the requirement would cover many more sources. However, unless there are ways to effectively streamline BACT determinations and permitting for smaller sources (as discussed below), BACT would not appear to be an efficient regulatory approach for many other types of sources. We request comment on the potential overall benefit of applying the BACT requirement to GHG emissions, and how this potential benefit is distributed among categories of potentially regulated sources and modifications. Below, we discuss and ask for comment on possible tailoring of BACT for GHGs.

Finally, in considering the potential for emissions reductions from the PSD program, it is important to note that, historically, sources generally have taken action to avoid PSD rather than seeking a permit, where possible. Companies can reduce their PTE, for example, by artificially capping production or forgoing efficiency improvements. While these PSD avoidance strategies can sometimes reduce emissions (e.g., limiting operating hours or installing other controls to net out), they can sometimes result in forgone environmental benefits (e.g., postponing an efficiency project). These effects are very difficult to quantify. For example, the developer of a large apartment building that would be a major source for CO_2 might elect to provide electric space heat if it were determined that the direct and indirect costs of PSD made installation of gas heat uneconomical. From a lifecycle analysis standpoint, PSD could—depending upon the source of the electricity—lead to either a better or a worse outcome for overall emissions of GHGs. Similarly, because PSD is triggered based on increases over a past baseline, a source considering a potential modification may have an incentive to increase emissions (to the extent that can be done without a modification) for the 2-year period before the modification to artificially inflate the baseline. Similarly, in the electricity sector, a desire to avoid PSD review could be a disincentive for some projects to improve efficiency, because a small increase in utilization of the more-efficient EGU would raise CO_2 emissions sufficiently to trigger review. We solicit comments on the potential indirect effects, adverse or beneficial, that may arise from the incentive to avoid triggering PSD.

c. Administrative Considerations and Implications of Regulating Numerous Smaller Sources

The PSD program is designed to provide a detailed case-by-case review for the sources it covers, and that review is customized to account for the individual characteristics of each source and the air quality in the particular area where the source will be located. Although this case-by-case approach has effectively protected the environment from emissions increases of traditional criteria pollutants, there have been significant and broad-based concerns about PSD implementation over the years due to the program's complexity and the costs, uncertainty, and construction delays that can sometimes result from the PSD permitting process. Expanding the program by an order of magnitude through application of the 100/250-ton thresholds to GHGs, and requiring PSD permits for numerous smaller GHG sources and modifications not previously included in the program, would magnify these concerns. EPA is aware of serious concerns being expressed by sources and permitting authorities concerning the possible impacts of a PSD program for GHGs.

While the program would provide a process for reviewing and potentially reducing GHG emissions through the BACT requirement as it has done for other pollutants, we are concerned that without significant tailoring (and possibly even with significant tailoring), application of the existing PSD permitting program to these new smaller sources would be a very inefficient way to address the challenges of climate change. We ask for comment on how we should approach a determination of (1) whether PSD permit requirements could be appropriate and effective for regulating GHGs from the sources that would be covered under the statutory thresholds, (2) whether PSD requirements could at least be effective for particular groups of sources (and if so, which ones), and (3) what tailoring of program requirements (options for which are described in more detail below) is necessary to maximize the program's effectiveness while minimizing administrative burden and permitting delays. We are particularly interested in how we might make such judgments in light of the limitations on our ability to quantify the costs and emissions reduction benefits of the PSD program, and whether there are specific examples or other data that would help us with such an analysis.

For example, if 100- and 250-ton thresholds were applied to GHGs, the BACT requirement would need to be newly implemented for numerous small sources and modifications that permitting authorities have little experience with permitting. It would also likely involve, for both large and small sources, consideration of new pollutants for which there are limited add-on control options available at this time. Thus, as with setting NSPS, a BACT determination for GHGs would likely involve decisions on how proposed installations of equipment and processes for a specific source category can be redesigned to make those sources more energy efficient while taking cost considerations into account. However,

efficiency and safety of existing energy capacity. Such discouragement results in lost capacity, as well as lost opportunities to improve energy efficiency and reduce air pollution.'' With respect to new facilities, the report said, ''there appears to be little incremental impact of the program on the construction of new electricity generation and refinery facilities.''

[271] However, EPA notes that the BACT requirement does not require consideration of technologies that would fundamentally redefine a proposed source into a different type of source (e.g., BACT for a proposed coal-fired power plant need not reflect emission limitations based on building a gas-fired power plant instead). See, for example, *In re: Prairie State Generating Company,* PSD Appeal No. 05–05, slip op. at 19–37 (EAB 2006).

unlike NSPS, because BACT is typically determined on a case-by-case basis for each facility and changes as technology improves, these decisions would have to take into account case-specific factors and constantly evolving technical information[272]. Due to the more-than-tenfold increase in the number of PSD permits that would be required if the 100- and 250-ton thresholds were applied to GHGs, and the potential complexity of those permitting decisions, state, local, federal, and tribal permitting authorities would likely face significant new costs and other administrative burdens in implementing the BACT requirement for GHGs. Large investments of resources would be required by permitting authorities, sources, EPA, and members of the public interested in commenting on these decisions. Also under this scenario, sources would likely face new costs, uncertainty, and delay in obtaining their permits to construct.

d. Definition of Regulated Pollutant for GHGs

We also note, as described above, that decisions on the definition of regulated pollutant for GHGs—whether GHGs would be regulated as individual gases or as a class—has implications for BACT determinations under the PSD program. If GHGs are regulated separately, it is possible that a control project for one GHG could trigger PSD for another (e.g., controlling methane in a way that increases CO_2). In addition, the economic and other impacts for BACT would need to be evaluated on a pollutant-by-pollutant basis. While regulating GHGs as a class would provide additional flexibility in this area, each BACT analysis would be more extensive because it would have to include combined consideration of all GHGs in the class. We ask for comment on the relative strengths and weaknesses of the various ways to define the regulated pollutant for GHGs as related to the BACT requirement.

e. Other PSD Program Requirements

Other parts of the CAA PSD provisions and EPA regulations that could be affected by bringing GHGs into the program include the requirement to evaluate, in consultation with the Federal Land Manager (FLM), impacts on Air Quality Related Values (AQRVs) in any affected ''Class I area'' (national parks, wilderness areas, etc.), and the need to conduct additional analysis of the proposed source's impacts on ambient air quality, climate and meteorology, terrain, soils and vegetation, and visibility, as provided for in section 165(e) of the Act. These requirements can result in adjustments to the permit (for example, permit conditions may be added if a FLM demonstrates to a permitting authority that additional mitigation is necessary to address the impacts of GHG emissions on the AQRVs of a Class I area). Due to the increase in number of permits, permitting authorities may have to make significant programmatic changes to deal with the increased workload to conduct these analytical requirements of the PSD program, and many additional applicants will have to devote resources to satisfying these requirements. In addition, given the uneven geographic distribution of new source growth, some permitting authorities may be required to conduct more permit analyses than others.

f. GHG NAAQS Nonattainment Scenario

If nonattainment NSR were triggered under a GHG NAAQS, the most significant requirement would be the LAER requirement. Because LAER does not allow consideration of costs, energy, and environmental impacts of the emissions reduction technology, the LAER requirement would have the potential to act as a strong technology forcing mechanism in GHG nonattainment areas. On the other hand, once a technology is demonstrated, this mechanism does not allow consideration of the costs, competitiveness effects, or other related factors associated with the new technology. As with PSD requirements, the application of LAER to numerous smaller sources nationwide would raise new issues on which we request comment. For example, with LAER, any demonstrated technology for reducing CO_2 emissions, such as a new efficient furnace or boiler design, could become mandated as LAER for all future construction or modification involving furnaces or boilers. Manufacturers would have to supply technologies that could meet LAER or face regulatory barriers to the market, and could face a constantly changing regulatory level that may result in newly designed products being noncompliant shortly after, or even before, they are produced and sold. New and modified sources would be required to apply the new technology even if it is a very expensive technology that may not necessarily have been developed for widespread application at numerous smaller sources, and even if a relatively small emissions improvement came with significant additional cost. We request comment on how EPA should evaluate the LAER requirement under a NAAQS approach for GHGs. In particular, we ask for information about whether the relatively inflexible nature of the LAER requirement would lead to economic disruption for certain types of sources (and if so which ones), and whether the benefits of a NAAQS approach including LAER would warrant further evaluation and possible tailoring of LAER to address GHGs.

We also ask for comment on any other NSR program issues particular to a NAAQS approach, should EPA decide to establish a NAAQS for GHGs. Although we have not provided a comprehensive discussion of such issues, a number of questions arise that are particular to the NSR requirements that flow from a NAAQS approach. For example, if the entire country were designated nonattainment for GHGs, would the offset requirement function as a national cap-and-trade program for GHG emissions for all major sources? If so, how would such a program be administered, and would the numerous small sources described above be covered? Would the offset requirement argue for regulating GHGs as a group, rather than individually, to facilitate offset trading? What would be an appropriate offset ratio to ensure progress toward attainment? Similarly, for the air quality analysis requirements of PSD, how would a single source determine whether its contribution to nonattainment is significant? When must such a source mitigate its emissions impact, and what options are available to do so? Should EPA set a PSD increment for GHGs if a NAAQS is established? Are there additional issues of interest that we have not raised in this notice?

5. What Are the Possible Implications on Other Provisions of the Clean Air Act?

If PSD for GHGs applied to the same sources as a new market-oriented program to regulate GHGs under the Act, the interaction of the two programs would be a key issue. PSD would ensure that new and modified sources were built with the best available technology to minimize GHG emissions. A traditional argument for NSR is that it ensures that new sources are built with state-of-the-art technology that will reduce emissions throughout the lifetime of that source, which can be several decades. However if the market-oriented program is a cap-and-trade system with sufficiently stringent caps, PSD would not result in more stringent control of new GHG sources than the

[272] The NSPS program does take into account improvements in technology, but does so during the 8-year review of the NSPS under 111(b)(1)(B) rather than on a permit-by-permit basis.