United States Environmental Protection Agency

Office of Transportation and Air Quality

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Program Update

EPA Technical Study on the Safety of Emission Controls for Nonroad Spark-Ignition Engines Below 50 Horsepower

The U.S. Environmental Protection Agency (EPA) has prepared a report evaluating the potential safety effects of applying new emission controls to nonroad spark-ignition (SI) engines. The technical study concludes that adding emission control technologies would not increase the risk of fire and burn to consumers, including fire due to contact with flammable items and refueling.

What is the Nonroad SI Safety Study?

This technical study assesses the incremental impact on safety of applying the advanced emission control technology expected to meet the new emission standards that EPA is considering for particular subcategories of nonroad engines and equipment, focusing on the risk of fire and burn to consumers. The study will be part of the rulemaking record for the upcoming proposed standards and satisfies the provisions of section 205 of PL 109-54, which requires EPA to assess potential safety issues, including the risk of fire and burn to consumers, associated with the proposed emission standards for nonroad SI engines under 50 horsepower (hp).

What types of engines and equipment are covered by the Safety Study?

This study evaluates new exhaust and evaporative emission standards for nonhandheld and handheld equipment in the Small SI engine category (such as lawn and garden equipment) and outboard and personal watercraft engines and vessels in the Marine SI engine category.

What types of emission standards is EPA considering?

- New catalyst-based standards to reduce exhaust emissions of hydrocarbons (HC) and oxides of nitrogen (NOx) from nonhandheld engines.
- New standards to reduce exhaust emissions of HC, carbon monoxide (CO), and NOx from Marine SI engines.
- New emission standards to reduce evaporative fuel emission from most types of equipment and vessels in the Small SI and Marine SI categories.

What are the technical report's general conclusions?

For each new standard, we conclude that the anticipated emission standards may be implemented without any incremental increase in risk of fire or burn to consumers. The testing and analysis further indicates that compliance with the anticipated emissions standards could somewhat reduce the risk to consumers using products in these subcategories.

What are the conclusions related to exhaust controls for nonhandheld engines?

We conducted the technical study of the incremental risk of catalyst-based HC+NOx emission standards for nonhandheld Small SI engines on several fronts. First, working with the Consumer Product Safety Commission (CPSC), we evaluated CPSC reports and databases and other outside sources to identify those in-use situations which create fire and burn risk for consumers. The following scenarios were identified for evaluation:

- Thermal burns due to inadvertent contact with hot surface on engine or equipment
- Fires from grass and leaf debris on the engine or equipment
- Fires due to fuel leaks on hot surfaces
- Fires related to spilled fuel or refueling vapor

- Equipment or structure fire when equipment is left unattended after being used
- Engine malfunction resulting in an ignitable mixture of unburned fuel and air in the muffler (engine misfire)
- Fire due to operation with richer than designed air-fuel ratio in the engine or catalyst

Second, we conducted extensive laboratory and field testing of both current technology (Phase 2) and prototype catalyst-equipped advanced-technology engines and equipment (Phase 3) to assess the emission control performance and thermal characteristics of the engines and equipment. We also contracted with Southwest Research Institute (SwRI) to conduct design and process Failure Mode and Effects Analyses (FMEA) comparing Phase 2 and Phase 3 compliant engines and equipment to evaluate incremental changes in risk probability as a way of evaluating the incremental risk of upgrading Phase 2 engines to meet Phase 3 emission standards. Our technical work and subsequent analysis of all of the data and information strongly indicate that catalyst-based standards can be implemented without an incremental increase in the risk of fire or burn to the consumer.

What are the conclusions related to evaporative controls for Small SI equipment?

We also evaluated the incremental risk of fire and burn to consumers for the evaporative emission standards we are considering for handheld and nonhandheld equipment. For both subcategories, we are considering standards to control fuel tank permeation and fuel hose permeation similar to those in place for other nonroad SI engines and vehicles, such as all-terrain vehicles and off-highway motorcycles. In addition, for nonhandheld equipment, we are considering requirements to reduce emissions related to evaporation of fuel during operation. Working with CPSC, we evaluated CPSC databases to identify those in-use situations that create fire and burn risk for consumers. Fuel leaks from tanks or fuel hoses on handheld and nonhandheld equipment were identified as the major safety concern for evaluation.

Fuel tanks used on handheld and nonhandheld equipment are constructed of different types of materials using different processes and each has a potentially different approach to controlling tank permeation emissions. EPA evaluated both current and treated fuel tanks in the laboratory for several years and identified no incremental safety risk related to the

technologies for reducing permeation emissions. Most fuel hoses meet American Society for Testing and Materials (ASTM) and Society of Automotive Engineers (SAE) standards, and the types of fuel hoses needed to reduce permeation are in widespread use today. In fact, some lawn and garden equipment already uses low permeation hose.
Beyond this, in situations where custom fuel hoses are used, there are the ASTM and manufacturer-specific test procedures and requirements that ensure proper in-use performance. With regard to fuel tanks, there are manufacturer-specific test procedures and requirements that manufacturers apply to current products and will continue to use in the future. The durability portion of EPA's permeation test procedures inherently includes the types of evaluations needed to identify the potential for leaks in-use.

The Failure Modes and Effects Analysis conducted by Southwest Research Institute also looked at systems interaction between engine modifications and the fuel system and determined that permeation controls and running loss controls for nonhandheld equipment would not increase the fire and burn risk probability, but could in fact lead to directionally better systems from a safety perspective. Overall, there is no incremental safety risk in applying advanced technology to reduced evaporative emissions from handheld and nonhandheld engines and equipment.

What are the conclusions related to exhaust controls for marine engines and vessels?

The Coast Guard keeps a close watch over marine safety issues. The Coast Guard, as well as organizations such as SAE, Underwriters Laboratories, and the American Boat and Yacht Council (ABYC), already have safety standards that apply to engines and fuel systems used in these vessels. The four-stroke and two-stroke direct injection engine technologies that are likely to be used to meet the exhaust emission standards contemplated for outboard and personal watercraft engines are in widespread use in the vessel fleet today. These more sophisticated engine technologies are replacing two-stroke carbureted engines. The four-stroke and two-stroke direct injection engines meet applicable Coast Guard and ABYC safety standards and future products will do so as well. The proposed emission standards must be complementary to existing safety standards, and our analysis indicates that this will be the case. There are no known safety issues with the advanced technologies compared with two-stroke carbureted engines. The newer-technology engines

arguably provide safety benefits due to improved engine reliability. Based on the applicability of Coast Guard and ABYC safety standards and the good in-use experience with advanced-technology engines in the current vessel fleet, we believe new emission standards would not create an incremental increase in the risk of fire or burn to the consumer.

What are the conclusions related to evaporative controls for marine vessels?

We also analyzed the incremental impact on safety for the standards under consideration to reduce fuel hose permeation, fuel tank permeation, and diurnal emissions. As with the exhaust emission standards, any EPA emission standards must complement existing Coast Guard, ABYC, and SAE performance and safety standards related to fuel hoses for marine vessels and similar standards covering portable and installed fuel tanks. All these standards are designed to address the in-use performance of fuel systems with the goal of eliminating fuel leaks. The low-permeation fuel lines needed to meet Phase 3 requirements would need to pass these standards, and evidence indicates that this would occur. In fact, fuel lines meeting these requirements are available today. The low-permeation fuel tanks needed to meet the Phase 3 requirements would also need to pass the applicable Coast Guard, Underwriters Laboratories, and ABYC standards. Work conducted by EPA and vendors supplying the marine tank industry indicates that the technology needed to meet these standards can be applied without an incremental increase in risk over current systems.

We are also considering diurnal emissions standards for fuel tanks used on Marine SI vessels. For personal watercraft and portable outboard fuel tanks, this would likely involve the use of fuel tank venting that is already commonly used. For vessels with installed fuel tanks, this would likely involve the use of activated carbon canisters to capture vented fuel vapors. Such canisters have been used safely on automobiles for more than 30 years and a prototype fleet run by industry last summer on marine vessels revealed no safety concerns. Overall, there should be no increase in risk of fire or burn to consumers in applying advanced technology to reduce evaporative emissions from these marine engines and vessels. In fact, the reduction of permeation emissions is likely to decrease safety risks from fire in the under-floor areas on boats where the tanks and hoses are installed.

Has EPA submitted the Safety Study for Peer Review?

Yes. We contacted three individuals with considerable expertise that was relevant to the scope of the safety study. Jim Hoebel spent 28 years at CPSC, including a position as Chief Engineer for Fire Safety; he is also a member of the National Association of State Fire Marshals. Mr. Hoebel encouraged some broadened discussion of safety concerns, but noted that the conclusions strongly support proceeding with Phase 3 exhaust emission standards for nonhandheld engines. Sam Coates has 20 years of experience in designing Small SI and Marine SI engines, and is currently an engineering professor at Michigan Technical University. Dr. Coates affirmed the study's approach and conclusions as well reasoned and well supported. Ron Heck is currently acting as a consultant after working in catalyst research and development for 31 years. Dr. Heck suggested several ways of expanding discussion to account for various additional factors and conditions. In addition, we have prepared the report in coordination with staff from the Coast Guard and CPSC. The safety study addresses each of the comments received from peer review and inter-agency review.

Are we holding outreach meetings related to the Safety Study?

Yes. We will be holding outreach briefings with key stakeholders in the week following publication.

Where can I find more information?

You can access this technical study on EPA's Office of Transportation and Air Quality Web site at:

- Lawn and Garden Equipment: www.epa.gov/otaq/equip-ld.htm
- Gasoline Boats & Personal Watercraft: www.epa.gov/otaq/marinesi.htm

For further information on the study, please contact the Assessment and Standards Division at:

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