Preliminary Comments
on the report titled
"Effects of Intermediate Ethanol Blends on Legacy Vehicles and Small Non-Road Engines (SNRE), Report 1," NREL/TP-540-43543 and ORNL/TM-2008/117, dated October 2008

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[GUERRY EDITED VERSION #1]

I. Major Adverse Impacts Observed

The reported results from the DOE ethanol study indicate the following **major adverse impacts**:

- Engine exhaust temperatures rose to an extent that may cause premature engine and equipment failure, increased fire hazards, and the degradation of plastic components (like fuel tanks and lines) that can result in additional hazards. The report merely notes certain temperature increases, but does not address the consequences. A rise in temperatures (exhaust, cylinder head, etc.) of the order of 20 to 70 C from E0 to E20 is significant. For several categories, even an increase in 5 to 10 C observed between E10 and E15 may be significant.
- Safety hazards dramatically increased due to unintentional clutch engagement caused by high idle speeds. While the report notes that idle speed increased and caused unintentional clutch engagement for hand trimmers, the obvious safety implication was not mentioned or discussed. The mitigation proposed in the Report (i.e., adjustment of fuel air mixture enleanment) is unworkable and may even be illegal tampering. It is certainly not feasible to do this type of adjustment on millions of legacy equipment that are already in use.
- Loss of durability. (Both of the tested "Residential Handheld Engines" (engines B-3 and B-7 as shown in Figure 3.9, pp. 3-18) suffered total and complete failures and would not start or operate after running on E-15 fuel for 25 or less hours, which is less than half of their useful life);
- Numerous adverse operational issues – such as erratic engine and equipment operation, stalling of engines, and dramatic power reduction – due in part to "materials incompatibility." (In fact, the report itself speculates that materials incompatibility (such as swelling of the elastomeric seat for the needle in the carburetor bowl) could be the

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cause of the engine stall for the Briggs and Stratton generator observed in the pilot study), and

- Irreversibility of impacts – such that problems observed above could not be reversed by reverting to E0 fuel.

II. Executive Summary vs. Actual Test Results

The Executive Summary does not accurately describe the limited scope and problematic results with the test program. Below, I have summarized several examples where there are material inconsistencies in the manner in which the results are reported in the main body of the Report versus in the Executive Summary.

- In discussing the unintentional clutch engagement, the Executive Summary (Sec. E.5.2) merely lists three handheld trimmers tested. However, the Report (Sec. 3.2) explains that clutch engagement could also occur on chainsaws. The hazards of unintentional clutch engagement in chainsaws and hedgeclippers (which are both examples of close-to-the-body equipment while operating) should be discussed and fully evaluated.
- With regards to materials compatibility, while the Executive Summary merely notes that "…no obvious materials compatibility issues were noted…" However, the Report explains that "…various fuel-wetted materials in some small engines may not be compatible with all ethanol blends…" and that "..materials compatibility issues…were not specifically characterized as part of the study…"
- Products included in the study experienced unstable governor operation when operating on E20 fuel, indicating unacceptable performance. However, these problems were not included in the Executive Summary.
- The Executive Summary simply notes that HC emissions "generally decreased" and that combined HC+NOx emissions "decreased in most instances." However, the report explains that while HC emissions generally decreased, HC emissions also increased in some engines. The net change in HC+NOx emissions ranged from -36% to +41% as reported in Sec. 3.2.2. It is important to note that for new engines, the net change in HC+NOx was often greatest in going from E0 to E10 and smaller in the other transitions (i.e., from E0 to E15 or E0 to E20). (see Table 3.7). For example, the

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numerical average for all engines shows that the HC+NOx reduction was: 16.6% from E0 to E10; -13.5% from E0 to E15; and only -9.5% from E0 to E20. Since more SNRE are already capable of E10 operation (and that fuel is already available), transitioning to E15 and E20 should actually increase HC+NOx from E10.

III. Limited Scope in the Testing

As DOE generally recognizes in the report, there are numerous limitations to the scope of the test program, including the following:

- No emissions testing pertaining to evaporative emissions was conducted. Thus, all references to "emissions" means tail-pipe emissions from the engine. This is only a portion of the emissions that are regulated and are expected to be regulated into the future for SNRE.
- The report does not contain any direct test data on materials compatibility testing or results – i.e. involving the various fuels tested and the materials that may be exposed to these fuels and how they interact. Yet, the report purports to note that "…no obvious materials compatibility issues were noted…" This is misleading. It is not clear what is meant by "obvious."
- As the report notes, no cold-start and or warm-up testing was done – although these are two very common modes of operation for many categories of SNRE. Additional performance tests that impact "operational issues" which should have been tested (but were not) include: acceleration; application performance; carburetor and breather icing; fuel consumption; governor stability; load pick up; and vapor lock. Individual categories of SNRE will likely have additional performance-related test requirements.
- The report does not adequately consider the implications of irreversibility – i.e., once exposed to E15 and/or E20, performance is not restored simply by reverting to E0. In the case of the Poulan weedeater, it is noted that there were poor operations with E15 and E20 and that "normal operation could not be restored on E0." This is significant. Actual users, when faced with operational problems with ethanol blended fuels, will likely revert to E0. What they will find is that doing so will not "unring the bell" – since the damage by the ethanol blends is not reversible simply by changing the fuel.

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IV. Limited Number of Tests Conducted

SNREs represent a broad swath of equipment and engine types. Only with an understanding of the context of the diverse SNRE population can the limited results of only 28 SNREs tested be fully appreciated. Yet, the category has not been defined in the report so that the extent of test results presented can be judged in context.

- While noting that millions of SNREs are sold each year (actually tens of millions), and that EPA certifies on the order of 900 engine emission families, the report does not cover the immense diversity of the category – including the various engine and equipment types used, the fuel delivery mechanisms, the various sizes and functions of the equipment, the constraints that the equipment operate under (such as close proximity to operators, as an example), and many other characteristics. The report also fails to recognize that engines in this product category utilize a wide variety of engine architecture – including both single and twin cylinders, two cycle and four cycle combustion, ported and valve charge controlled, side valve and overhead valve orientations, with and without exhaust after-treatment, governed load and product load controlled, etc.
- The types and numbers of engines and equipment tested are inadequate to be representative of even the limited types of SNRE that were the subject of testing. While practical constraints such as time and money will always constrain the amount of testing that can be done, the basis for choosing the engine and equipment – namely those found in "…popular, high sales volume equipment…" appears to not have been followed. For example, of the six pieces of equipment selected for the pilot study, four were generators. No chainsaws were tested, even though the OPEI had directly requested that they be included – given their high RPMs and extreme operational demands. Also, it is explicable why only one residential hand-held SNRE would be tested, even though these are likely to be most sensitive to fuel changes.
- The report should provide the basis of selection rather than referencing unspecified EPA sources. One of the constraints also seems to have been the available laboratory equipment (i.e., lack of small engine dynamometers). This is clearly an inappropriate basis for constraining equipment selection, especially if the goal is to obtain data on the entire class of SNRE.

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- A significant portion of the Class 2 (>225 cc) non-handheld engines produced each year are two cylinder engines. The report rightly notes the challenges associated with multi-cylinder engines – although characterizing these as being "more sensitive" is perhaps too vague. While the study included one twin cylinder engine in the initial screening process, there were no twin cylinder engines included in the more in depth portions of the testing program – even though . ~~Particularly when~~ the initial screening test clearly demonstrated significant influences of higher ethanol blends. ~~A significant portion of the Class 2 (>225 cc) non-handheld engines produced each year are two cylinder engines. The omission of these engines in the expanded program is puzzling. The detailed test program should include engines and equipment that demonstrated any significant influence during the screening tests.~~

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V. ~~VI. Deficiencies in Testing Performed~~Concerns with How the Tests were Performed and Reported

- As a consequence of the limitations and problems discussed above, it is difficult to separate the effects of engines, fuels, and aging. For example, the full-life tests do not allow the ability to distinguish between fuel-driven and engine-driven causes since only one engine was tested on each fuel. In the pilot study, the effects of the fuel and aging are similarly hard to separate.
- What is actually measured as HC in the study is unclear – since a FID was used for this purpose, uncorrected for any ethanol or aldehydes, as noted in the report.

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VI. Inadequate Fuel Characterization

- The report notes that the following fuels were used: E0, as well as splash-blended E10, E15, and E20. However, the report does not contain the actual ASTM specification of the blended fuels, including all relevant properties such as distillation cut point temperatures, etc. Table 2.2 of the report contains a few parameters of the blends. This is incomplete and a more compete fuel specification should be provided.
- While the report notes that "…the different fuel characteristics of match-blended and splash-blended fuels were not expected to have a significant impact on

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temperature…" the technical support for this statement is difficult to discern. Similarly, the observation that "…emission results…are not expected to vary significantly…" between these fuels is hard to evaluate since "significant" is not defined.

~~V.~~VII. Other Comments

- ~~A.~~ The comments above only pertain to the Small Non-Road Engine (SNRE) testing conducted and reported in the report.
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