7. Materials Technologies: Propulsion Materials

Advanced materials, including metals, polymers, composites, ceramics, and intermetallic compounds, play an important role in improving the efficiency of transportation engines and vehicles. Improvements in engine efficiency and vehicle weight reduction are among the most effective ways to increase vehicle fuel economy and reduce exhaust emissions. The development of propulsion materials is an enabling technology that helps reduce the weight and improve the efficiency, durability, and performance of advanced internal combustion, diesel, hybrid, and battery electric vehicles. The advanced materials research conducted under the direction of the U.S. Department of Energy and the Vehicle Technologies Program will help ensure the nation's transportation energy and environmental future by making affordable full-function cars and trucks that use less oil and produce fewer harmful emissions.

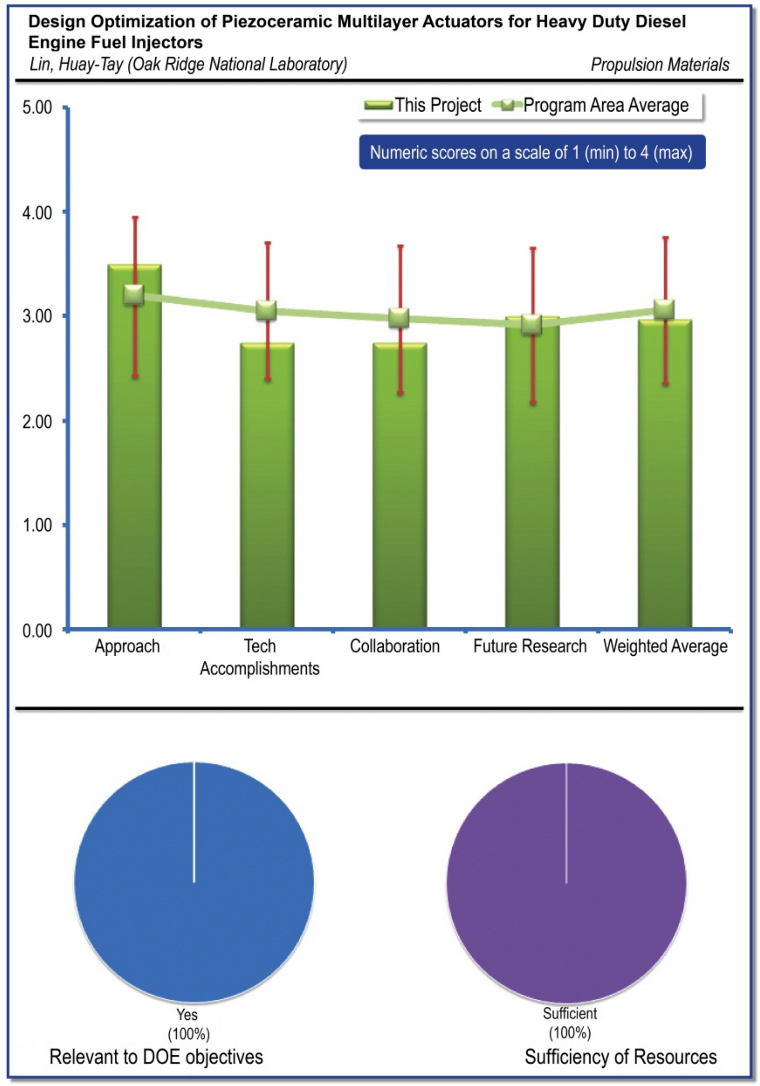
In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses *(on a scale of 1 to 4)*. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A summary table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Design Optimization of Piezoceramic Multilayer Actuators for Heavy Duty Diesel Engine Fuel Injectors	Lin, Huay-Tay (Oak Ridge National Laboratory)	7-3	3.50	2.75	2.75	3.00	2.97
Fatigue Enhancements by Shock Peening	Lavender, Curt (Pacific Northwest National Laboratory)	7-5	3.75	3.75	3.25	3.25	3.63
Fuel Injector Holes	Fenske, George (Argonne National Laboratory)	7-7	3.50	3.50	3.25	3.00	3.41
Tailored Materials for Advanced CIDI Engines	Grant, Glenn (Pacific Northwest National Laboratory)	7-9	3.50	3.50	3.25	2.75	3.38
NOx Sensor Development	Glass, Robert (Lawrence Livermore National Laboratory)	7-11	3.33	3.00	3.00	3.33	3.13
Low Cost Titanium - Propulsion Applications	Lavender, Curt (Pacific Northwest National Laboratory)	7-14	2.33	2.00	2.33	3.00	2.25
Friction and Wear Enhancement of Titanium Alloy Engine Components	Blau, Peter (Oak Ridge National Laboratory)	7-16	3.25	3.25	3.25	3.25	3.25
Erosion of Radiator Materials by Nanofluids	*Routbort, Jules (Argonne National Laboratory)*	*7-18*	*3.25*	*3.00*	*3.50*	*3.25*	*3.16*
Materials Issues Associated with EGR Systems	Lance, Michael (Oak Ridge National Laboratory)	7-20	2.67	2.67	4.00	3.33	2.92
Durability of Diesel Engine Particulate Filters	Watkins, Thomas (Oak Ridge National Laboratory)	7-22	3.33	3.00	2.67	2.33	2.96
Catalysts via First Principles	Narula, Chaitanya K. (Oak Ridge National Laboratory)	7-24	3.00	3.33	2.67	2.33	3.04
Thermoelectric Mechanical Reliability	Wereszczak, Andrew (Oak Ridge National Laboratory)	7-26	2.50	2.75	3.25	2.75	2.75
Thermoelectrics Theory and Structure	Singh, David J. (Oak Ridge National Laboratory)	7-28	3.33	3.67	3.00	2.67	3.38
Proactive Strategies for Designing Thermoelectric Materials for Power Generation	Hendricks, Terry (Pacific Northwest National Laboratory)	7-30	3.33	3.67	3.33	3.33	3.50

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Materials for HCCI Engines	*Muralidharan, Govindarajan (Oak Ridge National Laboratory)*	*7-32*	*2.33*	*2.67*	*2.33*	*2.00*	*2.46*
Hydrogen Materials Compatibility for the H-ICE	*Pitman, Stan (Pacific Northwest National Laboratory)*	*7-34*	*3.25*	*3.00*	*2.75*	*3.00*	*3.03*
Materials-Enabled High-Efficiency Diesel Engines	*Kass, Mike (Oak Ridge National Laboratory)*	*7-36*	*2.67*	*2.33*	*3.00*	*2.33*	*2.50*
Materials for High Pressure Fuel Injection Systems	*Blau, Peter (Oak Ridge National Laboratory)*	*7-38*	*3.33*	*3.67*	*3.33*	*3.33*	*3.50*
Materials for Advanced Engine Valve Train	*Maziasz, Phil (Oak Ridge National Laboratory)*	*7-40*	*3.00*	*3.00*	*3.33*	*3.33*	*3.08*
Compact Potentiometric NOx Sensor	*Singh, Dileep (Argonne National Laboratory)*	*7-42*	*3.25*	*3.00*	*2.50*	*3.00*	*3.00*
NDE DEVELOPMENT FOR ACERT ENGINE COMPONENTS	*Sun, Jiangang (Oak Ridge National Laboratory)*	*7-44*	*3.25*	*3.50*	*3.00*	*2.75*	*3.28*
Ultra-Fast Chemical Conversion Surfaces	*Erdemir, Ali (Argonne National Laboratory)*	*7-46*	*4.00*	*4.00*	*3.33*	*3.33*	*3.83*
Catalyst Characterization	*Watkins, Thomas (Oak Ridge National Laboratory)*	*7-48*	*2.75*	*2.25*	*2.75*	*2.50*	*2.47*
Ultra-High Resolution Electron Microscopy for Catalyst Characterization	*Allard, Larry (Oak Ridge National Laboratory)*	*7-50*	*3.50*	*3.25*	*3.00*	*3.00*	*3.25*
Low-Friction Hard Coatings	*Erdemir, Ali (Argonne National Laboratory)*	*7-52*	*3.25*	*3.50*	*3.25*	*3.25*	*3.38*
Residual Stress Measurements in Thin Coatings	*Singh, Dileep (Argonne National Laboratory)*	*7-54*	*3.00*	*2.75*	*2.25*	*2.75*	*2.75*
Durability of ACERT Engine Components	*Lin, Hua-Tay (Oak Ridge National Laboratory)*	*7-56*	*2.50*	*2.50*	*3.00*	*2.25*	*2.53*
Life Cycle Modeling of Propulsion Materials	*Das, Sujit (Oak Ridge National Laboratory)*	*7-58*	*2.60*	*3.00*	*3.20*	*2.60*	*2.88*
Non-Rare Earth magnetic materials	Mcguire, Michael (Oak Ridge National Laboratory)	7-60	3.50	3.00	2.50	3.00	3.06
Low-Cost Direct Bonded Aluminum (DBA) Substrates	*Lin, Hua-Tay (Oak Ridge National Laboratory)*	*7-62*	*3.00*	*2.67*	*2.67*	*3.00*	*2.79*
Improved Organics for Power Electronics and Electric Motors	*Wereszczak, Andy (Oak Ridge National Laboratory)*	*7-64*	*3.67*	*3.00*	*3.00*	*3.33*	*3.21*
Materials for Advanced Turbocharger Designs	Maziasz, Phil (Oak Ridge National Laboratory)	7-66	3.33	3.00	3.33	3.00	3.13
Engine Materials Compatibility with Alternate Fuels	*Pawel, Steve (Oak Ridge National Laboratory)*	*7-68*	*3.33*	*3.00*	*3.33*	*3.00*	*3.13*
Biofuels Impact on DPF Durability	*Lance, Michael (Oak Ridge National Laboratory)*	*7-70*	*4.00*	*3.67*	*2.67*	*3.33*	*3.58*
Electrically-Assisted Diesel Particulate Filter Regeneration	*Lance, Michael (Oak Ridge National Laboratory)*	*7-72*	*3.67*	*3.00*	*3.00*	*2.67*	*3.13*
Assessment of Nanofluids for HEV Cooling Applications	*Routbort, Jules (Argonne National Laboratory)*	*7-74*	*3.33*	*2.33*	*2.00*	*2.67*	*2.58*
Overall Average			3.20	3.05	2.97	2.92	3.06

Note: Italics denote poster presentations.

Design Optimization of Piezoceramic Multilayer Actuators for Heavy Duty Diesel Engine Fuel Injectors: Lin, Huay-Tay (Oak Ridge National Laboratory) - pm001



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first reviewer stated that the effort is designed to assist Cummins and other manufacturers to develop advanced diesel injection systems. Success in this effort could significantly impact fuel economy. Precise timing and control directly impact injection timing and control. A second reviewer thought that fuel injectors controlled by piezoceramic stacks are instrumental in reaching improved fuel efficiency; as such this is an enabling technology that supports the DOE objective. A third commentator expects piezo injector technology to be required for combustion engines, which will be around for the next 10-20 years. To achieve targeted improvements in thermal efficiency, internal combustion engines will need materials which can achieve higher peak cylinder pressure, fuel injection pressure, survive multiple fuel formulations, and which are well defined and ready for design use. The fourth reviewer thought that the project is questionable, appearing to be a basic research effort with undefined user potential for commercial applications. The project also uses exotic manufacturing and testing processes.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first commenter provided description of the technology and the research. The injector employs a lead zirconate titanate film (PZT) actuation system as a sort of on-off valve for fuel injection. The PZT element is the central component of the injector. Its operation under relevant conditions is important to characterize, and this work is concerned with this problem. The research includes efforts to examine performance under high temperature through fatigue test and mechanical strength. Accelerated test methods are being developed to enable rapid qualification of piezo-actuators. Mechanical data on PZT actuators, testing and mechanical strength experiments, and the effects of dielectric breakdown are being studied. The second two commentators liked the approach to performing the work, the first saying that it is a clear and no nonsense approach to develop materials in support of advanced fuel injection system with pressures > 2800 bar. The other reviewer thought the chosen approach is straightforward for fatigue testing, but that the mechanical loading conditions during testing are rather different from the conditions found in the actual injector. A FEM analysis should be performed to create an insight in the differences in loading conditions between practice and test rig. The final reviewer couldn't disagree with the overall technical work. The science seems sound. However, the relevancy to DOE objectives and potential for commercial applications remained unclear. The 2010 technical approach suggested a fuel injector; however, the 2011 approach suggested a testing regime for a PZT stack. There was no indication of any direct correlation between the two research years.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One of four panelists found that electric, mechanical, and thermal responses of PZT can now be tested under real life conditions with varying electric loading. Significant data supplied to support work in developing standard tests and some good candidates. However, the panelist thought that it would be good to have related the testing back to the 2800 bar goal. Cummins or one of the other partners should be able to provide this link. According to a second panelist, the project shows new results, primarily in the test procedure. However the list of future activities is approximately the same as during the 2010 evaluation. Missing is a comment on the progress towards an accelerated test procedure. This was mentioned as future work during the previous evaluation. A third panelist found that a range of testing was carried out, including developing an "electronic liquid bath", determining the effect of electric field and test procedures for processing data (to standardize it). A lot of work seems to have been done over the past year. However, the rationale was a bit obscure. A suite of tests and data were reported. The effort does seem worthwhile but the PI could have done a better job in framing the motivation for the approach taken. No doubt, the PIs have a good understanding of what is needed to achieve success. The communication of that understanding was not evident from what was presented. In the main, it seemed like a lot of testing but little thread to tie it together. Things like "piezoelectric coefficient", "dielectric coefficient" were mentioned. It was not evident why it was important to obtain this information. The final reviewer sees no indication of any potential commercial application. There appears to be no direct correlation to overall improvement in fuel economy, no fuel efficiency data. The research project appears to change the fuel injector material. No indication was given of how this project will improve the fuel injector material, or of how this will be manufactured, or how it will be tested, using what test equipment, and to what quality standard.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers said that the collaboration with Cummins and the suppliers of the material, Kinetic Ceramics, Inc., EPCOS, is very good. As such, there is a direct tie with industry. One evaluator said that while the PI and his industrial partners have evidently developed a plan that will benefit their industrial partners, they need to do a better job to show the importance of their data and why it is worth the investment. Another evaluator thought that they should possibly partner with an injector supplier to provide additional funding and design guidance toward fuel economy goal.

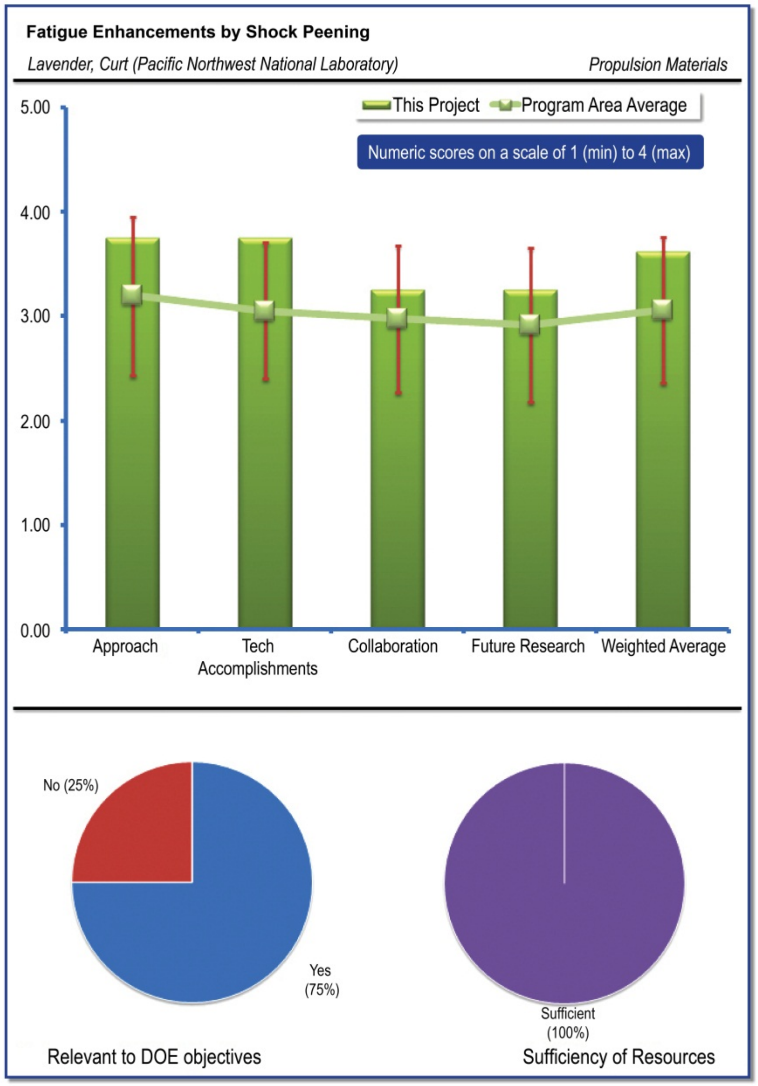
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The first reviewer said that the future work will include developing accelerated testing methods, further study of piezoelectric and mechanical reliability of PZT ceramics, fabrication of additional PZT stack fatigue test frames, etc. To an extent, this follows the trajectory of the past work. The second reviewer thought the proposed future work is clearly needed to reach the final goal; however, limited time is available to finalize all proposed activities. The third reviewer stated that the goal is to commercialize the technology, and that there is need to encourage Cummins to prepare and show injector design optimization activities which come out of this work.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The three commenting reviewers thought that this project is well-funded for the results obtained, that the resources mentioned should be sufficient to finalize the project, and that this effort, being supported at 300K/yr, seems OK though no doubt overhead takes a lot of this.

Fatigue Enhancements by Shock Peening: Lavender, Curt (Pacific Northwest National Laboratory) – pm002



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first reviewer wrote that this project concerns the effect of waterjet shock peening on fatigue of materials. The objective is to improve engine efficiency by increasing injection pressures and durability of reciprocating parts. A second reviewer stated that it deals with technology to improve engine efficiency with turbo machinery. A third reviewer sees this project evaluating potential technologies to increase the durability and/or strength of traditional engineering materials. This will allow for higher pressures resulting in improved fuel efficiencies. The fourth reviewer thought that this project is questionable and not indicating fuel economy increase. It appears to be a durability project to enhance service life of a specific engine part.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first commenter believed that this project's technical approach is reasonable. It does include a large suite of testing and measurement, and a component to improve the cost-effectiveness of the laser shock peening (LSP)/water jet peening (WJP) processes. The approach takes an established material and attempts to improve its fatigue performance by surface treatment, and to compare the results with traditional materials. A system evaluation of water jet peening and demonstration of increased design stress and component demonstration are performed. The materials include steel and aluminum. The second commenter thought this project is very well planned and executed. Results based data with good datum, clear benefits, and identified target application of technology to begin use near term. The third reviewer believed that the approach is well suited to characterize the fatigue performance of surface treated materials. The characterization of relevant processing parameters is well defined. The third commenter also suggests that the ground process should be described in more detail since this is a parameter that can cause variation in fatigue performance. The last commenter has no issues with the technical approach. The project appears to be focused primarily on enhancing service life of a specific part, but gave no indication of any overall fuel economy improvements.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first evaluator stated the status of the project, where the PIs have developed fatigue life laser shock peening protocols and showed 12% increase in high cycle fatigue and 50% increase in rolling contact fatigue. The PIs focused on A354 aluminum alloy for the WJP studies and showed significant improvement in fatigue performance. Nice results were shown on the effect of WJP on stress amplitude. The work progressed to translation of the tool and processing parameter development. They have also shown good progress to develop a more complete understanding of the effects of surface treatment on material performance. The second evaluator sees that water surface treatment has clearly positive impact on first target application, and knowledge of material processing and characteristics will enable use of aluminum by others for other applications. The third evaluator said that the chosen surface treatment shows a significant improvement in fatigue strength, especially in case of WJP. This was only possible through well controlled production of specimens. This provides insight in future process specification for future components to be treated by this process. The final evaluator believes that although the accomplishments are noteworthy, the overall goal is unclear - as no final choice of material was indicated. If the project goal was to select a peening or other technology, then the project suggests a lighter weight material could be selected while maintaining or enhancing the service life of the specific engine part. No indication of a lighter weight material selection process. The presentation included no indication of any manufacturing change plan, no indication of any service life projections, and no indication of any quality control standards during manufacturing of end product.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

All of the observers agreed that there was no issue with collaboration or coordination with Cummins, the South Dakota School of Mines, or equipment suppliers. One reviewer suggested that the PIs should further explore deployment of their concept for full scale evaluation with Cummins. Another reviewer said that a wider spread of the technology amongst Tier 1 and OEM's will have an improved effect on overall fuel efficiency would be an improvement.

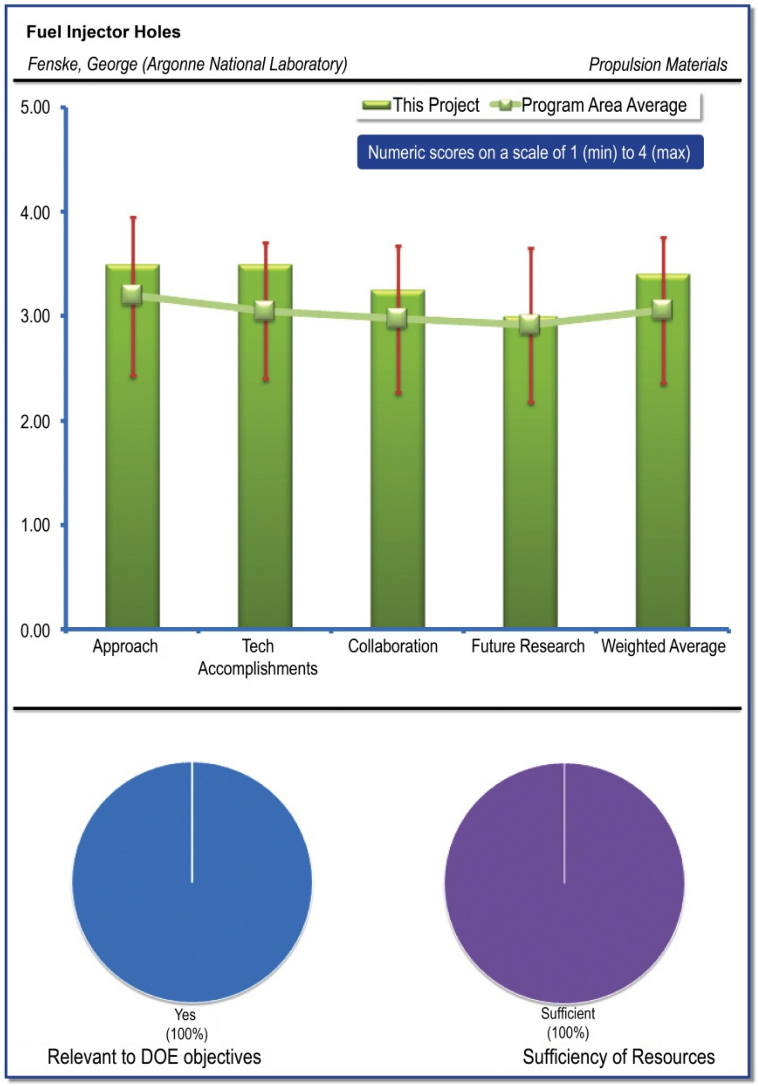
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

All of the reviewers believed that the project should be able to finish the final phase of its work before funding terminates at the end of the year. One reviewer goes on to specify that the future work will include continuing with testing of components treated by the WJP process, development of consolidated and defect free welds of friction stir processing (FSP) cast iron with same processing parameters, investigation of potential tool designs to overcome graphite alignment observed in FSP of cast iron, and completing a final report.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One commenter said that with DOE funding and partners this project is sufficiently funded. Another said that this year the funding was at the level of 150K, which is a reasonable cost. The 50% Cummins cost share is very good as well. The third simply stated that the funding should be allowed to terminate on schedule.

Fuel Injector Holes: Fenske, George (Argonne National Laboratory) – pm003



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Reviewers commented that this project supports DOE's objectives. The first reviewer stated that the ultimate goal is to reduce in-cylinder emissions and to improve atomization, and that both are important for efficient operation of engines. The second reviewer saw the reduction of in-cylinder formation of particulates as primarily affecting emissions, and the improved combustion and mitigation of after-treatment fuel consumption as primarily affecting efficiency. The third reviewer said that this project results in more efficient combustion of diesel fuel due to improved atomization and flow into the combustion chamber. In the third reviewer's opinion the efficiency gains are a secondary benefit, with the reduction in particulate formation being the primary benefit. Nevertheless, the benefits are a win-win: improved emissions, reduction in cost for after treatment systems and improved fuel economy. The reviewer believed that the design improvements being realized by this project are very necessary. The final reviewer thought that this project addresses a technology that is enabling an improved combustion, which will lead to improved fuel efficiency

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One commenter said that it is a novel idea to take traditional electro-motive diesel (EMD) injector holes and coat them with electroless Ni to reduce hole size to less than 50 microns. Another reviewer said that they have done a pretty good job describing the issues and addressing the concerns. The approach is practical and straightforward, and they do a good job proving the benefits of their approach and results. The video clips they used in the presentation were quite impressive, showing clearly how the coatings were uniform and sound. One reviewer commented that the PIs began their work with identifying potential micro-orifice fabrication techniques and identified an electroless nickel (EN) deposition process for coating. The main objective has been to develop a methodology to reduce the droplet size in injectors. The approach is to improve injector design. The orifice size is on the order of 50 micrometers. This past year the PIs demonstrated an x-ray absorption imaging technique for nondestructive evaluation of an internal coated orifice, and a method to coat the interior surface of small injector orifices using the EN process. The final reviewer stated that the approach is straightforward, and that during the project new approaches were chosen like the nickel plating in industrial facilities. This could be foreseen and so faster progress would have been possible.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

All panelists had positive impressions of the progress of this project. The first reviewer said that progress has been very good. The major hurdles appear to have been overcome. It appears that future work will have little concern with major obstacles and will focus more on optimizing design. A second reviewer thought that the PIs addressed and resolved some early issues that were found regarding coating adhesion. The solution apparently was found in the precleaning/etching, control of solution chemistry and post-deposition annealing. They also transferred their technology to a commercial industrial plater/coater. Flow visualization studies demonstrated enhanced flow characteristics. Development of multi-size orifices was also pursued. A third reviewer thought that the project demonstrated an improved atomization by smaller orifices. It is likely that an improved emission is realized opening up the possibility of improved fuel efficiency. The multi orifice diameter option could also open up further fuel efficiency improvement by a reduction in injection pressure. Higher pressures generally result in an overall improved fuel efficiency but there also an increase in parasitic losses to create the high pressure. The final panelist concluded that the project demonstrated that it was feasible to coat interior surfaces of small injector orifices using EN, addressed and resolved early issues related to coating adhesion, transferred concept/technology to industrial plater/coater, demonstrated enhanced flow characteristics in single-size orifices (100, 75, and 50 µm) at 3000 bar, demonstrated x-ray absorption imaging technique for non-destructive analysis (NDA) of internal coated orifice surfaces, and evaluated American Society for Testing and Materials (ASTM) Method G32-09 to determine cavitation erosion performance of plated nozzles.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer said that the project does not appear to have a significant amount of industry collaboration; however, it did not appear to be necessary given the scope of the project to date. Future collaboration will be necessary, since it precludes going into production. Another commenter said that the success of the project is demonstrated by an increasing number of participants. A third reviewer stated that the primary collaborator seems to be the EPA. Sandia also has capabilities for these sorts of visualizations. Beyond the EPA, it was somewhat vague on precisely who the collaborators were, for example the OEMs. The linkage to industry should be developed in their continuing work. The final reviewer thought that the project had good collaboration efforts with Imagineering Finishing Technologies, fuel system OEMs, an Engine OEM, small business (for integration of EN process into nozzle production line), and finally the EPA.

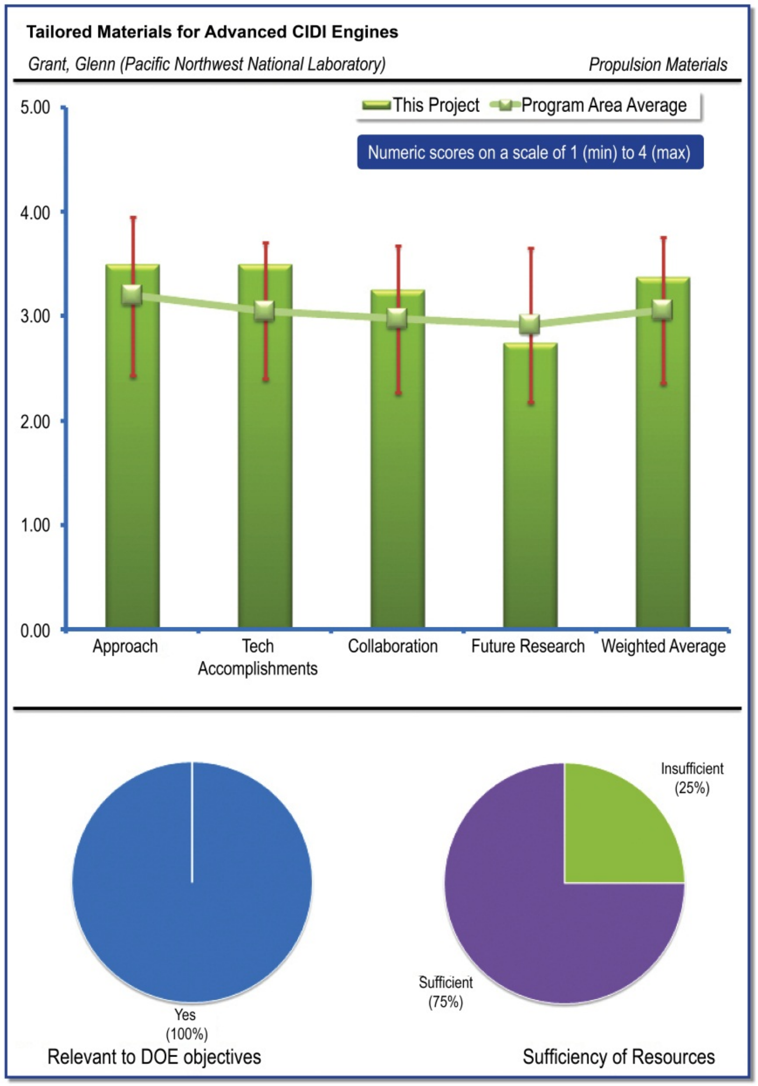
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Two commenters stated that the proposed future work involves near term and far term efforts. Two reviewers both described that for the near term, the EPA will do further flow visualization tests, second generation multi-size orifices will be developed for an OEM, cavitation erosion studies will be carried out, and x-ray imaging for in-situ characterization will be pursued. Longer term will concern engine emission tests with an OEM, integration of the nozzle into an engine, and combustion studies. A reviewer commented that the PI should endeavor to get his technology integrated into an engine to evaluate performance. This task was listed as longer term but given the length of the project it should be pushed up. A second reviewer commented that the mentioned activities are in line with the project approach. However, a more systematic approach should also be incorporated to evaluate the potential of injection pressure reduction. A third reviewer said that several details are being addressed with the proposed future work. Collaboration with OEMs will be needed to push toward commercialization.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One commenter advised that the investment so far has been 1.6M, and in FY 10 it has been 400K. This seemed a bit high, but the payoff could be high if it can be quantitatively demonstrated that the nozzle treatment methods lead to a concrete improvement of emissions as envisioned. A second reviewer thought that the resources appear to be appropriate for this project. The third commenter said the resources look sufficient. This reviewer also noted that the end date of the project has shifted 2 years in comparison to the 2010 evaluation.

Tailored Materials for Advanced CIDI Engines: Grant, Glenn (Pacific Northwest National Laboratory) – pm004



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

All reviewers agreed that this project meets DOE objectives. The first reviewer stated that this process concerns surface modification technique of conventional materials to achieve higher efficiency performance. Bowl rim fatigue failure is a problem that this project addresses. Durability and cracks often occur under high pressure operation. A second reviewer thought this project was in line with goals because it aims to increase the thermal efficiency, mechanical efficiency, and durability of engine materials through the development of a new surface engineering technology. It also aims to achieve high strength materials and lighter weight materials, and reduce power train cost. A third commenter said that this project does support DOE objectives, with several other benefits that indirectly support DOE objectives (e.g., durability, cost). The final commenter affirmed that the project improves the surface of materials leading to higher allowable loads resulting in reduced fuel consumption.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first reviewer thought that the approach appeared to be well laid out, with well-defined benefits. Significant progress had been made, demonstrating their ability to overcome the major obstacles. A second reviewer held that the technical barriers were well addressed for the Aluminum friction stir process. For the steel related friction stir welding the approach was a standard one, unfortunately there will be a need for a novel approach; otherwise the outcome will be disappointing. Perhaps friction stir welding (FSW) and steel is not a good combination. A third reviewer commented that the project is based on a very novel idea to improve base aluminum piston without going to steel. The project is primarily investigating FSP, a new technology that can produce functionally graded surfaces with unique and tailored properties that will allow propulsion materials to withstand higher temperatures and pressures without losing appreciable strength, hot hardness, or wear resistance, and exhibit improved resistance to thermal fatigue. The final reviewer stated that over the past year the PI experimentally applied the FSP for aluminum materials, quantified performance advantages, and developed FSP tools and parameters to allow surface modification of steels. Friction Stir processing (a process that modifies the microstructure of a material) is a new approach to improve durability. This project over the past year concerned this process for aluminum, specifically materials used in pistons and heads. The systems investigated included cast hypo-eutectic aluminum with no introduction of any new component materials; FSP of eutectic Cu-Ni aluminum alloys by “stirring in” various quantities of carbon nanotubes and nanofibers; and FSP of 6061 alloys to develop mixing parameters. Fatigue improvements by a factor of two, along with significant wear resistance were shown. A bowl-rimmed piston was investigated.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

All four commentators agreed that progress has been good, the first commenter relaying that in FY 11, the PIs performed a number of testing studies to improve the microstructural and mechanical properties that most influence thermal fatigue (i.e., CTE, conductivity, and, to a lesser extent, high temperature strength). The PI wanted to find the best methods of stirring in particulate into the aluminum substrate while producing the most homogeneous and highest particulate loading possible. They carried out tests using carbon fiber in place of nanotubes and found that long fibers were fragmented distributed reasonably well. Good bonding was achieved between the aluminum and the carbon fiber fragments with no reaction zones (aluminum carbide) noted. A second commenter thought the FSP process has been demonstrated in this project to significantly improve fatigue performance of current low-cost, engine materials, potentially allowing them to operate under highly aggressive combustion regimes anticipated in the next generation of energy efficient engines, especially combustion regimes that will require higher Peak combustion pressures like HCCI. The second commenter also said that the experimental work on aluminum alloys has shown significant increases in fatigue lifetime and stress-level performance using friction processing alone, and has shown the potential to create mechanically mixed alloys of aluminum and carbon nanotubes or fibers that may provide unique properties to specific areas of engine components. A third commenter believed that the progress on the project has been very good. With this progress, it is important for future work to demonstrate the DOE goal benefits - the engine efficiency benefits are implied, but should be more explicit. The final commenter understood that this project represents a significant step forward in Friction stir welding of Aluminum piston materials. This will allow a wider operating window for this type of pistons. Aluminum pistons have a higher potential in improving the fuel efficiency compared to the steel alternatives seen nowadays in HD applications.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first evaluator confirmed that this project is a CRADA with Caterpillar at 50% cost-sharing, which is good. The first evaluator thought the collaboration with academia (Missouri and Brigham Young University [BYU]) showed a good return on investment with student projects. The second evaluator agreed that collaboration appears to be good, which is important with a project like this. This reviewer also stated that more collaboration may have greater benefits since FSP should have benefits in various components of light vehicle engines as well. Another reviewer stated that the only cooperation mentioned is with Caterpillar. This reviewer thought that a wider consortium involving universities and piston manufacturers would improve the deployment of the results of the project. The final reviewer listed the collaborators as Caterpillar, Missouri University of Science & Technology, BYU, and PNNL.

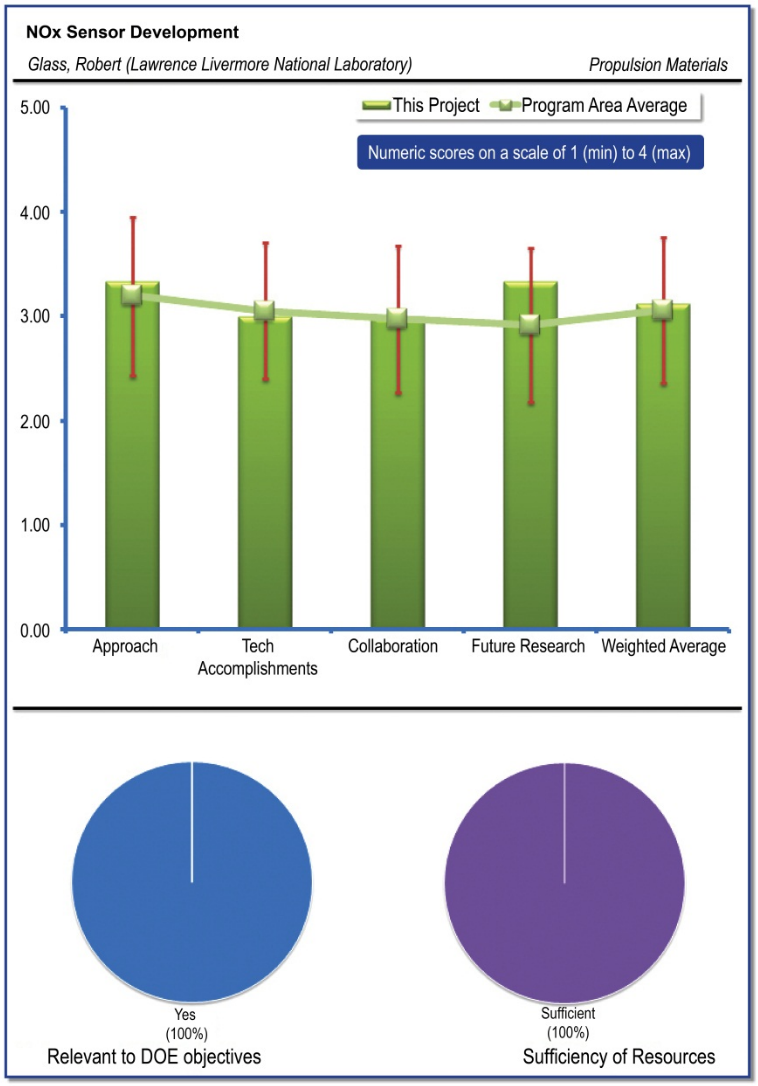
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The first reviewer commented that the future work will concern reporting and data transfer, which (in the electronic version) was a bit vague. Another reviewer stated that the future work includes project reporting and data transfer to industrial partners, but that the PI may want to conduct thermal fatigue testing of FSP aluminum pistons in the bowl rim areas. A third believed that the future work explained during the oral presentation seemed to be appropriate and beneficial. In this reviewer's opinion this project appeared to be worthwhile and will definitely result in efficiency gains. A fourth reviewer understood that no future research was proposed, which was understandable since the project was already 90% finished.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer said that resources appear to be sufficient for this project, another reviewer thought that the resources look appropriate for the amount of work to be completed in the remaining time frame, and a third evaluator stated that the funds were used for students and scientists. At 150K the cost seems a bit low. The collaborations with academia were good and represent a good return on the investment.

Nitrogen Oxide (NOx) Sensor Development: Glass, Robert (Lawrence Livermore National Laboratory) – pm005



Reviewer Sample Size

This project had a total of six reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

All reviewers agreed that increased use of diesel will lower oil consumption. The first reviewer stated that a durable, reliable, economical and accurate NOx sensor is essential from an emissions standpoint. This is an enabling project rather than a project that results in direct fuel economy advantages. However, implementation of this technology will contribute to the greater use of efficient, environmentally friendly diesel vehicles. A second panelist believes that the ability to accurately measure NOx is critical to optimizing both combustion strategies and engine architectures for maximizing fuel efficiency while meeting emissions requirements. Important commercial parameters were identified, including reliable operation, known performance over time, and cost. Success with this project will have significant impact. A third reviewer concluded that NOx sensing can be an enabler for emissions control and monitoring. Specifically, it facilitates management of SCR or LNT processes to minimize fuel losses due to regeneration activities. The fourth reviewer affirmed that the project involves in developing a sensor for diesel engines with low cost base, and that diesel will improve energy efficiency and reduce oil consumption. The final commenter concluded that accurate, responsive and sensitive NOx sensors can contribute to the close control of engine emissions and minimize the impact of NOx control on engine fuel efficiency. Their application to diesel engines in particular could help minimize one of the barriers to wider adoption of diesels. As noted in the presentation, if a third of the U.S. light-duty vehicle (LDV) fleet could be converted to diesel engine power, the U.S. transportation petroleum demand could be reduced by as much as 1.5 MMbbl/day. By the same mechanistic reasoning, a 2/3 replacement of LDV SI engines with diesels could reduce petroleum demand by 3 MMbbl/day. It should be borne in mind that other factors, technical and non-technical, probably have as much or more to do with the broad acceptance of diesels in the LDV sector.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer stated that this project is well focused, laying out the barriers and approach clearly. A second reviewer believes that the project, even though had to be restarted after five years of work on other material, has shown great improvements in the past two years. The team is developing a new sensor (with new material, processing and final product) for NOx detection which is showing high promise. The third reviewer affirmed that the project is complex, and that a brief description of the history indicates various roadblocks that were encountered. To the team's credit, a new, clever approach was taken, looking at the alternative current (AC) impedance and phase angle response. The fourth respondent pointed out that the sensor designs discussed have been in play for over 10 years. The novel approach using frequency to identify species is an interesting idea; however, the basic approach is based on the datum of the sensors impedance. Durability data from O2 sensors (a very similar design) indicate wide changes in sensor impedance "drift" over aging. This information was ignored by the researcher and the impacts have not been considered until the end when in fact this may be a show stopper for the technology. It may be that due to the new concept, the changing impedance of the sensor over time is not a concern, or that advances have been made to address this issue so the variation is limited; however, none of these items were addressed in the research, discussed in the presentation or properly responded to during questions. The mentioning of the "drift issue" in future work "Preliminary solution for drift issues by appropriate materials choice, pre-use aging, experimental protocol, and design" indicates that the researchers were/are aware of this critical issue, but have chosen to take it on tomorrow.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first reviewer commented that the accomplishments have been excellent, laying out the various alternatives and their advantages. Rather than choosing just one path, a multi-faceted approach is giving results that can be compared, contrasted and justified. The second reviewer commented that recent progress has been significant relative to earlier years work. The new approach of phase angle response looks very promising. Several technical challenges remain, including response characterization over time. This reviewer agreed with the researchers that a curve fit better than a two slope approximation will easily improve the cross-sensitivity results. A third reviewer relayed that the process to manufacture the sensor for the use is being developed; the prototype production indicates the feasibility of mass production. The fourth panelist considered the gas flow bench data and preliminary dyno data to show good results, however, this type of data has been also available for over 10 years with voltaic Au and other Zirconia based O2/NOx sensors. The novel sensor system achieves some improvements in sensitivity to NO, H20 and O2, and now what is needed as 10 years ago are 1. demonstrated long term performance and durability on an engine across multiple sensors (not done); and 2. demonstrated ability to meet cost targets including a reasonable manufacturing method, (partially complete). These 2 items have been the challenges for O2 sensor based NOx sensors for over a decade and are not significantly addressed.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Five commentators all look forward to finding out about future collaboration. A first commenter understood that only one OEM was involved, but negotiations with other Tier 1 suppliers was encouraging; hopefully the technology is transferred to many players to promote the widespread use of the invention. A second reviewer deemed the project’s collaboration to be good. Commercialization pathways are being addressed with other companies as well. A third commenter agreed that collaboration with a supplier is necessary for commercialization. The 2011 presentation indicates that several appropriate suppliers are engaged. A fourth reviewer thought that the collaboration with Ford and a "U.S. Part supplier" appeared to be working well. Additional input from other OEMs, Universities or National Labs for design and testing will expedite commercialization. The final reviewer was looking forward to learning more about prospective collaboration with the named and particularly the unnamed "commercialization entities" mentioned in the 2011 presentation.

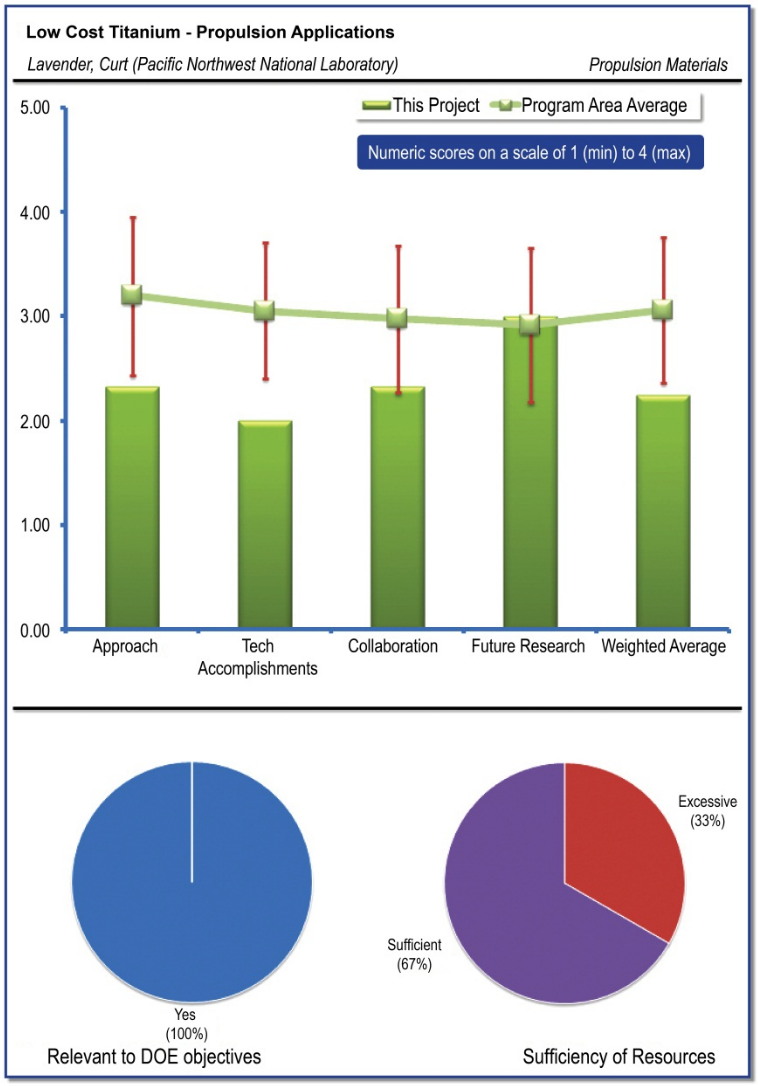
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The first evaluator concluded that future work appears to be targeted toward implementation. This is what future work should be focused on. The proposed work is truly necessary for implementation. A second evaluator believed that the future planned work makes sense. The significant effort to commercialize appears to be well understood. Plans are in place for refinement of materials used and processing methods, improved bench tests, and engine/vehicle testing. A third reviewer relayed that the commercialization path is identified but the material down-selection is still not completed. A fourth commenter acknowledged that cost was a significant issue raised in the overview. The project needs a path to target cost since it is raised as a major barrier. A fifth reviewer thinks that the future work outlined seems rather vague. More specific information would have helped to understand the specific areas that will be focused on to advance the sensor design. The sixth and final opinion was that the proposed work for 2012 is good; however, two items have been the challenges for NOx sensors for over a decade and are not significantly addressed: demonstrated long term performance and durability on an engine across multiple sensors (not done), and demonstrated ability to meet cost targets (partially complete).

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Three reviewers believed the resources appear to be appropriate, sufficient for development prototyping, or that the project has good support from Ford, DOE, and national lab facilities. One reviewer further stated that suppliers are engaged. The fourth respondent stated that based on the good technical progress to date, it must be concluded that resources are at least sufficient. Every effort should be made to seek the maximum levels of co-funding from prospective commercialization partners (Delphi, Emisense, etc.) as the work progresses, in view of the likelihood of significant cuts in DOE funding availability in the next fiscal year(s).

Low Cost Titanium – Propulsion Applications: Lavender, Curt (Pacific Northwest National Laboratory) – pm006



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

All three reviewers agreed that this project supports DOE objectives. The first stated that in view of the excellent mechanical properties of titanium and its engineering alloys and especially its very high strength-to-weight ratio, it would seem this project offers the potential to achieve significant vehicle mass reductions, which will clearly enhance fuel efficiency, albeit indirectly. The presentation also mentioned the possibility of directly increasing engine efficiency by exploiting the high-temperature properties of Ti. The second panelist reported that this project supports lightweighting of engines and vehicles, which should reduce fuel consumption. The third reviewer concluded that titanium can be used in two ways: to reduce the weight in structure as well as improve energy efficiency of powertrains. Cost is a barrier to overcome for increased use of Ti. This project is aimed to reduce the cost and increase the use saving fuel consumptions.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers had different opinions as to how to overcome the cost barrier for titanium that this project is concerned with. The first reviewer described the project as being aimed primarily at reducing the cost of Ti vehicle parts, as cost is seen as the principal barrier to more widespread use of the metal. This is certainly important, but the reported work seems to be concentrated much more strongly on the technical processing of Ti alloys and the resultant properties. Relatively little information was reported this year on cost reduction and the cost analysis phase appears only to be getting started. This reviewer regards this to be an imbalance of emphasis. Also, as noted in last year's review, it would be reassuring to have the issue of end-of-life recycling of Ti alloys and their separation from the dominant ferrous and aluminum alloys currently used in vehicle/engine construction. If this is not seen as an issue, that should be addressed and stated explicitly. The second reviewer stated that first and most important is the lightweighting impact and expected fuel economy result. Since it is not clear whether the result of the estimate is or not significant, then this work may not be a priority and should stop. The initial study should not be difficult to do and could be as simple as a material substitution assumption for the entire engine. For example: Engine weight with Steel: xxxx#, engine weight if engine mass changed to Titanium tttt #. Savings = , Fuel economy =. The commissioning of a University Study is good to get a more detailed result for rotating vs. non-rotating, but some number should be available. The third reviewer confirmed that the barrier for titanium use is the cost; by using a low cost titanium (but not necessarily low quality) this project is aimed to reduce that barrier. It involves setting the benchmark for the material by comparing the new product with existing Ti64 alloy data base.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer reported that the properties of conventional alloys produced using the new powder material is completed. The processing of this material has posed some challenges (cracking during drawing) that have been resolved. However, new formulations of alloys need to be undertaken as the requirements for auto industry may be different from aerospace industry. Also some of the alloying elements (Vanadium) may be expensive and difficult to process increasing the cost of the material. The other reviewer responded that it was difficult to see results from work. Major achievements are not related well.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first evaluator responded that this project collaborates with the University of Michigan, and uses ADMA for cost models. The second reviewer claimed that some fourteen vehicle and engine OEMs have made limited production runs of Ti-based parts. In view of this implicit expression of interest, it seems wider collaboration with OEMs should be sought. Cummins is the only OEM now collaborating with the investigators. Broader collaboration could also offer the potential of greater cost sharing with DOE.

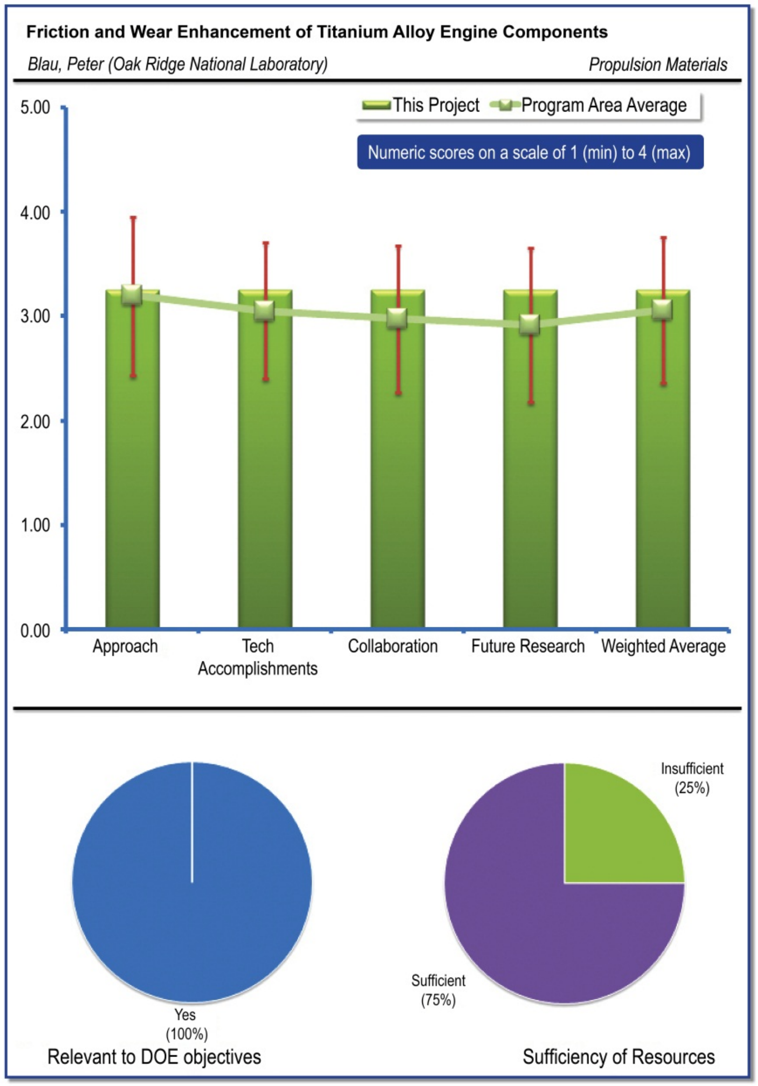
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer commented that as noted above, it seemed that a significant part of proposed future work should have been completed earlier - the cost modeling in particular. The potential of the TiH2 powder approach to Ti alloy production to reduce cost at various production scales should also have been explored before now. Another reviewer concluded that no future vision is presented for the product; the project is expected to be completed with some more data generation but without identifying a product or path forward. A CRAD, as has been done in other areas of the Propulsion Materials (PM) sub-program, would be worthwhile. The third commenter thought the future to be well mapped; however, the steps maybe should be series not parallel. This reviewer provides an example: 1. Estimate weight reduction - fuel savings.2. Estimate cost impacts - practicality.3. Perform engineering work. 4. Refine 1,2 Currently skipped 1, 2.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that the project partnered with Cummins and suppliers. Another reviewer commented that in view of the emphasis that has been placed to date on fabrication and processing techniques and characterizing the resulting alloy properties (in lieu of cost analyses), project resources may not be excessive so much as poorly directed.

Friction and Wear Enhancement of Titanium Alloy Engine Components: Blau, Peter (Oak Ridge National Laboratory) – pm007



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

All evaluators agreed that use of titanium reduces engine component weight, while enhancing service life. One evaluator said that doing so indirectly supports DOE goals. Another panelist considered this project to be exploring various concepts that will lead to a greater use of titanium alloys in engine components, including for connecting rods, valves, crankshafts, bushings, etc. The focus on Ti is based on its improved resistance, high strength and weight. A third reviewer reasoned that substitution of materials with higher specific strength (strength per unit weight) is a viable path to lightweighting engine components, thereby improving freight efficiency. The use of titanium for a reciprocating engine component such as a connecting rod has the added benefit of reducing inertial forces, which may allow an additional opportunity for reducing mass. The fourth evaluator deemed that for Ti alloys to achieve broad use in engine parts (in particular), and if their advantageous properties are to contribute to mass reduction and the ability to operate at higher temperatures and stress levels, their tribological properties must be at least as good as current materials. This project is aimed at identifying coatings and surface treatments that will enable Ti alloys to meet that standard.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

According to one reviewer, the approach taken in fy11 has been to complete friction and wear studies of coatings and treatments which passed screening tests of 2010; completing construction of a variable load bearing test apparatus; extensively evaluating a suite of materials using bench-scale tests; identifying a commercial diesel engine connecting rod as a candidate for replacement with a surface engineered Ti-based version; and constructing a rotary bearing test system. According to another reviewer, the technical challenges for successfully using titanium for connecting rods in reciprocating engines are several. A primary technical challenge of a titanium part acting as a structural component to transfer loads to the crankshaft has already been met in racing applications using a machine from billet approach. The proposed approach considers HIP or sintering from powder, which holds the promise for reduced cost. Cost is a significant challenge to overcome for widespread adoption in the transportation industry, which this project addresses via process. Tribological challenges at the connecting rod small and big ends as well as wear (fretting) at the big end joint have been identified and are being investigated. One reviewer could not argue with the application technical barriers or the project milestones. This appeared to be a replacement of one material for another. This reviewer suggested a review of how to manufacture the Ti material, quality control standards, and availability of Ti material and suppliers.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One commenter considered the objective to be completing the friction and wear studies of coatings and treatments that passed the screening tests of last year; materials screening (applying ASTM standard G133); wear tests of flat Ti and bearing steel slider measured; building a variable-load bearing test (VLBT) test system; friction and weal tests. These objectives seem to have been met throughout the past year. Another reviewer felt that the researchers described a logical approach, starting with previous literature surveys and developing an understanding of other's progress and issues. The project outline is traditional in that bench testing is the next step given the completion of a variable load test rig over the past year. Down-selection of promising approaches is planned, followed by scaled-up validation tests (presumably in running engines).

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer said that the collaborations are reasonable: Cummins, NASA; ANL; Eaton Phygen; and ORNL. The collaborations may be considered more informal (e.g., providing materials, advice, co-authoring of conference papers) than solidified through, for example, CRADAs. The PI has signed a non-disclosure agreement (NDA) with Cummins. Another commenter said that up to this point, collaboration seems to be limited to other government groups within ORNL and the High Temperature Materials Laboratory(HTML). This is appropriate given where the project presently resides but will represent a limitation if one or more industrial partners are not involved or consulted for realistic design considerations and operating conditions (loads, lubrication/tribology). It seems that the project would benefit from more formal industrial collaboration. The respondent was of the impression that this project has gone as far as an NDA, which this reviewer considered to be a start, but more on the informal side compared to a CRADA.

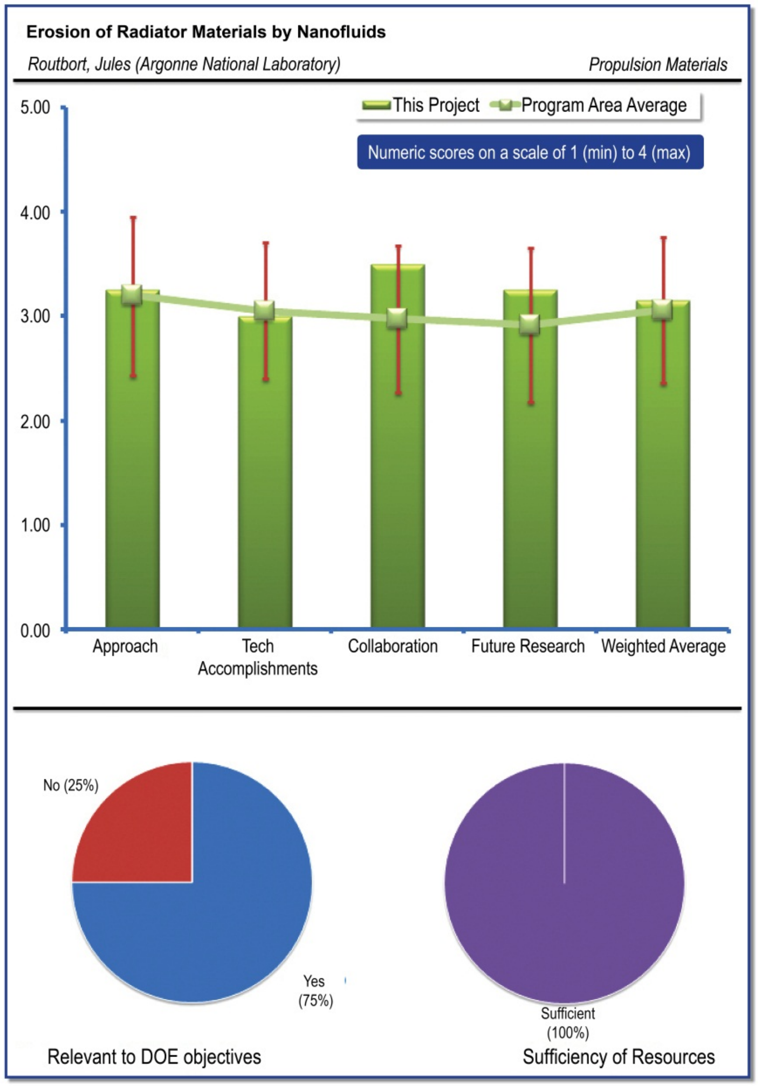
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The first reviewer commented that the PI wants to continue bench scale tests and apply the variable load testing of coatings and treatments, and "confirm" plans for scale up of concept validation in year 3, "if funding permits." Variable load testing of the leading candidates' coatings and treatments would also be pursued. The panelist suggested that the PIs could outfit an engine with a Ti connecting rod now, even before more detailed evaluations are complete, in order to assess performance and to determine if perceived benefits are in fact realized. A second reviewer suggested a review at the end of phase II. Determine if this is better continued by private industry or if there is a direct correlation between DOE goals and private industry needs. A third reviewer commented that the research plan was logical and traditional (a proven approach). One or more external partners are needed to provide real-world engine guidance. Manufacturing and cost considerations can be given further attention down the road following successful identification of candidate approaches. The next phase of research is focusing on friction/wear bench testing. Thus the project would benefit from strong participation of a tribologist. This is particularly true since studies of time-varying lubrication regimes are explicitly planned. A key consideration in the thermal management of the connecting rod bearings is heat conduction from the lubricant film through the bearing material into the connecting rod material. Continued this reviewer, the thermal conductivity of titanium is significantly lower than steel by almost an order of magnitude. The impact will be higher oil film temperatures and lower oil viscosity leading to reduced minimum oil film thicknesses. The fourth reviewer thought that because the presentation suggested funding for Year 3 of this project is tentative, it may be an opportune point at which to hand this project off to industry. Questioned this reviewer, if proposed testing of the 8 candidate surface treatments/coatings does not produce a production-feasible "winner," is there a Plan B?

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer concluded that the research needs for this project are clear and can be accelerated with additional resources. While the resources are appropriate for the planned level of work, the scope, pace, and sense of urgency can easily be increased. The second reviewer deemed the cost of $150K seems reasonable. The investment in building the VLBT hardware seems to be worthwhile if it facilitates testing under realistic load-bearing conditions.

Erosion of Radiator Materials by Nanofluids: Routbort, Jules (Argonne National Laboratory) – pm008



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first reviewer described that nanoparticle-loaded heat transfer fluids, with demonstrated capability to increase heat transfer, could result in smaller heat exchangers (radiators), pumps, etc. This could reduce vehicle mass, frontal area and hence fuel consumption, provided they did not also significantly increase fluid pumping power or reduce engine cooling system longevity via erosion, etc. The second reviewer explained that there is an opportunity for lower friction/higher performance cooling fluids in terms of electronics cooling. Higher performance coolants allow lower weight and smaller systems to improve fuel efficiency. Electrification of the vehicle is supported by more efficient cooling. The third evaluator detailed that nanomaterials in automotive coolants have the potential to be significantly better thermal fluids than traditional ones. This will help optimize the weight of auto radiators and thereby make the vehicles lighter and more energy efficient. The final observer saw no apparent relevance to petroleum displacement from the presentation or poster.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first reviewer felt that development of bench-scale test apparatus for rapid evaluation of heat transfer fluids was a good initial approach. The second commenter agreed that the project displayed a clear approach relating back to DOE objectives, having well defined requirements, test set up, and parameterization. The third asked reviewer questioned, why not do all the nanoparticle concentrations in all the fluid combinations? It would be good to know which provided the best performance -thermally 1st and then its erosion. The fourth reviewer called this project a 3 at best. According to this reviewer, Slide 9 of the presentation is perhaps the most telling for the status. There was no erosion after hundreds of hours of pumping. So, with no apparent erosion, it is questionable what value added is gained in continuing this effort.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

According to the first reviewer, the project achieved all objectives relating to evaluation of nanoparticles in cooling systems. The first reviewer also related that the project developed effective measurement equipment which can be reused for future work. No erosion or plugging was observed at tested solution levels. The other respondent again rated the project a 3 at best, questioning what value is gained to overall engine technology other than prolonged engine service life, as well as doubting the relevance to DOE goals.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer concluded that several collaborating organizations appear to be materials suppliers only, and others' contributions appear to have ended at this point in project. The other reviewer believed the project to be very well-partnered and leveraged, and listed partners: TARDEC, Michelin, DOE, Saint Gobain (partner in DOE Office of Industrial Technologies [OIT] project to develop manufacturing capacity for nanofluids), Nanoscale, Sasol (supplied Al2O3 nanoparticles), Ashland Oil (Valvoline), new partner in OIT project, graphitic based nanofluids request to partner in Tardec project in FY12 – 13.

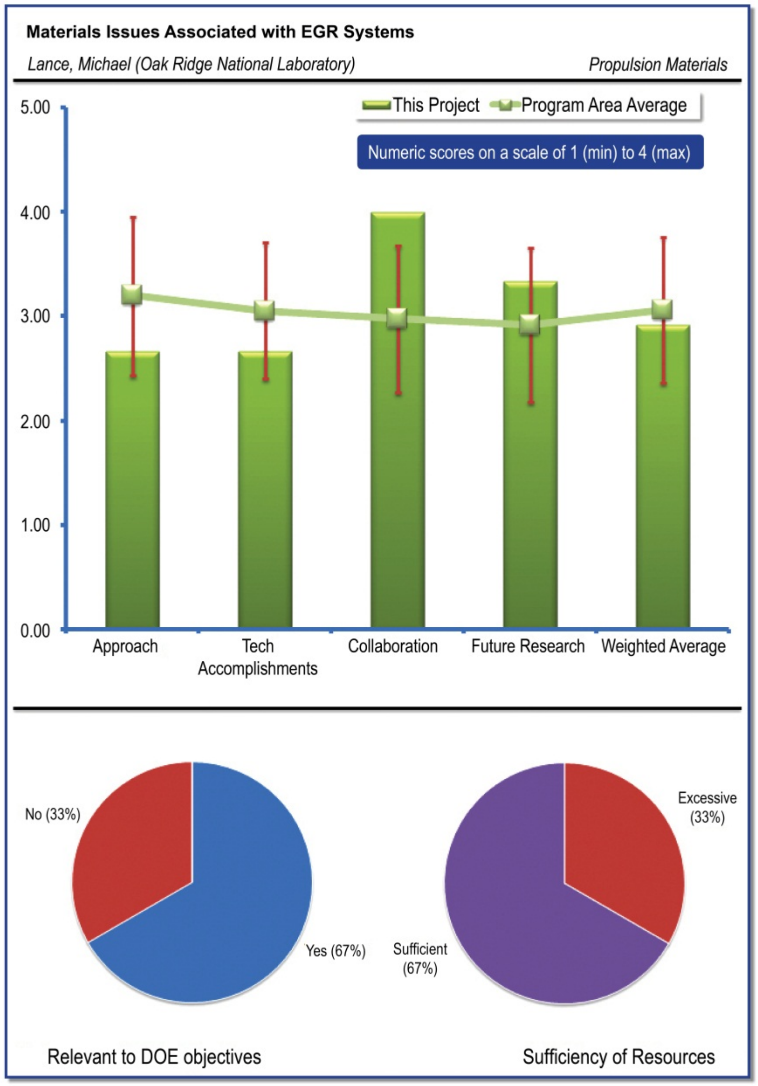
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer saw this project as developing a good tool set and performance database for an emerging and valuable technology. The other reviewer cautioned that any future work should be critically reviewed. Given the barriers and the accomplishments to date, suggests the project should be terminated, a final report written, and a model created to compare with any future nanofluids for use in radiators.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that the funding is well used. Based on the results, it is a great use of funds.

Materials Issues Associated with EGR Systems: Lance, Michael (Oak Ridge National Laboratory) – pm009



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first evaluator stated that the project focuses on solving the problems with respect to fouling of EGR coolers. Fouling leads to sub-optimized engine management settings and extra fuel consumption, so solving this problem will improve fuel efficiency. The final reviewer commented that meeting EPA standards for NOx and PM emissions with little or no fuel economy penalty requires the use of EGR and EGR coolers. EGR coolers have historically become restricted or plugged resulting in poor NOx performance and/or high maintenance costs. This project is an enabler for improving plugging performance of EGR coolers. The third reviewer believed that the statements concerning the centrality of EGR made in the presentation cannot be gainsaid, and it must be acknowledged that EGR is used universally in current-technology engines and will likely remain in universal use to control NOx emissions of all or most future-technology engines. However, according to this reviewer, this project does not appear directly to support the petroleum displacement objective of DOE vehicle technology R&D. Rather, it aims to find means whereby the level of new-engine NOx control can be maintained over the life of the vehicle. This goal, if successfully achieved, may prevent deterioration of new-engine efficiency, but that is not considered by this reviewer to represent additional petroleum displacement

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer considered the project to have a good approach to performing the work of understanding formation. Possibility to learn from data which has been accumulated on intake valve deposits due to fuel injection targeting and "internal EGR" backflow across the intake valves. The other reviewer felt that the approach shows some specific weaknesses based on the fact that there was little information on the specimens coming from the industry making a good evaluation difficult.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer acknowledged that the problem addressed is relatively complex. The theory on the development of the fouling layer had to be developed during the project. Now a better understanding is available making it possible to define future work more clearly. The other reviewer described how the project created a bench top reactor to generate controlled deposit formation but did not consider the engine combustion quality in the formation of deposits. When performing engine mapping, they took advantage of specific conditions which generate PM, High HC and other materials. This reviewer added that efforts should be considered to understand how these engine based parameters could be improved to improve fouling. Filter smoke number (FSN) and HC ppm were lower at "Heavy Duty" operation point but the deposits were worse. If the flow was the same across the EGR, why are the deposits worse with lower PM, HC?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

All three panelists were pleased with the collaboration. The first evaluator stated that a wide consortium is involved. Necessary experts are consulted when needed. The second reviewer praised the extensive list of collaborators in this project as an indication of the universal and keen interest and concern over long-term EGR cooler performance of engine builder and vehicle producers. The third reviewer felt it was good that all in the industry are interested and taking advantage.

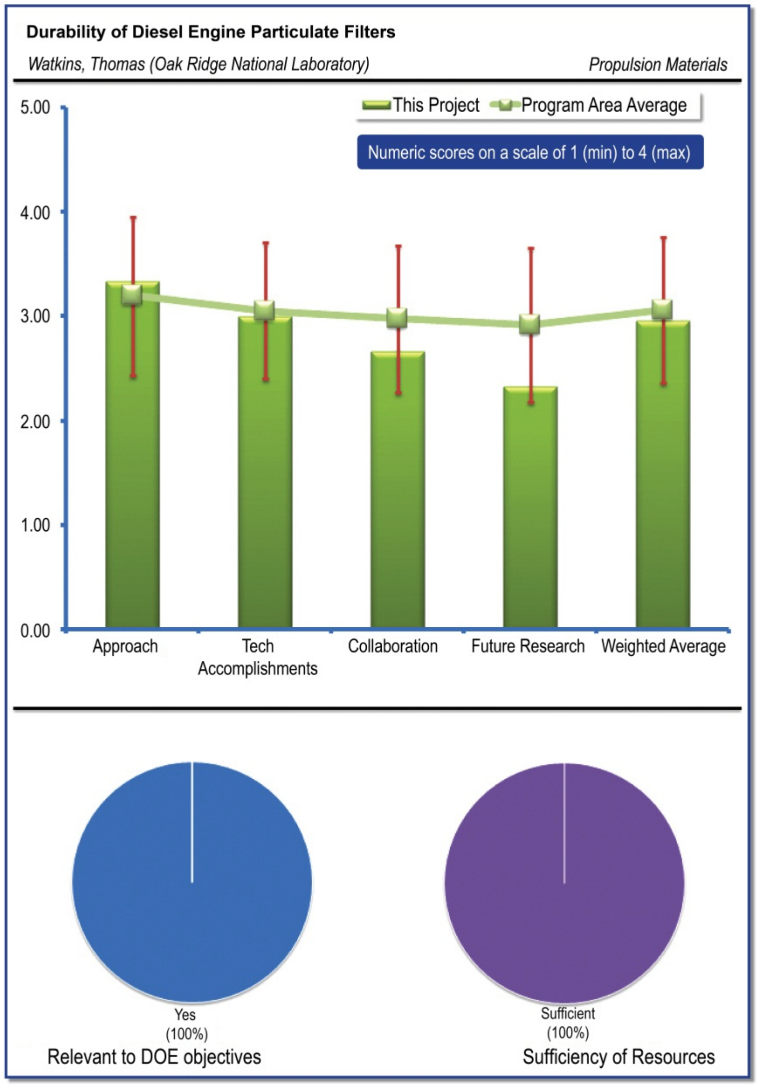
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Three reviewers commented positively on the future research. One reviewer stated that the future work planned built on the lessons learned from the earlier stages of the project. A more focused approach is provided, resulting in an increased change on success. A second commenter believed the proposed collection of field-returned EGR coolers for inspection and analysis in the second phase of this project is logical and likely to yield key information. The third reviewer opined that it is very good to begin solutions with Modine for heat exchanger geometries. This reviewer suggested the project consider partnering with a combustion team to identify chemical composition and other exhaust parameters which drive deposit formation.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that funding looks adequate, another commented that the project is well funded, and the third reviewer said that considering the value of this research to the engine and vehicle builders (to whom it is critically important), it could be argued that the current level of DOE (i.e., public) funding is excessive.

Durability of Diesel Engine Particulate Filters: Watkins, Thomas (Oak Ridge National Laboratory) – pm010



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Two reviewers clarified how this project is close to DOE goals, and the other described that the project attempts to optimize the regeneration of DPFs via advanced materials. One reviewer commented that the project has assessed the regeneration strategies that can be implemented with advanced materials to determine the petroleum displacement impact. Another reviewer declared that one clear remark has to be made. The project focuses on optimization of durability. This optimization should be complemented with a fuel efficiency related parameter like back pressure to ensure an optimum for both fuel efficiency and durability. The project promotes the use of diesel engine resulting in an overall improvement of fuel efficiency of the fleet. The final reviewer stated that although this project does potentially reduce fuel consumption, there are only weak linkages to petroleum reduction goals in that after treatment devices which are more durable will require less regeneration and thereby reduce fuel consumption. The fuel consumption improvement appears to not be significant when compared to the goals. 600 gallons / rated life (100,000 - 1,000,000 miles for HD trucks) yields at best a 0.6 Mpg (100,000 miles) or 0.06 Mpg if useful life is assumed to be 1,000,000 miles. Increased consumer use of clean diesel will not be impacted by this project. Significant (additional) reduction in diesel engine/system cost are needed to justify consumer acceptance.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first reviewer described the approach as building up the material knowledge from base material at ambient conditions towards coated components at elevated temperature. The influence of stress rate is not taken into account. The second reviewer thought the premise of reducing regeneration the approach was good, and likely to result in more durable catalyst materials, more resistant to thermal shock materials (faster regen). The third panelist felt the approach to be well-designed. The integration of Cummins via a CRADA agreement increases the probability of this research being integrated into a commercial product. This activity has been recently refocused to address the recent issues identified by the accelerated deployment of DPF into the commercial marketplace. The determination of the current technology baseline will greatly assist the researchers when designing the DPF to achieve the durability goals.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

According to one reviewer, after the refocus of the effort away from Aluminum Titanate and towards other SiC substrates, it appears that this project is on path to achieve the target milestones. It appears that the down-selection of SiC substrate material is ahead of schedule and this project has potential to be completed in advance of the scheduled completion date. A second reviewer commented that within this project a lot of data are produced by means of complex measurements; this is an important step forward. One of the barriers will be to find the optimum solution with respect to durability and fuel efficiency. The third reviewer reported that the results presented did not demonstrate success at meeting goals. Raw data presented did not convey significant conclusions. The “new thermal shock” ranking methodology was utilized and the model explained. The Ansys model is a good idea, but no conclusion relating model to results.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first reviewer said that the consortium is rather limited but shows a good vertical integration from knowledge institute over Tier 1 supplier towards an OEM. The second reviewer thought collaborations with Corning and Cummins were good. Clear tie-in to application integration, commercialization, fuel economy reduction, and industry use of models/tools/databases developed in this work are needed. A third reviewer considered there to be an excellent relationship between Cummins and ORNL via a CRADA agreement. The establishment of a closer agreement between ORNL and Corning (the emission control manufacturer) would greatly improve the collaboration with industry. According to this reviewer, from the presentation given by Thomas Watkins, ORNL and Corning only communicate informally once a year in January. A more formal agreement between ORNL and Corning would increase the likelihood of the integration of this research into a commercial product.

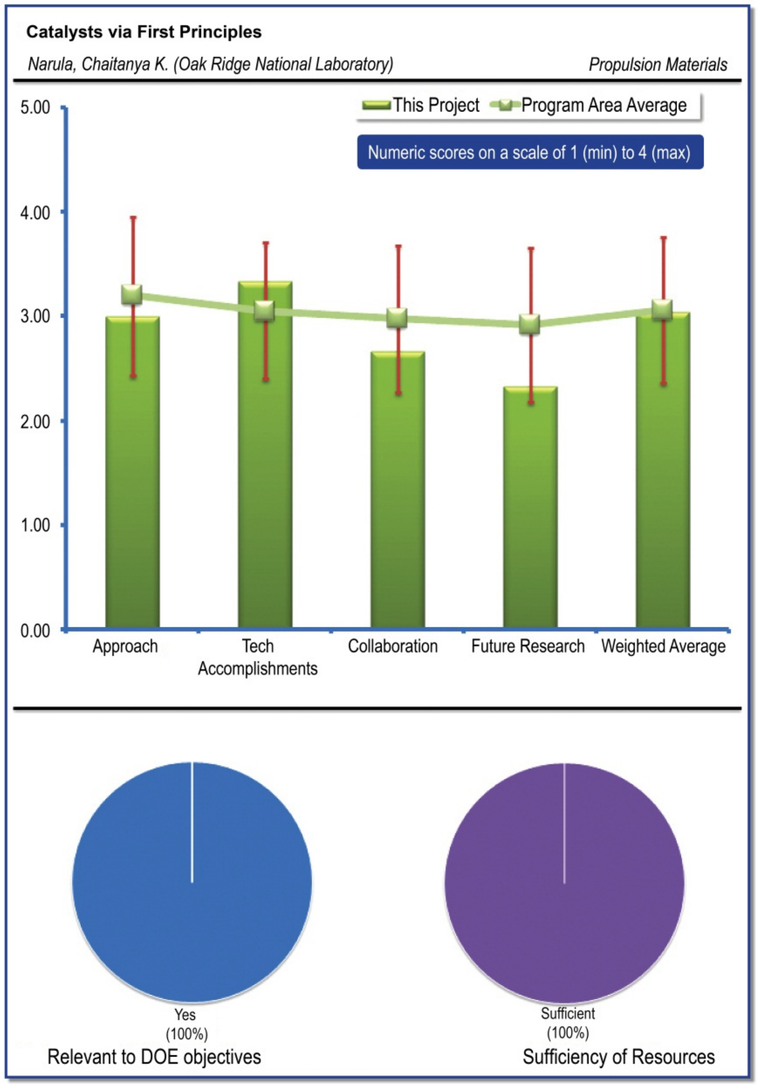
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The first panelist concluded that in the proposed future work a number of relevant measurements are defined. An interpretation of the results into a model or guideline should be made. A second panelist relayed that the goals for industry here are to develop models, tools, and databases. There are words which point to these activities by continuing to evaluate samples, but the big picture results are not clear. This reviewer suggests that larger picture, possible results-based activities could be: Provide data to Ansyis model to optimize design xxx for substrate shape/material improving durability by xx hours; thermal shock model used to rank 10 candidates for substrates and provide a summary report of top candidates: A, B, C. A third panelist reported that firm decision points or Go/No-Go evaluations were not presented. From what Mr. Watkins stated during the presentation, it appeared that a SiC material (Mullite) has been identified. If this is in fact true and the research team believes that the durability goals can be met with this material, the effort should focus on using this material and begin activities to design durable DPFs with this material to achieve the 1,000,000 mile useful life.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The first respondent claimed that this type of work is relatively costly, so the budget is in line. A second reviewer commented that if there is continued monetary cost share interest from industry, then this is supported at the level needed. The third evaluator suggested that if work is moving forward faster than planned, DOE should consider terminating funding when the goals are achieved.

Catalysts via First Principles: Narula, Chaitanya K. (Oak Ridge National Laboratory) - pm011



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

All reviewers explained how the project meets DOE goals. The first reviewer stated that it is likely that this work will accelerate catalyst discovery and development and improve catalyst performance, both initially and over the life of the catalyst. This can result in reduced cost, reduced catalyst size (volume and mass) and enhanced engine emissions control. These improvements can have indirect effects on petroleum consumption (particularly reductions in catalyst mass) and perhaps enable other developments, such as leaner engine operation, that will directly affect fuel use efficiency. The second reviewer explained that there is a link between emission controls for NOx and fuel economy capability. Fuel economy and cost improvements are possible with breakthrough technologies which do not require regeneration or SCR with ammonia injection. The third affirmed this project was concerned with demonstrating that catalyst systems can be designed from a "first principle theoretical models" approach and to carry out a range of experimental and theoretical studies to optimize the catalyst structure through nanostructure characterization.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first commenter reasoned that although the direct link to fuel economy is weak, this approach to make designer materials and to allow modeling of the results is outstanding. A second commenter provided a lengthy summation of the approach: A "first principles" modeling approach for designing platinum clusters on oxide supports, and zeolite catalysts is being pursued. The experimental approach includes synthesis of Pt nanoclusters, interaction with various gases, and zeolite catalysts. Scanning transmission electron microscopy (STEM) analysis is being used to determine Pt particle sizes; the atomic make-up of the nanoclusters comprises 10 to 20 atoms. Gas phase studies of Pt clusters show that atoms are held together more strongly as the cluster size increases. The simulations (apparently using density functional modeling) show some disagreement on the bulk ceramic structure which is currently being further investigated. The effect of CO and NO oxdiation on structural changes on ceramic substrates is being investigated, as is the influence of nanoparticles, and the incorporation of heteroatoms in metal exchanged zeolite which was shown to affect the NOx conversion temperature. The second commenter said that the approach of developing catalysts by design may be an emerging field. At the same time, many are pursuing the general problem of "materials by design" (reviewer's quote). The PIs did not mention much about other groups doing fully numerical simulation of materials, even though the applications may not necessarily be the one targeted here, for example whether or not their tools are unique or simply redirected from other fields. The rating reflects a concern that the approach is well known and only an application of existing theoretical approaches are being brought to bear on this problem rather than developing an entirely new approach. Whether or not new ground is being broken is uncertain.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

According to the first reviewer, some barriers that seem to have been overcome include that a combination of theory, experimental studies, and nanostructural characterization can advance catalyst discovery process. These accomplishments are consistent with the approach. Some of the technical accomplishments include the following: catalyst by design is effective in reducing development time in speeding up the discovery process; single atoms and 10-20 atom Pt agglomerates can influence CO oxidation; Pt occupied a position between two surface oxygen atoms above aluminum; CO oxidation can occur by O2 addition and O insertion intermediates; and a new bimetallic mordenite framework inverted (MFI) zeolite was shown to exhibit high NOx conversion. The second reviewer was pleased with some key findings and universally usable approaches, and remarked Modeling/ Results Reuse and applicability of data is very good. Catalyst by design approach is effective to speed up the discovery process. New hetero bimetallic MFI zeolites exhibit high NOx conversion at 150 C.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first reviewer thought that the work with John Deere was useful, though a bit vague. The publications were extensive though did not evidence a substantive collaboration with the John Deere (no co-authorship, if appropriate). A second reviewer pointed out that catalyst suppliers and developers would seem to be logical collaborators in this work, but the sole current collaborator from the private sector is an engine/vehicle builder. The third evaluator concluded that although John Deere was engaged for direct application, other OEMs can certainly benefit from this approach. Get them engaged! Co DOE-Industrial Technologies Program (ITP) funding is very good leveraging.

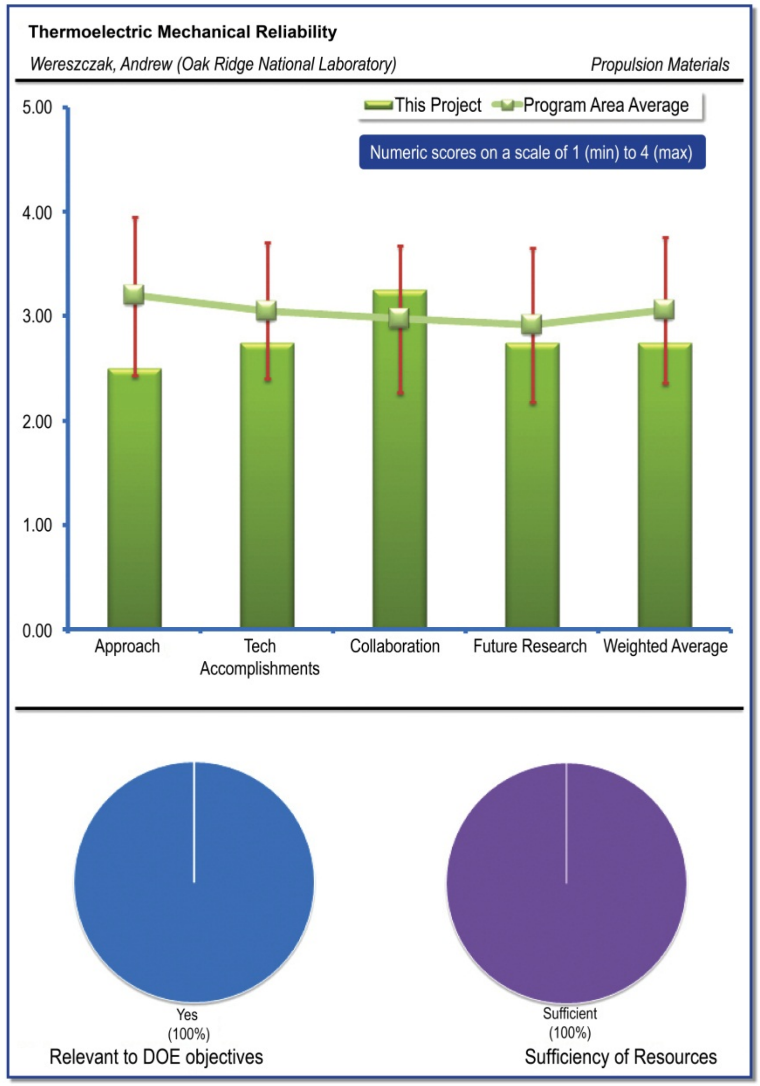
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Doubts about future research were expressed by all reviewers. One reviewer felt that although the plans were good, the presenter needed to reiterate or explain their significance. A second evaluator pointed out that the project will end at the close of the next fiscal year; will it have produced practically applicable results by that time, and if so, who will apply them? Deere produces no LDVs and only a relatively small number of heavy-duty diesel (HDD) engines. The third reviewer reported that the PIs would like to study several aspects in future work including CO, NOx and HC oxidation mechanisms on Pt/?-Al2O3systems (and they mention "Theoretical models”), and bimetallic systems to alleviate Pt sintering, again by a "theoretical studies" approach. The plan is a bit vague on what gaps in the past work will be quantitatively addressed in the future work, and what the significance is of this work. Furthermore, simply stating that the PI wants to carry out "synthesis of sub nanometer particles" does not provide much information of how material synthesis would fold into the theoretical approach, or how the analysis would guide the synthesis efforts. The reviewer concludes by reiterating that the project is now in its 7th year, and one would hope that a real catalyst could be designed, tested and put in the field with the approach of this project.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The first reviewer thought that the funding of $300K appears to be more than adequate for the proposed tasks. A second reviewer stated that at $300K for 2010 and 2011, this project would appear to have more than ample funding, particularly if this funding level has been maintained since project inception 7 years ago. The third reviewer considered leveraging of resources to be well done.

Thermoelectric Mechanical Reliability: Wereszczak, Andrew (Oak Ridge National Laboratory) – pm012



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first reviewer stated that the project concerned exploring thermoelectric materials for on-board power generation in automobiles. In this way, there will be some savings in fuel economy. The second reviewer explained that the ability to generate usable electrical energy from the otherwise wasted heat output of an IC-engine vehicle would clearly help to save petroleum by unloading the vehicle alternator. Likewise, the use of thermoelectric materials (TEMats) to cool power electronics and reduce the parasitic loads associated with that function would help make EVs and HEVs more practical and perhaps speed their penetration into the national LDV fleet. It might be that neither effect would be huge, but both or either would be directionally helpful. The third reviewer believed that heat recovery can contribute significantly to the energy efficiency and impact petroleum displacement costively.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer thought the project approach, involving characterization of material, was clear. The other evaluator stated that the approach concerns measuring thermomechanical and thermophysical properties of candidate (brittle) thermoelectric materials. The data are considered to be useful to enhance the design of a TEG. This year, the PIs have developed a property database on thermoelastic property data as a function of temperature. The materials are Marlow's p and n type material. The weakest link is the TE material but there are other elements such as the role of bonding and interfaces. This reviewer continued, bonding is included but interfaces are not considered in the plan. This may be a shortcoming that could be addressed by including efforts to evaluate the efficacy of interfaces to provide sound electrical and thermal contacts across different material systems.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first reviewer commented that the thermomechanical characteristics of available TEMats seem to be a principal factor limiting their application to practical systems, which justifies the project approach. The second reviewer responded that the effect of surface flaws on the properties was evaluated. By enhancing the surface quality, the tensile properties were shown to improve significantly. Since TEMats are inherently brittle any surface flaw is tend to initiate cracks easily. However, it was presented that the machining improved the high temperature strength as well which could not be explained. This reviewer suggested that more testing needs to be done to confirm the results. The third evaluator summarized the progress, reporting that the materials are skutterudite materials. High temperature strength data were obtained. A method was developed to eliminate residual stresses. The accomplishments are rather narrowly developed in keeping with the objectives. At the same time, the problem of TEGs for waste heat is far more than just strength and mechanical properties and elimination of thermal shock. Even if this problem is solved, the more traditional questions will remain (interfaces, ZT, etc.). There are competing effects of high k required as counterbalanced by the need for a low k for high ZT. The PIs thereby focus on enhancing the tensile strength. The need to consider CTE of the TE materials is in part driven by the design of the TEG itself, where de-bonding could occur by mismatch in material differences. This reviewer continued, other TEG designs leverage material expansion to essentially squeeze the interfaces as temperature is increased (e.g., the BSST TEG design, which also reduces interface effects). The design for being able to probe properties of small material samples is very good. The development of a method to nondestructively test residual stress is also good.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

All three of the respondents were concerned about a lack of collaboration with end users. The first stated that the project has a CRADA with one supplier, but most of the work was characterizing the material developed by the supplier. Involving more industries including users would be beneficial. The second agreed that the collaboration with Marlow, who provided TE materials, was excellent, but more effort should be made to work with General Electric (GE) to actually integrate a TE device into a vehicle. The third respondent said that even indirect participation in the project by a major automobile builder (GM) is desirable. Does the absence of other engine/vehicle producers suggest that thermoelectric recovery of waste heat is a low-order priority among that group, or has wider collaboration simply not been sought?

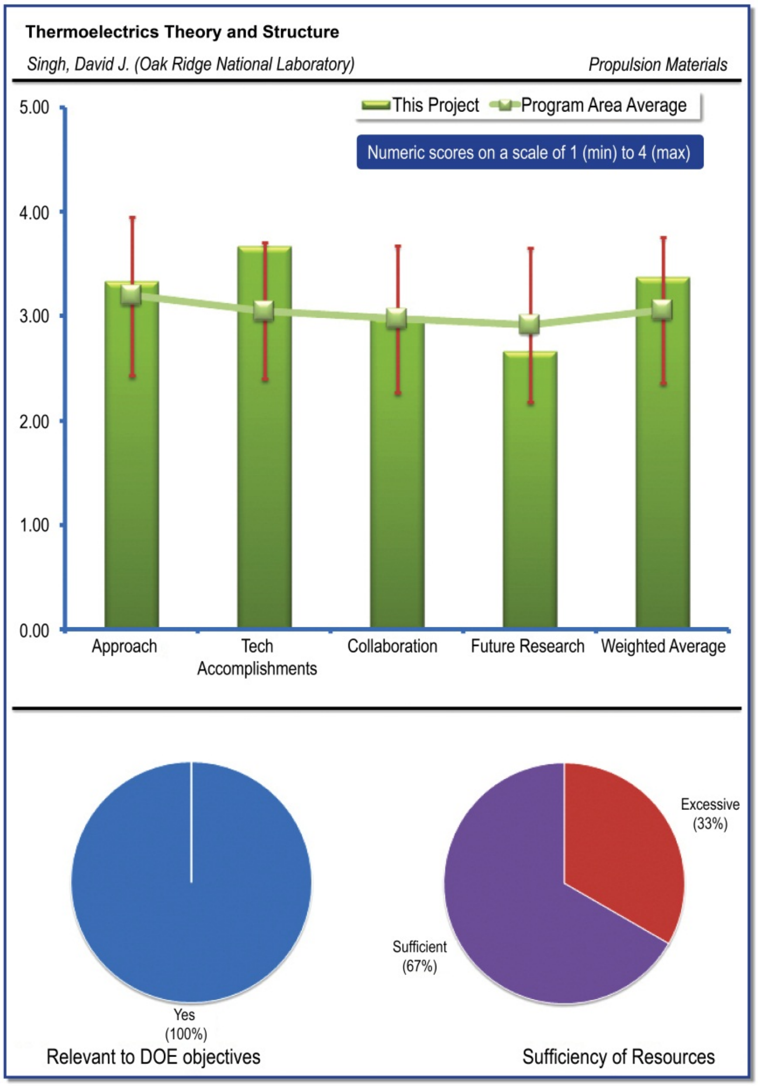
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer said that continuing work will examine strength of high temperature TE materials. Mechanical property evaluation will be pursued for next generation TE materials. It is encouraged that a component be devoted to interface characterization, both for electrical and thermal contact resistance.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that the budget of 150K is reasonable, especially given the collaboration with Marlow.

Thermoelectrics Theory and Structure: Singh, David J. (Oak Ridge National Laboratory) – pm013



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer saw direct correlation to DOE goals and petroleum displacement. The second evaluator thought this project relevant by virtue of its potential to improve fuel economy in automotive systems by converting the waste heat from the exhaust to electricity. The ability to predict performance of TE materials is quite relevant.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

All observers positively reviewed the approach of this project. The first reviewer was excited about the potential for low cost thermoelectric that can be designed. The second evaluator reported that the presentations suggestions improved evaluations techniques have dispelled generally held opinions on certain elemental combinations. Technical approach appears capable of meeting overall project goals. This project was suggested to TARDEC for review. The third reviewer considered the broad approach essential to identify new materials by applying density functional theory to develop materials with high ZT. The approach seems to be one of "materials by design.” The base case was a tellurium-based TE material.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer said that this project should definitely continue. The second reviewer concluded that the past work appeared to have shown that it is possible to "design" TE materials to meet specific targets. The PI predicted a ZT of 1.5 for PbSe materials at 1000K which turned out to be close to measured values at 800K. This year, new skutterudites were predicted with detailed transport calculations. An enhancement was found by modification of the band structure. The results also showed that PbSe was an excellent TE material with proper doping. ZT values are predicted to exceed 1.2 at 800K.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer said that this project’s collaborations are primarily ones of data sharing and communications of results. Ultimately, it will be important to transition these materials to automotive systems. A plan and path to that end was not given. This appears to keep the present study centered in a rather research-oriented direction.

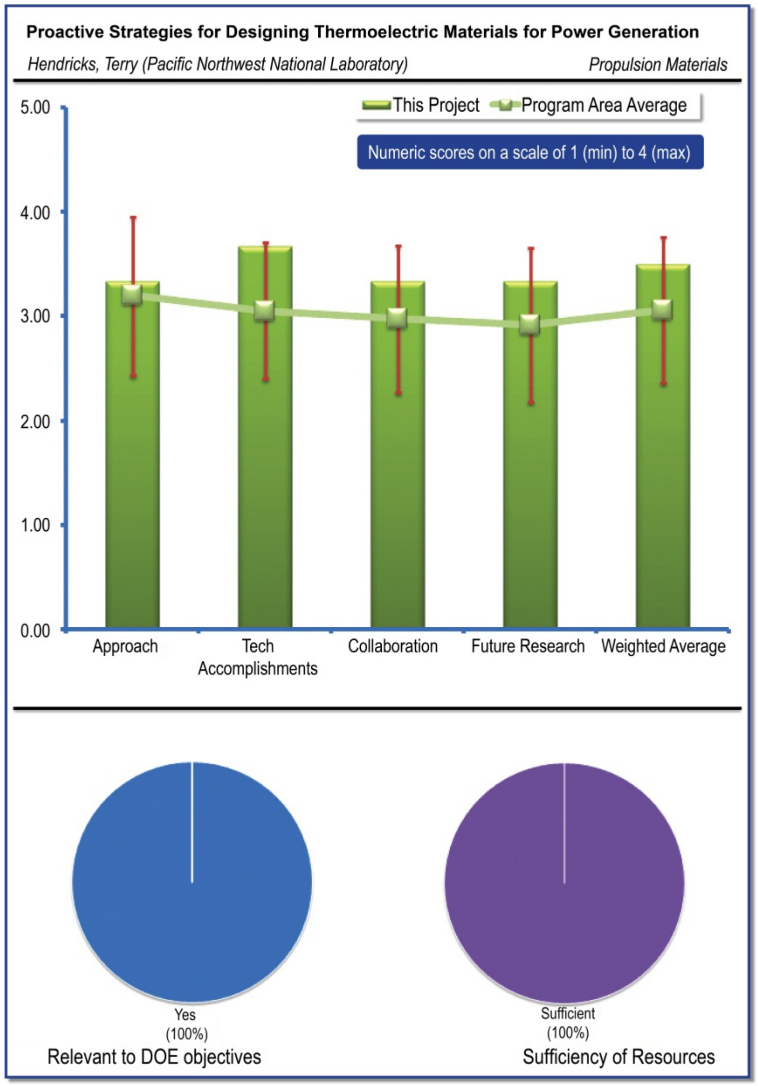
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The first evaluator asked, since the project has a few promising materials and the program is set to end in FY12, why not focus on optimizing these and not searching for other potential materials? The second reviewer commented about the suggested suite of materials. This reviewer suggested focusing efforts on solving one problem and use application before trying to find skutterudites for multiple applications. This reviewer also noted that it looks like PM 014 could support this effort. The third evaluator concluded that the future work will include such activities as "seek ways...", do "detailed calculations..." and "survey other low cost...". These tasks are non-specific and do not provide much to go on regarding gaining an understanding of precisely what the PI has in mind with these buzz phrases. The third reviewer wanted to encourage the PI to be far more specific regarding quantifying the methodology, formulations, analyses, etc., behind these rather vague words.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer said that the cost of $400K seems a bit high relative to other projects in this program, especially given its emphasis on simulation.

Proactive Strategies for Designing Thermoelectric Materials for Power Generation: Hendricks, Terry (Pacific Northwest National Laboratory) – pm014



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer relayed that the broad goal is to develop TE skutterudite materials that will meet targeted performance goals of ZT >1.6 at 600K or higher. If successful, such an activity will be relevant for improving fuel economy in vehicles.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first commenter remarked that the project ended in December 2010. The second reviewer asked if there was any concern about the use/dependence on the rare earth cerium in this design. The third evaluator stated that the materials selected are skutterudites comprised of cobalt alloys because of their ability to accommodate multiple rattler systems. The collaboration with Oregon State University (OSU) concerns characterizing the materials at higher temperatures than in the past. PNNL is characterizing system level performance. The suite of instrumentations at OSU appears to be extensive and based on commercial systems. This reviewer continued, the material characterization efforts seem to be well in hand. There was some uncertainty on potential anisotropic effects and the extent to which the metrology could decouple measurements (e.g., thermal conductivity) in different directions.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first reviewer said the question is not applicable, as the project ended in December 2010. It supported PM 013. The second reviewer was curious about any lot-to-lot variation/reproducibility. Thermal cycling slides show 2 samples -were they prepared from the same batch of starting materials or separately? The third reviewer reported that extensive arrays of data were presented, some of which show that ZT values approaching 1.6 at > 600K are realized. The other data are also extensive (e.g., CTE, E, Poisson's ratio, etc.). The effects of thermal cycling are perhaps the most important outcome of the results obtained this past year. The thermal conductivity may increase or decrease with repeated cycling. This sort of information is very important to know (and rarely reported or perhaps not even known). More effort should be devoted to understand the mechanisms responsible for this effect. The PI is encouraged to share his thoughts with others in the field on this effect, and is strongly encouraged to write a paper for an archival journal on the effect.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first reviewer reiterated that the project ended in December 2010. A second commenter stated that the collaborations are crucial to the success of the effort. PNNL and OSU are doing material thermal and electrical characterization; PNNL has characterized system-level benefits of material compositions; Tellurex and ZT plus are commercialization and technology transfer partners.

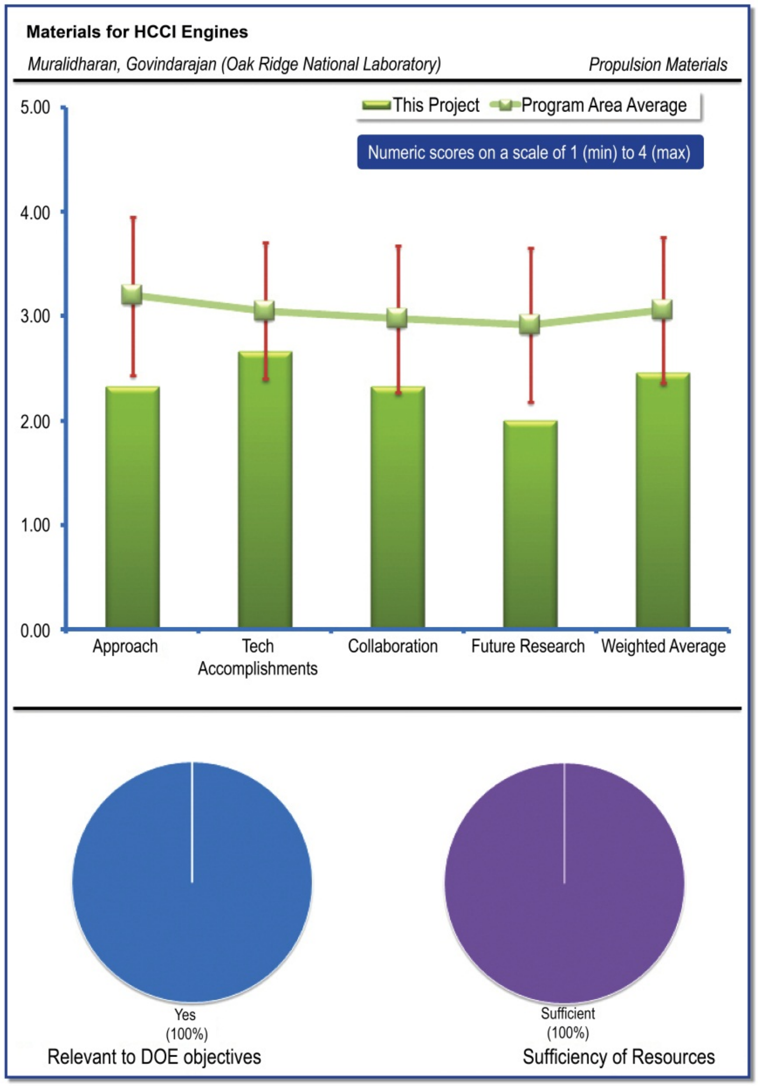
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer was curious what the chances for success are in creating the TE p/n couple, and what will be the risks and mitigation strategies. A second reviewer understood that future work will focus on cobalt n-type materials, high temperature structural characterization and ZT reproducibility. Fabrication of high density samples and completing a TE module are planned. They have already completed experiments to measure CTE. Another reviewer said they had no comment on proposed future research, since the project ended in December 2010.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer said that the budget is about right for the tasks reported, and another reviewer remarked that this question is not applicable.

Materials for HCCI Engines: Muralidharan, Govindarajan (Oak Ridge National Laboratory) – pm018



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Two reviewers thought the project supported objectives, with one reviewer commenting that development of material for high temperature applications is always useful to improve the engine efficiency, and a second reviewer commenting that producing valve materials capable of operating at higher temperatures will allow engines to operate more efficiently. The third evaluator deemed the project's support of goals questionable. This reviewer elaborated that there may be a correlation but it was not apparent from the presentation. It appears to be a materials identification and characterization effort. Project does not indicate any petroleum displacement, fuel economy improvements, etc. It does indicate the need for advanced materials for exhaust valves based on higher performance engines.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer believed that producing valves capable of operating at 870C will likely result in fuel efficiency gains. However, the targets of improving passenger vehicle fuel economy by 25% and commercial vehicle engine efficiency by at least 20% appear to be unrealistic and untested. The actual efficiency gains could be measured prior to valve fatigue failure, which would demonstrate the efficiency gains this project would actually achieve. This reviewer explained that once the actual gains have been demonstrated, then the development of high temperature valves can be rationalized. If the efficiency gains are found to be minimal but engine life is extended, then the project goals should be modified and the project should be judged based on the revised goals. A second reviewer concluded that the problem is to increase the operating temperature of the engines and the solution provided is developing new material. Also, the preferred path is using Ni as the major alloying element. The presentation should have included the rationale for this decision. The second reviewer asked, why not other materials, what is advantage of nickel alloys and what is known so far? Nickel alloys are used in aerospace for long time and we understand the material more clearly. The third reviewer found the approach to be questionable. The project appears to focus on identifying new alloys without any consideration to transition to manufacturing, or how to manufacture the new alloys into exhaust valves. It appears to be focused on a material improvement to one specific part, no apparent consideration to fuel displacement.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer believed that progress has been good in developing high temperature exhaust valve materials. The other evaluator stated that the alloy development is more empirical; it is acceptable that the data available for modeling may not cover all the ranges that need to be evaluated. However, it did not mention whether any of the new data is being used to modify and strengthen existing data bases for future modeling.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer thought that collaboration appeared to be good. Another reviewer saw some very limited coordination, which appeared to be consultation in nature, but saw no apparent direct collaboration.

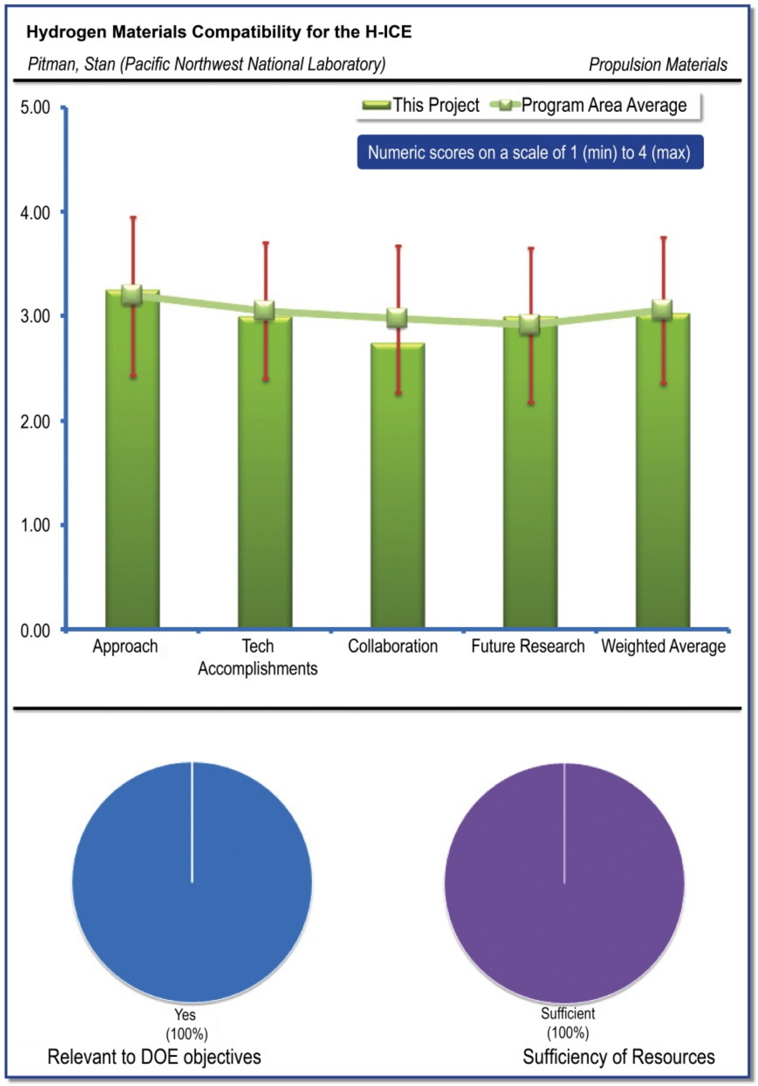
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The first reviewer reported that some discussions have been carried out with potential manufacturers, but no specific collaborations were mentioned. The second evaluator refers to his note above, stating that the actual gains that would be realized with completion of this project should be quantified through testing to demonstrate the actual efficiency improvements that would be attained. Another reviewer said the project was questionable, and that it appeared to be the development of more alloys, with no end product suggested.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that the resources appear to be sufficient to achieve the milestones stated. Another evaluator commented consider writing the findings and final report and terminating this effort.

Hydrogen Materials Compatibility for the H-ICE: Pitman, Stan (Pacific Northwest National Laboratory) – pm019



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Commenting reviewers agreed that this project supports DOE goals. One reviewer stated that this project focused on improved performance and reliability of fuel injectors for Hydrogen Internal Combustion Engines that are not petroleum fueled. A second reviewer said that hydrogen generated by non-petroleum sources used for internal combustion engines would be an alternative to fuel cells, and would have desirable applications. The third reviewer explained that fuel cells using Hydrogen will allow full displacement of petroleum when generated with Nuclear power. Nuclear electric and H2/Electric vehicles are the 2050 solution.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Respondents were positive about the approach to this project. The first reviewer claimed that the approach appears to be very appropriate for the goal of the project. A second evaluator thought the approach is correct to detect the root cause of the issue with H2 damage to piezeo-electric devices. The third respondent stated that this project evaluates piezo damage based on materials selection of piezo and electrode material with ion scattering (elastic recoil detection analysis [ERDA]/Rutherford backscattering spectrometry [RBS]) and SEM.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first reviewer commented that the progress of this project appears to be very good. Their ability to identify a metal with excellent resistance to hydrogen damage will be determined by the results of this project. A second reviewer responded that there was good progress to identify root cause and potential materials which perform best. Mechanism implies that all known materials will be impacted and may not be practical for use. A third panelist stated that the work performed included: Evaluating Pb diffusion in 5 different PZT/metal systems with RBS; Evaluating H uptake with ERDA in 5 different PZT/metal systems; and looking at surface blistering and Rb surface migration with SEM/energy-dispersive X-ray spectroscopy (EDX). The final reviewer asked, what if materials are used to absorb hydrogen before it reacts with piezoelectric materials? This will reduce the amount of hydrogen entering the materials and cause blisters and lead segregation.

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

The first reviewer thought that collaboration is good, and appears appropriate for this project. A second reviewer stated that PNNL partnered with Westport International and Ford Motor Co. on this project. The third replied that it was only Westport innovations, and Ford is mentioned peripherally. It is possible that this project could leverage universities, injector suppliers, industry groups or others for interest and knowledge related to this issue.

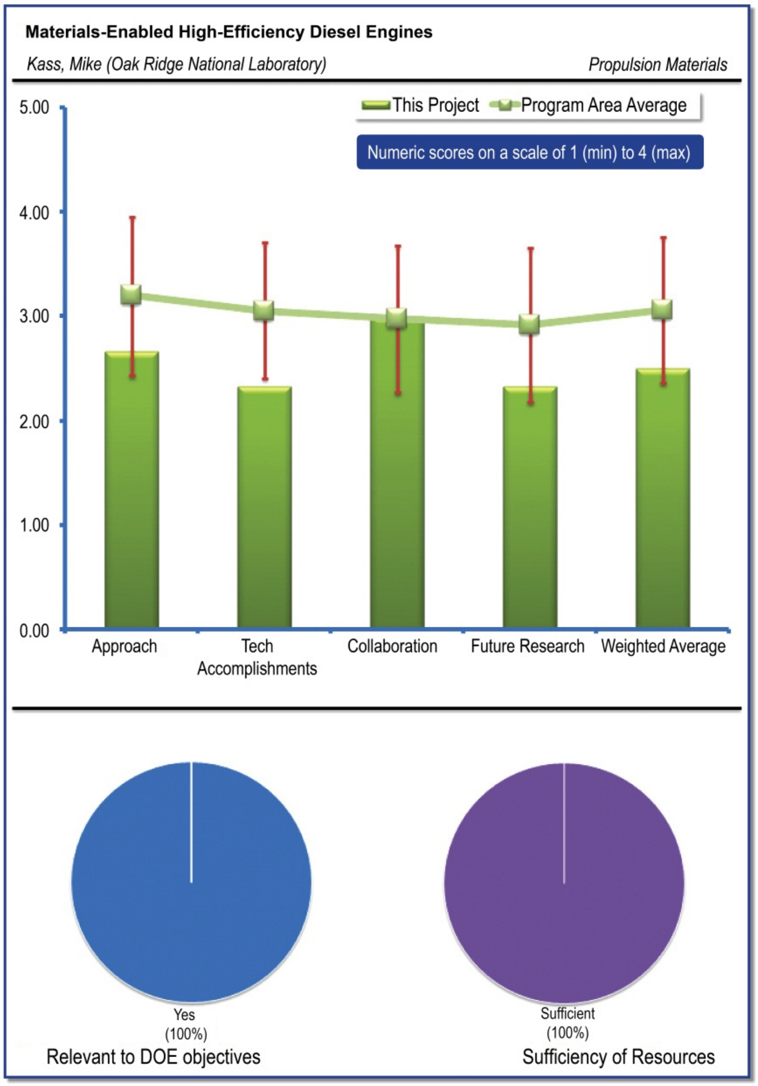
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

The first evaluator said that because the mechanism indicates that all known materials will be impacted without protection, some sealing mechanism or material may be an additional source for additional work. A second reviewer thought that the proposed work to be done appears to be appropriate for accomplishing the goals of this project. The third evaluator stated that this project will be ended in FY2011. The proposed future work included: complete ERDA/RBS and SEM damage studies on remaining barium titanate (BTO)/metal (5 types) systems; H diffusion studies in PZT and BTO with NMR to complement earlier neutron work; and compiling report evaluating H2 materials compatibility.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

One reviewer said funding for 2011 is $100K. Another reviewer thought the resources appear to be sufficient. The third reviewer believed that to complete planned work the existing funding is sufficient. Additional funding may be considered for work to identify alternative solutions for protecting piezo devices.

Materials-Enabled High-Efficiency Diesel Engines: Kass, Mike (Oak Ridge National Laboratory) – pm020



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer remarked that this project meets DOE goals. This reviewer stated that higher-temperature/pressure operation is a straightforward means of raising diesel engine efficiency which is, in turn, an aid to petroleum conservation. It can also raise specific power which could enable some reduction of engine size and mass, which indirectly benefit fuel conservation. Both approaches are enabled by higher-performance engine construction materials.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

No comments on approach were entered.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first reviewer noted that it appeared significant time and funds were required to address problems with test equipment. This is unfortunate, but such problems are often inevitable and must be dealt with. Consideration is being given to production application of an improved turbocharger turbine design tested in this project. This is a potentially significant technical accomplishment. The second reviewer commented that there was too little technical data to be able to evaluate the program. No preliminary data, no discussion as to what to expect. "Essentially no difference in the recession for either the standard or Ni-alloy valves" - so what is the value add-cost? Manufacturability? The third reviewer relayed that this project has focused on characterization of material developed earlier at ORNL; however what is the operating temperature for these engines? There is another project trying to develop new material for 860C while this project is testing an existing material. It may be that one of them is not necessary.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first reviewer offered that Caterpillar has provided considerable in-kind support to this project and planned future work calls for further support of this kind from Cat. The other evaluator stated that this effort is part of a CRADA with one OEM, but there may be a need to involve many more companies so that the tech transfer will be effective.

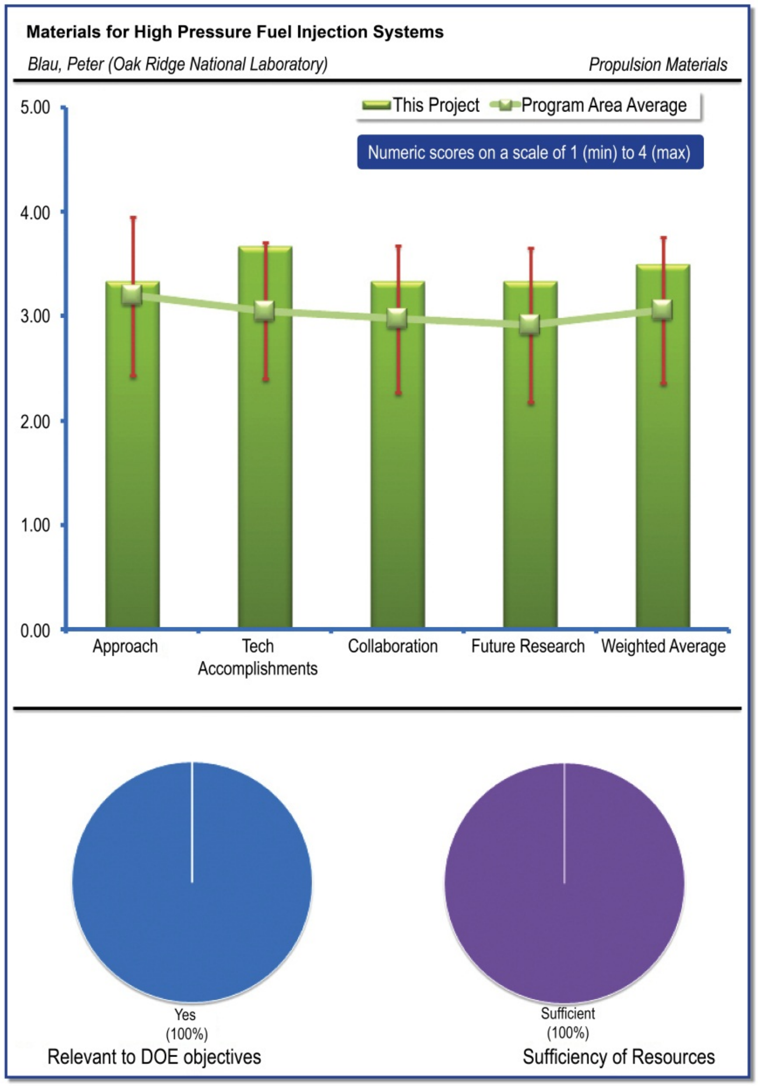
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One evaluator said that all of the work/results seem future-loaded, which is very difficult to evaluate. The other reviewer stated that to date, special alloy exhaust valves seem to have delivered equivalent performance to that of the stock valves. How will their potential to tolerate higher-temperature operation be evaluated? Likewise, the stainless steel manifold Cat will provide later for evaluation is a lower-cost alternative to the current design. This reviewer commented that cost reduction is desirable, but is the manifold anticipated to offer equivalent performance or improved performance at lower cost, and how will that be assessed?

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments on resources were entered.

Materials for High Pressure Fuel Injection Systems: Blau, Peter (Oak Ridge National Laboratory) – pm021



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer said that the recent history of diesel engine technology development has shown that higher injection pressures, at least within limits, can be helpful in improving engine-out emissions, operating flexibility and fuel efficiency. It remains to be seen if raising injection pressures to levels as high as 2800-3000 bar will be as valuable as the increase to the range of 2000 bar has been, but the work undertaken in this project will be necessary to make that determination.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer said that this is a concluding project which appears ready to transition to the manufacturer.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer commented that this is a concluding project, and a second reviewer stated that excellent progress has been shown by a series of logically ordered goals and steady progress in meeting milestones.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One evaluator stated that it is limited to one manufacturer. The second reviewer understood that the CRADA partner in this effort pioneered the trend to very high injection pressures in HDD engines and has contributed on the order of a 50% cost share.

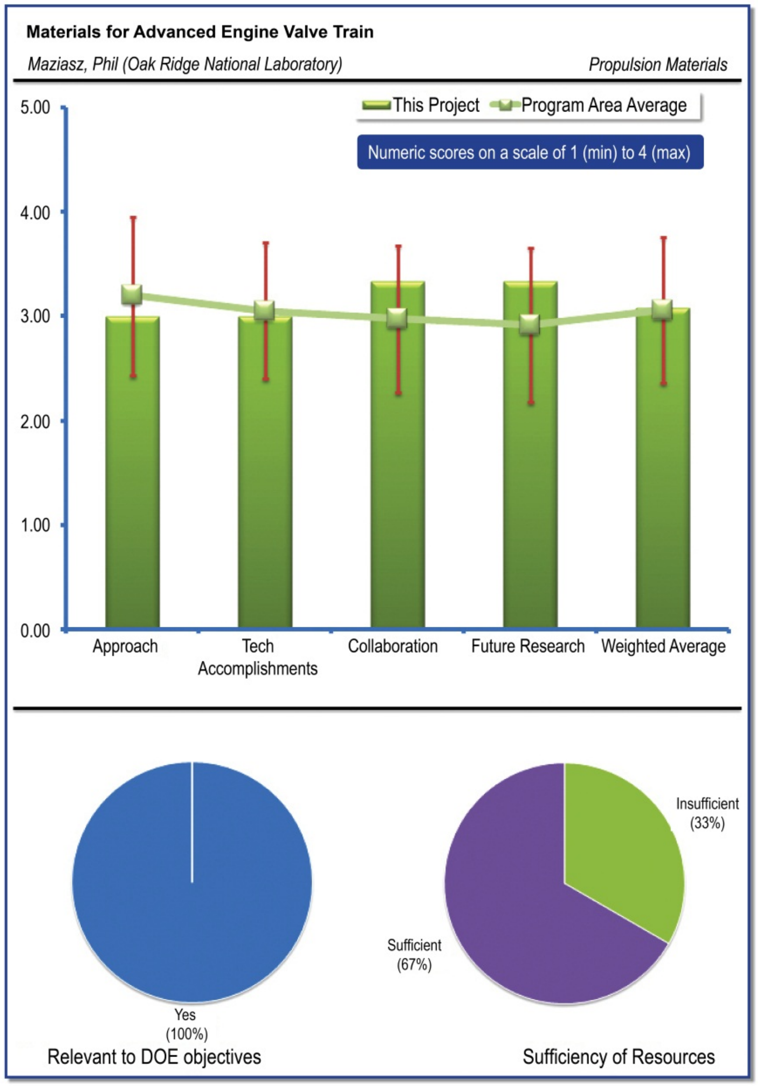
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer pointed out that this section is not applicable as this is a concluding project. This reviewer continued a curiosity of this effort is to determine the performance of the injectors using various fuel formulations. Consider that diesel fuel can vary from one country to another in the same region, have differing contaminants, and could have been delivered/pumped from any handy source into the vehicles fuel tank.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were entered.

Materials for Advanced Engine Valve Train: Maziasz, Phil (Oak Ridge National Laboratory) – pm022



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first reviewer concluded that this project will allow for improved thermal efficiency of internal combustion engines. A second panelist affirmed that the project is aiming at higher heat resistance of valve materials, which allows for higher combustion temperatures, which in turn will lead to further fuel efficiency improvement. The third reviewer commented that future engine combustion strategies will most likely result in higher temperatures in order to achieve improved fuel efficiency. This work may be considered enabling technology.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

All reviewers liked the approach. The first evaluator commented that the approach of this project is to reduce the increased wear between exhaust valve and seat inserts through the use of improved alloys. This appears to be a practical approach to resolving their defined problem. A second reviewer felt that this project is well planned. Progress is evident and milestones are being met. The second reviewer especially liked presentation Slide 6 which showed normalized wear rates for the valve seat insert and the mating exhaust valve as a material couple. The wear rates for the valve and the mating seat may not be independent. The third panelist thought that within the project there is a link between base material properties, rig testing and engine testing. This will lead to a better understanding of the phenomena that are responsible for wear of valve/valve seat pairs. One aspect is not mentioned for the material selection; heat conductivity of the valve and seat. This has an influence on the actual operating temperature of the valve the best heat resistant material is not necessarily the best choice.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first reviewer thought that the accomplishments and progress appear good. The method chosen was to test several alloys to determine which performs the best. This approach will determine the best alloy for this application among the candidates, but there are potential alloys not being considered that are not being tested. A second reviewer felt that a path forward was clearly defined, so in the future a higher heat resistance valve will be possible. The tests are time consuming making it difficult to assess intermediate results. The third commenter believed that the 2011 summary mentions previous clearly identified root causes of wear attack. While there is only limited space to present results, the root cause definition actually comes across more as a hypothesis than proven. The underlying physics and root cause confirmation may exist, but are not evident in either the 2011 or 2010 presentations. While it is always preferable to understand why things work, it must also be recognized that it is not a necessary condition.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Two of three panelists were pleased with collaboration and the third offers suggestions. The first two reviewers said that collaboration appears to be appropriate for this project; and that the collaboration between the two partners is good however the number of project partners is limited. The third reviewer reasoned that supplier involvement is a critical element for commercialization. Otherwise, the work might be considered a science experiment with no impact on actual products. Valve seat and exhaust valve suppliers have provided prototypes.

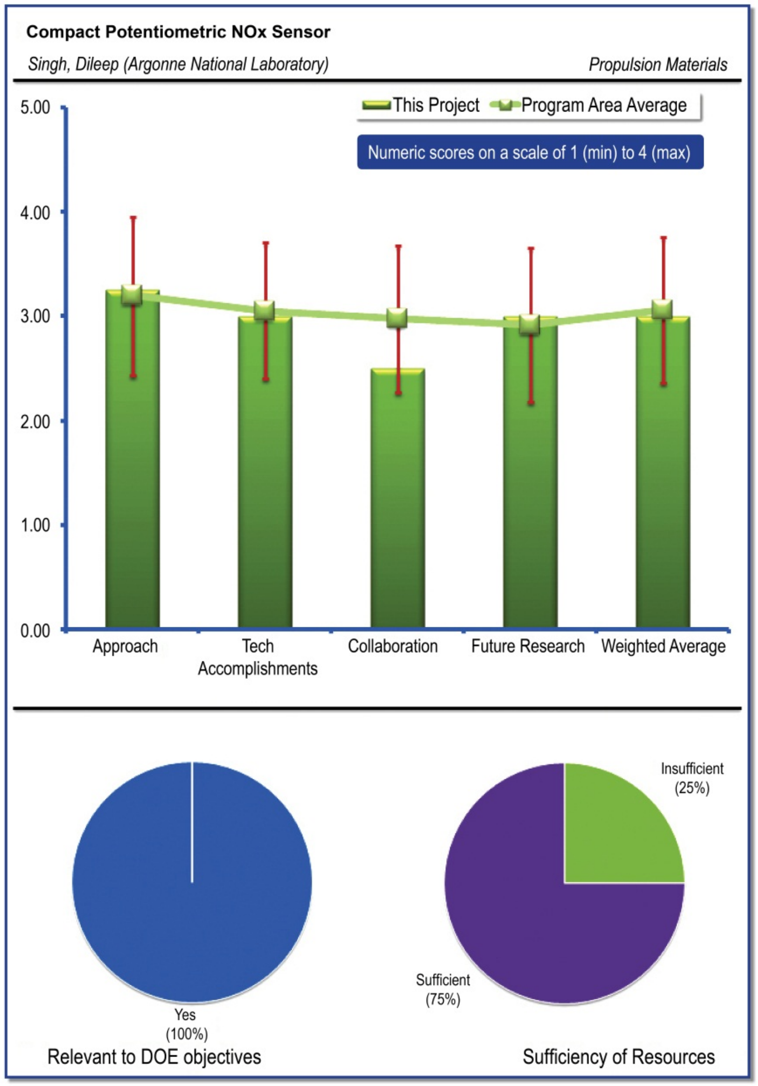
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Three respondents offered views on future research. The first reviewer saw it as a clear follow-up on the work already done. The second evaluator stated that future research appears to be able to accomplish goals. Alternate alloy optimization may be something to consider for additional improvements, assuming that any additional gains would be worthwhile. The third reviewer’s response was that the validation plans made sense - downselect using bench tests, perform accelerated wear testing on test rigs, followed by running engine evaluation. A split test might be considered in order to confirm relative improvements in wear rate under the same operating conditions.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Two reviewers were of the opinion that the resources and budget appear to be sufficient for the scope of this project. The third evaluator qualifies this by stating that the funding level is sufficient up to the point of running engine validation. Engines are expensive and for the fuel to run endurance tests even more so. Funding for validation for release to production is insufficient. It might be mitigated by "piggy back" testing on other tests that are already paid for.

Compact Potentiometric NOx Sensor: Singh, Dileep (Argonne National Laboratory) – pm023



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Two reviewers explained the project in relation to DOE goals. The first reviewers explained that real-time monitoring of combustion products in the exhaust stream provides information that is critical to controlling combustion, minimizing regulated pollutant production and maximizing combustion efficiency, which minimizes fuel consumption. The second reviewer acknowledged that NOx sensing will enable engine and after treatment control strategies which reduce fuel consumption.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Two respondents were pleased with the approach. The first reviewer said that the project appears to be on track for potential prototyping and shoot off testing with other competing technologies in FY12. This reviewer suggested such a shoot off. The second reviewer felt the issues identified to solve materials concerns were good: non-Pt based sensor; optimizing materials; and devising joining methods with zirconia sensor. Missing are critical issues related to automotive applications: performance on an engine for control; repeatability; susceptibility to noise; durability performance in the presence of contaminants; thermal cycling; thermal shock; and water impingement.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first reviewer stated that interest of sensor manufacturers in technology and possible licensing agreements indicates technical accomplishments have been significant. The second respondent felt it great work to identify a substitute material. Needed are: performance on an engine for control; repeatability; susceptibility to noise; durability performance in the presence of contaminants; thermal cycling; thermal shock; and water impingement. Most problematic in all previous attempts to make this type of sensor were: durability (cracking, aging performance, loss of coatings, loss of heaters); variation (fresh sensors: sensor to sensor variation aged: Sensor to sensor and degradation factor amplitude / consistency); and signal strength (signal to noise).

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first respondent concluded that an identifiable manufacturing and distribution industrial base was apparent. The second panelist thought that the lack of industry support for such a key sensor was striking. Questioned this reviewer, are there no sensor suppliers ready to work together with Argonne to perfect this technology identify true costs?

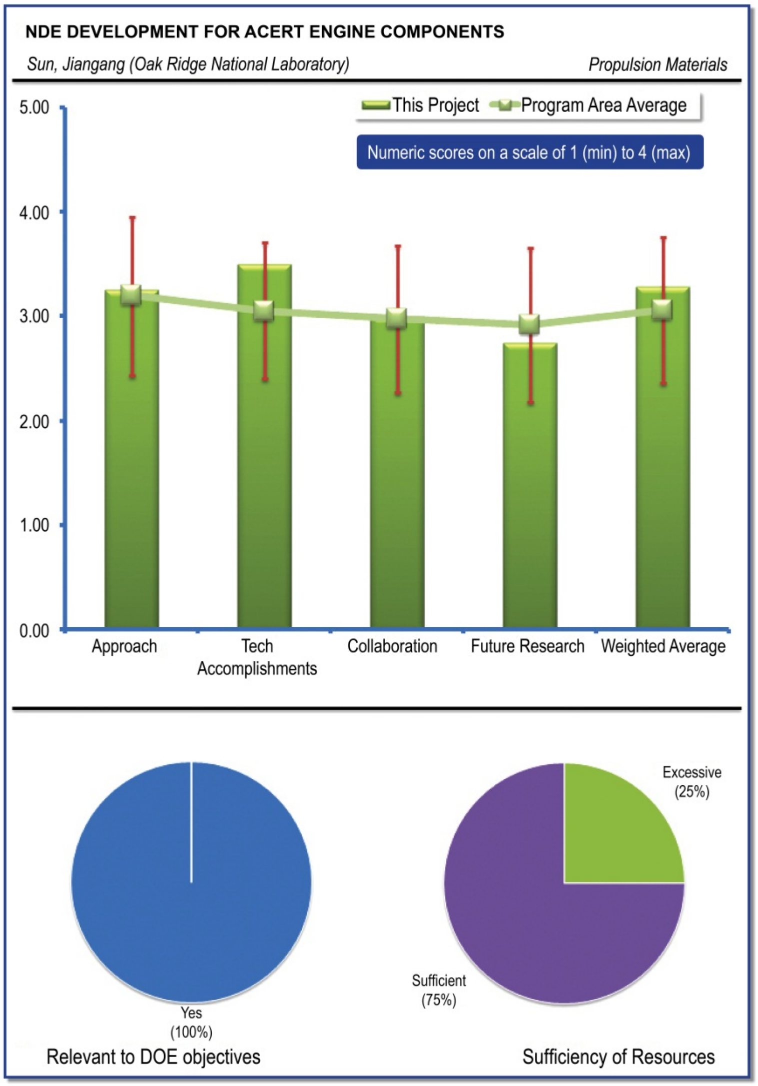
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The two responses given were positive about future research. The first reviewer stated that the path forward is very good. The second evaluator pointed out that the effort terminates in FY12. As mentioned above, the reviewer suggested a shoot off of best O2/ NOx sensor technology. Tests should include criteria for reliability, durability, and maintainability. Also, ease of servicing and removal, method of manufacturing, availability of materials, and overall cost to manufacture should be evaluated. Consider that this item may be on an engine used in another country with totally different atmospheric standards.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The first reviewer responded that there has been very good progress and significant technical accomplishments on a relatively modest budget. The second reviewer thought that it will take much more than $100K to truly implement this work, and that additional sources and partners should be pursued.

Non-Destructive Evaluation (NDE) Development for Advanced Combustion Emission Reduction Technology (ACERT) Engine Components: Sun, Jiangang (Oak Ridge National Laboratory) – pm024



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Three reviewers offered explanations as to how this project enables DOE goals. The first reviewer reported that this is an enabling project. While it will not directly result in energy efficiencies, it will enable the use of designs that will allow greater energy efficiencies. The second evaluator agreed that high temperature materials and processing are key enablers for higher efficiency IC engines. This project prepared tools and has identified one real world solution in turbocharger manufacturing. The third reviewer thought the project supported the DOE objective, but only partially. The presentation suggested a correlation between the NDE for turbine engine components; however, the presentation failed to provide a compelling rationale for any direct correlation to DOE overall goals or petroleum displacement.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Three reviewers were pleased with the approach. The first reviewer thought this project's approach appears to be well focused. A second evaluator agreed with the need for NDE for turbine parts; this supports other turbine engine hardening efforts. The third reviewer found this project to have a perfectly stated and well supported goal, one of the most concise this reviewer had seen: "Develop rapid, reliable, and repeatable NDE methods to support the material enabled high efficiency diesels program (ACERTTM program) to achieve the VT Program Goal of 50% engine efficiency by 2015." The third reviewer also suggested seeking industry input for real world solutions to turbos, structures, and coatings.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Three commentators left positive responses. The first reviewer thought accomplishments have been good, and expected that this NDE procedure can be used for other applications to improve efficiencies as well. A second reviewer felt that using high resolution imaging diagnostic methods were excellent, as well as its correlation to faster, lower cost ultrasonic methods. The third reviewer stated that this effort is part of a CRADA project, and was delivering characterization, in this case NDE. This reviewer thought the development test process was good, and could be used for other materials or products.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Two reviewers left positive comments for this question. The first reviewer thought that collaboration is very good. A second panelist stated that this effort leveraged technology and know-how from medical imaging to improve results. This project was focusing on needs of industry through Cummins partner as well as universal applications. The third reviewer commented that collaboration was limited to one manufacturer and ORNL.

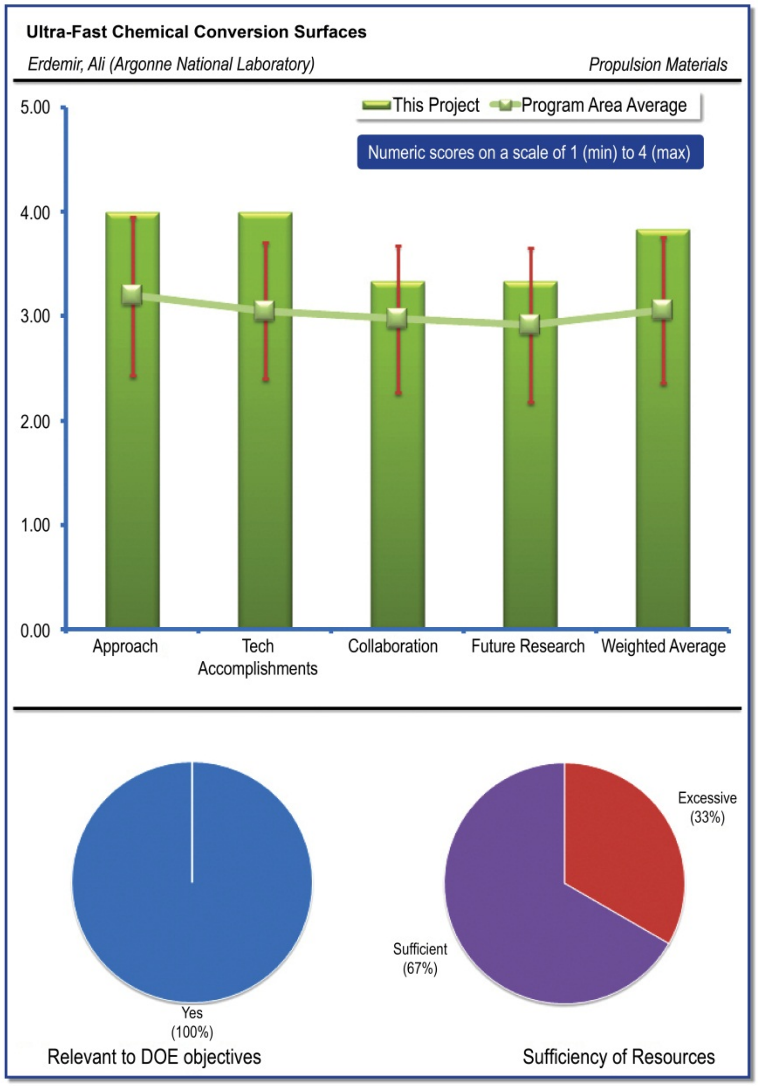
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Three reviewers were pleased with the future research. The first reviewer felt that proposed future research is well focused. If these NDE methods can be used to evaluate other joining methods not covered by the scope of this project, there may be more applications to consider (e.g., the evaluation of spot welds). A second panelist was of the opinion that this researcher was performing excellent activities, and that follow on was needed for expanded scope and use of x-ray and ultrasonic NDE. The third evaluator stated that the presentation indicated the project is at 80% funding while indicating continued efforts through FY15. He suggested a review of the continued relevance to DOE goals.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer reported that the resources appeared to be sufficient for the defined project. The second panelist thought the project to be well funded, but additional funding could be used for expanded scope with additional manufacturers to refine the x-ray / Ultrasonic NDE and database for characterization of material properties, joining, and durability.

Ultra-Fast Chemical Conversion Surfaces: Erdemir, Ali (Argonne National Laboratory) – pm027



REVIEWER SAMPLE SIZE

This project had a total of three reviewers.

QUESTION 1: DOES THIS PROJECT SUPPORT THE OVERALL DOE OBJECTIVES? WHY OR WHY NOT?

The first reviewer stated that it supports DOE goals indirectly. The overall result is enhanced durability and service life. Bluntly, the process will make the borided surface harder with less friction thus increasing the engine efficiency. A second evaluator confirmed that the project at this time indirectly supports the objective of petroleum displacement. The focus is on a process technology. The objective will be met when the tribological properties and cost to implement align with commercial production. The final panelist stated that reduction of friction in engines will increase their mechanical efficiency, permitting more of the fuel energy released to be delivered to the drivetrain. Reduced wear will permit this advantage to be maintained over a greater part of the engine life.

QUESTION 2: WHAT IS YOUR ASSESSMENT OF THE APPROACH TO PERFORMING THE WORK? TO WHAT DEGREE ARE TECHNICAL BARRIERS ADDRESSED? IS THE PROJECT WELL-DESIGNED, FEASIBLE, AND INTEGRATED WITH OTHER EFFORTS?

The three reviewers had positive remarks about the approach. The first reviewer reported no apparent technical barriers, and suggested prioritizing the work to boride critical parts while scaling up for other, larger engine components. The second reviewer found the approach to be very well focused as far a process technology development project. At that time, there was little mention of how/where the surface modification will ultimately affect wear or friction. This should be added to the plan as a future phase. The third reviewer thought that the approach to this work appears to offer the promise of a process readily adaptable to the requirements of the automotive industry and effective in meeting the goals of wear resistance and friction reduction.

QUESTION 3: CHARACTERIZE YOUR UNDERSTANDING OF THE TECHNICAL ACCOMPLISHMENTS AND PROGRESS TOWARD OVERALL PROJECT AND DOE GOALS.

The first reviewer stated that once the development thrust is prioritized to specific engine parts, the developer should consider if the project could be accelerated and by how much. Additionally, if the process is successful on specific parts, then by analogy the same could be said of larger parts. This may only require emphasis on the scale up and the establishing of manufacturing quality control standards. The second reviewer’s score was based on the process development, as the application was not well addressed. Process - The accomplishments are promising so far. The ability to batch process as well as not requiring a line of sight for application gave this process a distinct advantage over other processes. Application - At present, the project might be considered to be a process looking for an application. The underlying hypothesis of improving wear and friction seems to be "try it and see." This impression can be addressed by more clearly articulating plans for post process development.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

All three reviewers saw potential for more collaboration. The first reviewer said that at this time, coordination is limited the national lab and one contractor. Project seems to indicate potential for other manufacturers once the process has demonstrated full scale up operation and production. The second panelist thought that for the process and its development, collaboration with industry is appropriate. It would help to align with a component supplier or engine manufacturer to assist with application selection, design requirements, operating conditions, and validation. The third reviewer relayed that only one industry collaborator was named, but participation by "others" was mentioned.

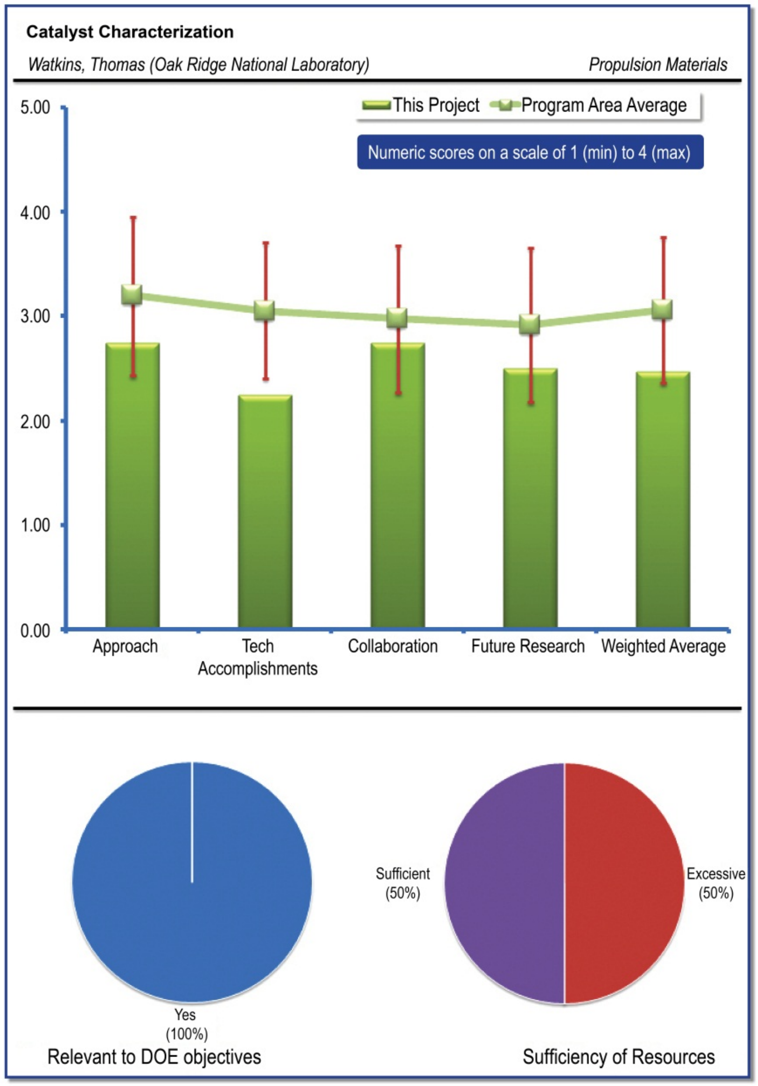
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The first reviewer said that given the project plan in the presentation and the comments above on prioritization and simultaneous scale up, this reviewer suggests the project could transition to industry in late FY12 or early FY13. The reviewer also suggested the project re-evaluate its milestones for early FY13 transition to industry, and that DOE review the project in FY12 for potential of completion in FY13. The second commenter responded that no specific components or tribological interfaces were defined, nor were the failure modes that may be affected explicitly addressed. This may be due to where the project presently resides in process development. The commenter would have expected articulation of one or more candidate applications, with a description of the issue to be addressed and the outcome anticipated.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One respondent remarked that resources look appropriate. Another reviewer asked that given the excellent progress made to date, could this project be terminated and the process and results turned over to industry before the scheduled 2014 end date? Doing so would conserve DOE funds and it would appear that industry interest should be high.

Catalyst Characterization: Watkins, Thomas (Oak Ridge National Laboratory) – pm028



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Three reviewers explained how the DOE objective relates. The first reviewer claimed that a better understanding of NOx control over the lifetime of the catalyst will widen the operating window of the combustion system leading to reduction of fuel consumption. A second commenter explained that advanced catalyst formulations enable use of lean combustion technologies and limited fuel penalty due to regeneration, flow restriction, or durability life issues can result in petroleum displacement. The third evaluator stated that, in common with other catalyst characterization projects, this project can be expected to support the DOE petroleum conservation goal indirectly by (possibly) enabling effective emission control of alternative-combustion-regime engines. The current and planned objectives of this research vis-a-vis ammonia slip catalysts specifically; however, seems to this reviewer to be unrelated to petroleum displacement. Presumably, the project, now entering its ninth year, has dealt previously with technical issues of greater relevance to the DOE goal.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Commenters praised the approach. The first reviewer said that the chosen approach is solid: Characterization of the material after several stages is a proven approach. Difficulty remains in predicting the outcome. The second commenter deemed the approach to be well known and reasonable: test catalysts to understand atomic mechanisms for adsorption and aging; seek the atomic mechanisms and chemistry of adsorption and regeneration processes; seek to understand the thermal and hydrothermal aging processes and other degradation mechanisms throughout the lifecycle of the catalytic material.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Of the four commenting reviewers, only one thought progress was good, clarifying that it is in comparison to the somewhat poor 2009 results. First ideas to improve have been generated. A second reviewer reported that this is a ten-year, five million dollar program, and this reviewer would have liked to see where these catalysts are implemented and show the investment impact. It was not clear. A third panelist commented that there were no significant findings here for broad applicability. Claimed contribution to improvement of Dodge Pickup after-treatment was vague and not well supported. The fourth reviewer pointed out that concerning ammonia slip catalysts specifically, as the presentation notes, ammonia is not currently a regulated automotive engine emission. Moreover, this reviewer is not aware that engine and vehicle manufacturers regard current means of controlling ammonia slip as inadequate or punitively expensive.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first reviewer thought OEM and supplier partners were good (being Cummins and Johnson Matthey). The second reviewer stated that good collaboration is established. The consortium has a good mix of OEM, Tier 1 and research institutions. The final reviewer felt that although Johnson Matthey is a logical and potentially valuable collaborator in any catalyst characterization project, the presentation did not suggest that company's involvement goes beyond technical consultation and information exchange. Cummins' motivation for involvement in this subject area is obvious, but Cummins is a catalyst user, not a catalyst producer.

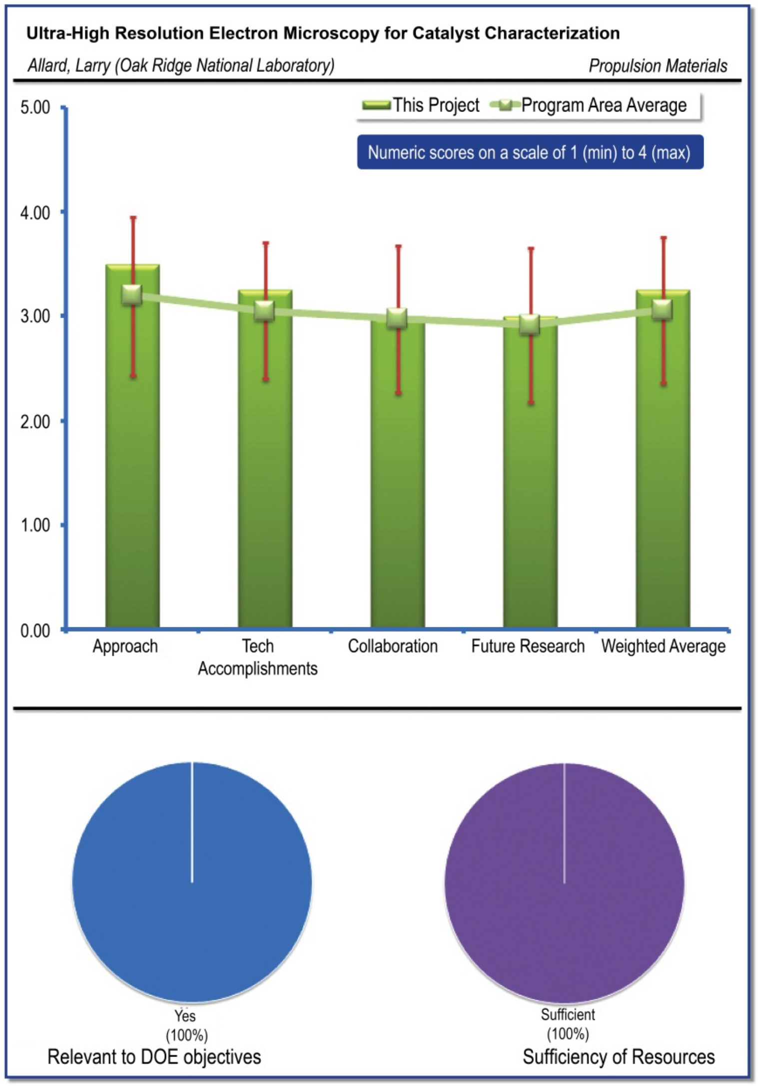
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Two commentators thought follow-up appears reasonable, and the third raised questions. The first reviewer said that the future work appears to be a straightforward follow up on the results booked so far. The second reviewer was of the opinion that the proposed follow-on work for the next year is a logical extension of the work reported; however, the third item: "Assist Cummins to competitively produce engines which attain the required prevailing emissions standards etc., etc." strikes this reviewer as an excessively narrowly focused objective. Cummins' support of this project has been substantial (> $2M), but one would hope that ORNL would aim its efforts more broadly at the engine/vehicle manufacturing community. The third evaluator expressed concern that most of future work has vague language or work which appears to be outside of the scope of the project. More powerful is "Lifetime prediction Model to be available for ammonia oxidation (AMOX) catalyst after hydrothermal aging studies complete. Model will be able to predict xxx for use by xxx design engineers to optimize catalyst formulations including wash coat, loading, and substrate. Utilize in situ capabilities to xxxx? Assist Cummins to competitively produce engines by date?

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The first reviewer considered the resources to be sufficient for the characterizing activities. A second reviewer thought that based on the 2011 presentation and the work reported, the funding level seemed excessive for the scope of the work and its stated aims. The third reviewer believed that DOE should consider if this project may be included with other similar projects with larger scope/ goals and higher division of labor/ more collaborations.

Ultra-High Resolution Electron Microscopy for Catalyst Characterization: Allard, Larry (Oak Ridge National Laboratory) – pm029



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Three reviewers explained how this project meets DOE objectives. The first reviewer stated that in common with most catalyst characterization studies, this project will eventually support the DOE petroleum displacement goal indirectly if its results can enable commercialization of alternative-combustion-regime engines or other technologies that increase the efficiency of prime movers or (perhaps) petroleum refining so as to increase yields of transportation fuels from crude. The second reviewer saw some potential reduction in fuel consumption with advances in catalyst technologies to address NOx with reduced or eliminated regeneration. The third panelist considered catalysts necessary for the operation and improved efficiency of diesel engines.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first reviewer relayed that the project is developing processes and attachments for electron microscopes for analysis of reactions. The technique can be used for other applications even beyond the vehicle technology area. A second opinion was that ultimately, it is necessary to understand catalytic processes and mechanisms at the atomic level, where they occur. Sub-Angstrom microscopy is one of a very few available tools to enable such understanding. The third reviewer stated that this project's goal is to focus on understanding and modeling of catalytic processes at atomic level and in use.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first respondent thought that reasonable developments have been achieved over the last year. A second reviewer commented that the discussion and clear depiction of the reaction rates single atoms vs. clusters vs. typical catalysts was nicely done. The third reviewer relayed that "test equipment to measure in situ results has been achieved: Gen 3 environmental cell capability." This may enable other critical research to multiply output. Specific optimizations or improvements in material technology should be mentioned or discussed.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Two panelists mentioned the impressive list of partners. The first reviewer thought that collaboration was excellent, and that the project had support from many stakeholders and researchers, as indicated from the presentation. The second panelist thought that the presentation was heavily oriented toward technical accomplishments and descriptions of experimental apparatus and techniques. Therefore it was difficult to assess the degree of coordination with the impressive list of "partners" other than ProtoChips.

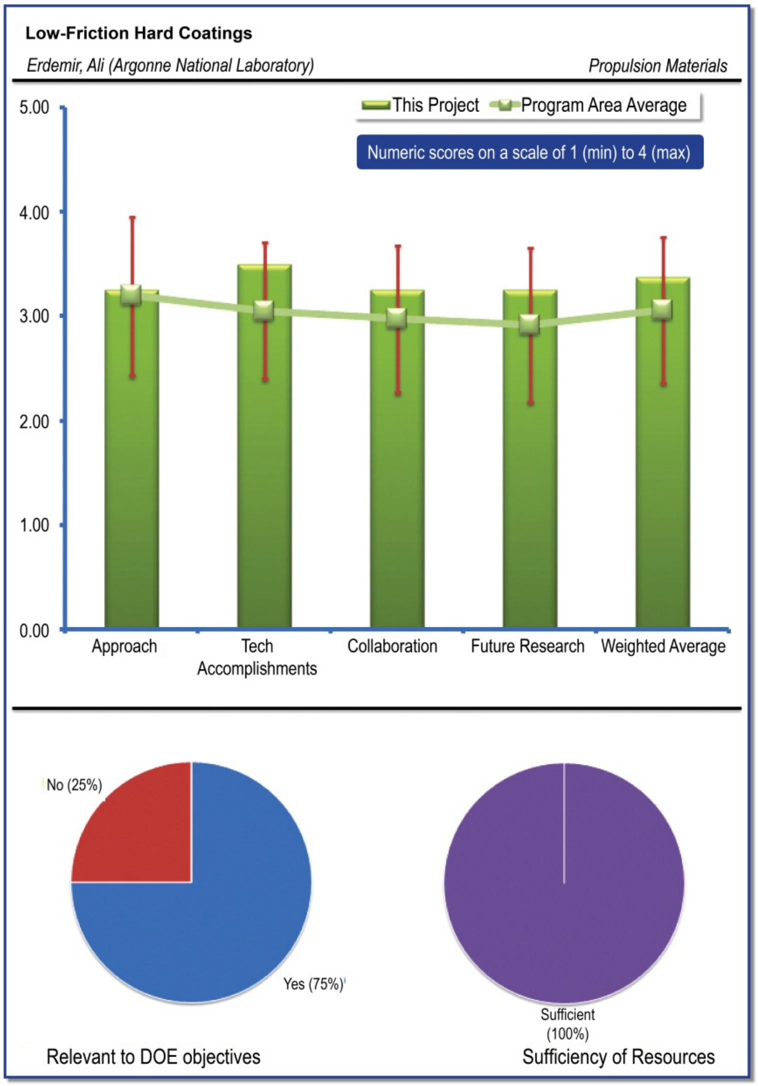
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The two responses for future research were positive. A first reviewer said: Excellent. Expanded capability for static and dynamic flow, nano particles, and dispersed catalytic species. The second reviewer commented that proposed future work seems to be essentially "more of the same." Given the impressive technical achievements of the past year's work, this is probably the appropriate approach.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The first panelist reported that funding had been increased from DOE but the amount of leverage from external partners is minimal. A second panelist hoped private-sector collaborators in the coming years work will offer increased cost sharing.

Low-Friction Hard Coatings: Erdemir, Ali (Argonne National Laboratory) – pm030



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first reviewer stated that reduction of engine and drivetrain friction is a straightforward way to increase drivetrain mechanical efficiency, which will directly reduce fuel consumption. Increasing the durability and performance retention of anti-friction-treated drivetrain parts will permit this fuel economy advantage to be retained over the useful life of the vehicle. A second reviewer thought that reducing the friction in engine components can improve efficiency but the technology may be far from application. A third reviewer concluded the goal of this project was to design, develop, and implement low-friction and super-hard coatings to increase fuel economy, durability, and environmental compatibility of advanced engine systems. The final reviewer stated that this project enables the use of efficient, longer lasting designs.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first reviewer predicted that the field trials and dynamometer tests being conducted will provide performance data under actual life conditions. A second reviewer claimed that the results of the approach to this work speak for themselves. A third reviewer considered the project approach to be well thought out. The fourth reviewer thought the approaches to be good and logical: the steps being to identify and optimize deposition conditions that are most critical in physical, mechanical, and tribological properties of super hard and low friction coatings; develop reliable deposition protocols for large-scale manufacturing of MoN-Cu and near-frictionless diamond like carbon coatings; demonstrate durability and performance in engine applications; and demonstrate large-scale production, cost competitiveness, and commercial viability.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Two of the three respondents found good progress, the third questions the applicability. The first reviewer thought the accomplishments and progress to be excellent. A second reviewer said that outstanding progress was made in many fronts: Successful demonstration of superhard nanocomponent (SHNC) coatings on a large number of actual engine parts using lab-and commercial-scale deposition systems with production-scale loads; verification of superior tribological properties of SHNC coatings in a variety of engine components; validation of superior performance in field and fleet of cars (currently underway); and scale-up and commercialization efforts in their final stages. The third reviewer relayed that the coatings are reported to induce severe wear on other surfaces; if this is the case then application of these coatings on some surfaces will reduce the tolerances and cause loss of efficiency. Patent applications can indicate the innovativeness of the process but not the applicability of the technology.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

All four reviewers thought collaboration to be good, while one wondered about unnamed OEMs. The first panelist stated that collaboration is excellent with firms and organizations able to test the results of this project under field conditions. A second reviewer thought that collaboration appeared to be appropriate for this project. A third evaluator felt there was great collaboration among Argonne, coater, and many engine OEM's: Galleon International – Hauzer Techno Coating – Several engine OEMs, including transaxle and fuel injection system manufacturers, engine part suppliers, racing teams, and car manufacturers – and Argonne National Laboratory. The fourth reviewer reported the presentation mentioned talking with many OEMs, but no names were provided. Two companies, coating developers are involved indicating the usefulness of the technology.

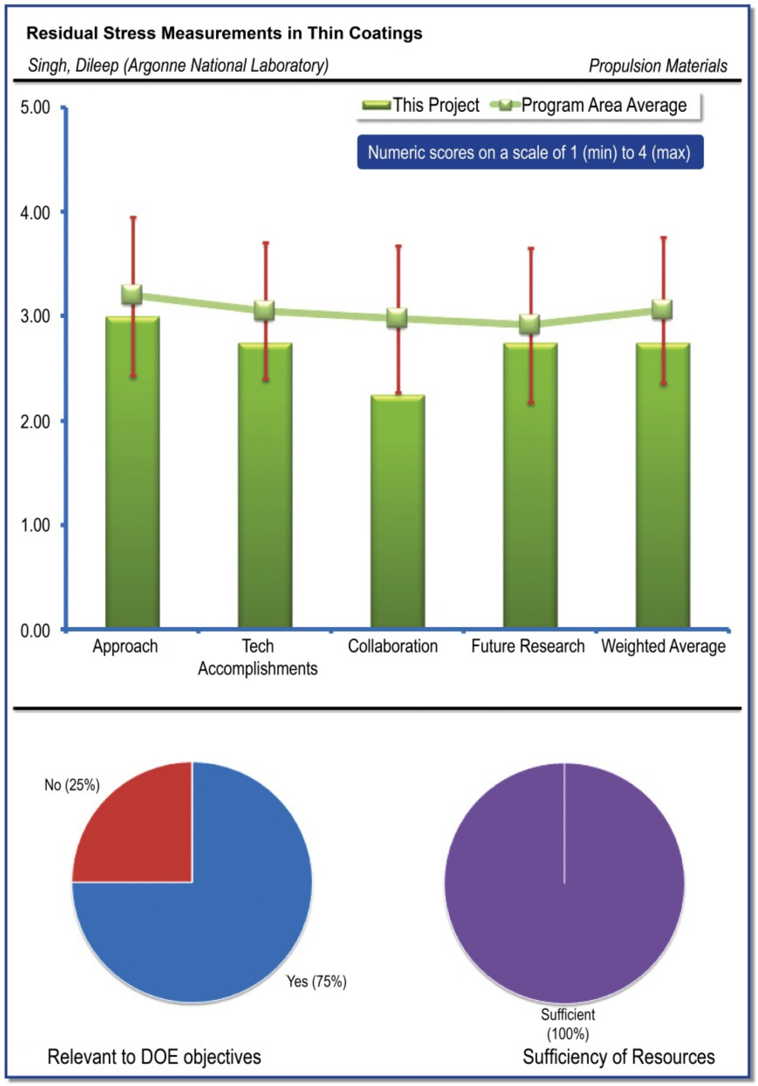
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Two commentators liked proposed research. The first reviewer thought this project was well laid out. The future work is well defined and appears to be appropriate. The second reviewer responded that the proposed future research looked good. Long-term durability of the coating under actual engine operation conditions is still yet to be demonstrated. The actual benefits of fuel consumption data need to be gathered, and the project needs to show the cost benefits of this new coating process.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer stated that resources appear to be appropriate for this project.

Residual Stress Measurements in Thin Coatings: Singh, Dileep (Argonne National Laboratory) – pm031



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Reviewer feedback was positive. The first reviewer thought that this project does not appear directly to support petroleum displacement, but as it complements other work in the area of low-friction, high-durability coatings for drivetrain parts, it can be viewed as indirectly supporting such goals. A second reviewer commented that this is an enabling technique that allows accurate measurements of thin coatings that can be used to reduce friction and wear of engine components. A third reviewer agreed that this is an enabling project which will enable design efficiencies through the better use of coatings. The final reviewer felt that the friction reduction coating process was far from the application in real life conditions. Any savings proposed will not be realized in a short time.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Two of three responses praised the approach, the first reviewer claiming that the approach appears to be excellent, and the other evaluator said that the following approach looks fine. The key challenge will be how to correlate the measurements to the actual durability of coating. The second reviewer also went on to suggest developing or refining high energy x-rays for profiling residual strains in thin coatings by measuring the change in the lattice parameter of the coating constituents, depositing low friction high wear resistance coatings and profile residual stresses, developing nanoindentation & scratch-based techniques to measure hardness, fracture toughness, and adhesion energy of thin coatings, and relating residual stresses, mechanical & tribological properties, and processing to coating durability. The third reviewer stated that this project used various testing methods and characterization technologies to measure the quality of the coatings on surfaces. It was claimed, though not explained, that the residual stresses are important in controlling the performance of anti-friction coatings.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Two of the three responding panelists saw progress. The first reviewer responded that progress toward improving adhesion through measurement of residual stresses appears to be very good. A second reviewer saw good progress made in the project: Cross-sectional micro-diffraction have been used for studying strain gradient in nanocrystalline MoNCu films deposited on silicon and steel substrates. As-deposited MoN film is under in-plane compression; effects of Cu additions on coating adhesion and tribological performance was investigated; and coating processing variables and resulting properties are correlated to their structure and can be used to optimized for enhanced tribological performance by optimizing adhesion energy. The third reviewer thought that the interface between the substrate and the coating is not explained well but the quality of the coating was analyzed; the reason for spalling needs to be related to the interface strength.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first reviewer thought that collaboration appears appropriate for this project. A second reviewer stated that this effort has some partners who had provided coatings for evaluation, as well as internal collaboration with other groups in ORNL. A third panelist concluded per the presentation that collaboration with industrial organizations will increase in the coming year. To date, however, there did not appear to have been strong collaboration/coordination with other institutions and organizations. The final panelist felt that this project was mainly to support another internal project within ANL, and that the project needs to seek industrial partners.

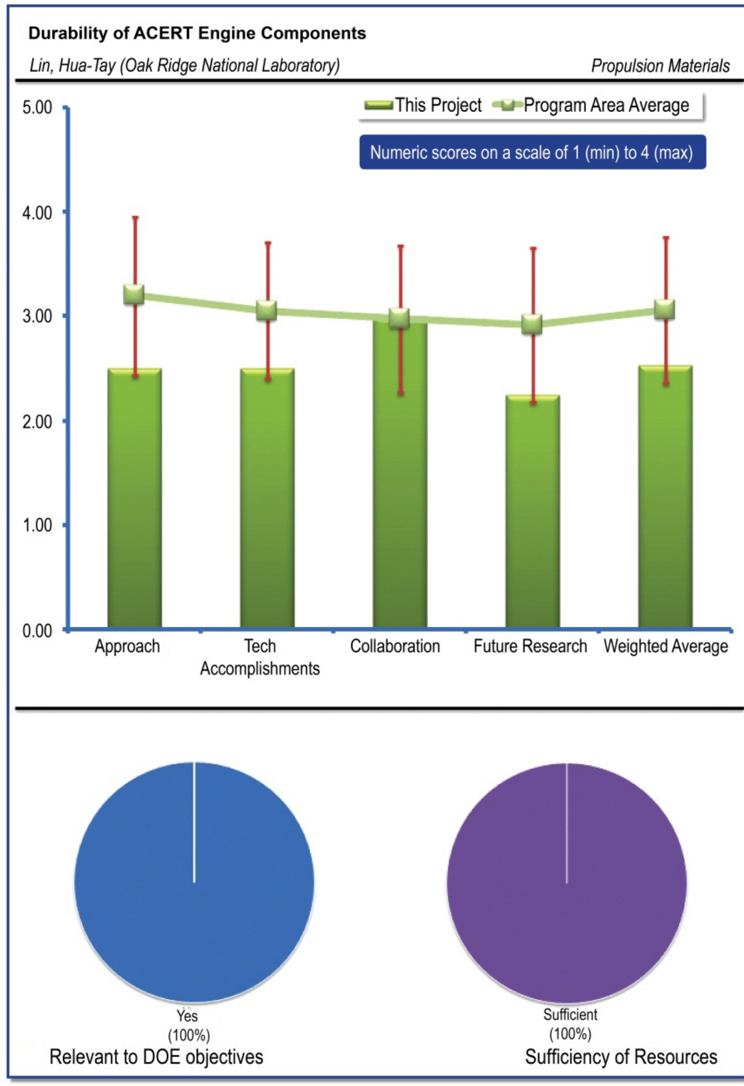
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Two reviewers liked the proposed future research. One reviewer said that future work proposed appears to be well laid out. The other evaluator thought the proposed future approach looks fine. The proposed future research is to include: Complete adhesion energy evaluations for TiC and ZrN; complete mechanical properties of TiC and ZrN coated samples for varying processing conditions; measurement tribological performance for TiC, and ZrN coated samples; correlation of the measured residual stresses in ZrN, TiC coatings to tribological properties and processing; and initiation of discussions with coating manufacturers for collaboration.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer responded that resources appear to be appropriate for this project.

Durability of Advanced Combustion Emission Reduction Technology (ACERT) Engine Components: Lin, Hua-Tay (Oak Ridge National Laboratory) – pm033



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first reviewer stated that improving the thermal efficiency of engines can contribute significantly to the petroleum displacement. A second reviewer considered there to be several elements to this research, one of which is application of thermal barrier coatings to an exhaust manifold. Fuel efficiency will be improved by preserving thermal energy for downstream turbomachinery and, in the near future, waste-heat recovery systems. The final commenter thought that this program, now apparently complete, was relevant to DOE's petroleum conservation goal since it explored means to protect HDD engine components from higher temperatures resulting from operation either in new combustion regimes or from straightforward high-temperature/pressure operation, both of which can increase thermal efficiency and/or power density. The final reviewer also thought that it was unusual to review a project retrospectively when all chance of modifying its direction or approach was gone. Though the reviewer acknowledged that this exercise was not necessarily without value, as it may yet offer insights into how future projects of a similar nature can be improved, the reviewer opined that it is kind of weird, nonetheless.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A range of sentiments from three reviewers were expressed. The first reviewer responded that the project objective is to examine the cause of failure in material used for components in diesel engines. Diverse examples are presented including testing of ceramic materials and thermal barrier coatings. A second panelist concluded that the approach employed in this project probably should be evaluated as lying somewhere between "good" and "outstanding"; “very good," perhaps. The third evaluator thought that the 2011 presentation did not convey a well-focused approach. Work jumped from exhaust valves to turbocharger wheels to exhaust manifolds. Any of these would have been worthy of a separate project. This impression may simply be a consequence of how the presentation was constructed as a summary of research effort over the life of the project. The approach has the flavor of guess and try, which is especially evident in the exhaust manifold thermal barrier coating (“we tried a coating and it spalled”). A deliberate approach based on the underlying physics was not obviously conveyed by the presentation. Research aimed at an understanding of the physics became more evident in the development of the Al-oxide coating and process.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first observer felt that some good work has resulted from this project. Durable thermal barrier coatings can be of immediate benefit to fuel efficiency. The benefit from the exhaust valve work (beyond speculation of durability of alternate materials) and the turbocharger wheel work is not evident in the presentation. A possible outcome is that the knowledge and learnings gained in the work on these two components are not documented and shared beyond the one industrial partner. It is possible that this was done in the earlier years of this project. If so, the current presentation is just deficient in summarizing the technical findings. The second reviewer found that the technical accomplishments were probably useful, ultimately, despite the results, which appear to have been somewhat disappointing. Is there ongoing effort to evaluate ORNL's alternative thermal barrier coating technique? The performance of the thermal barrier coating (TBC) assessed in this program appears to have been unacceptable for industrial application. The final reviewer stated that the project is mostly characterization and testing of various materials used in engines. No conclusions are drawn from the failure of TBC or the fatigue failure of ceramic valves. This was a very simple testing and data analysis project. A new coating process has been reported as developed at ORNL. Is there any Intellectual Property (IP) protection process being followed for this new invention?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first evaluator stated that this project was part of a CRADA and only one OEM is involved. A second commentator thought that collaboration was clearly evident with the industrial partner Caterpillar. The third reviewer deemed that the collaboration with a HDD engine manufacturer was appropriate. However, the specific industrial partner has since exited the on-highway truck engine market in the USA.

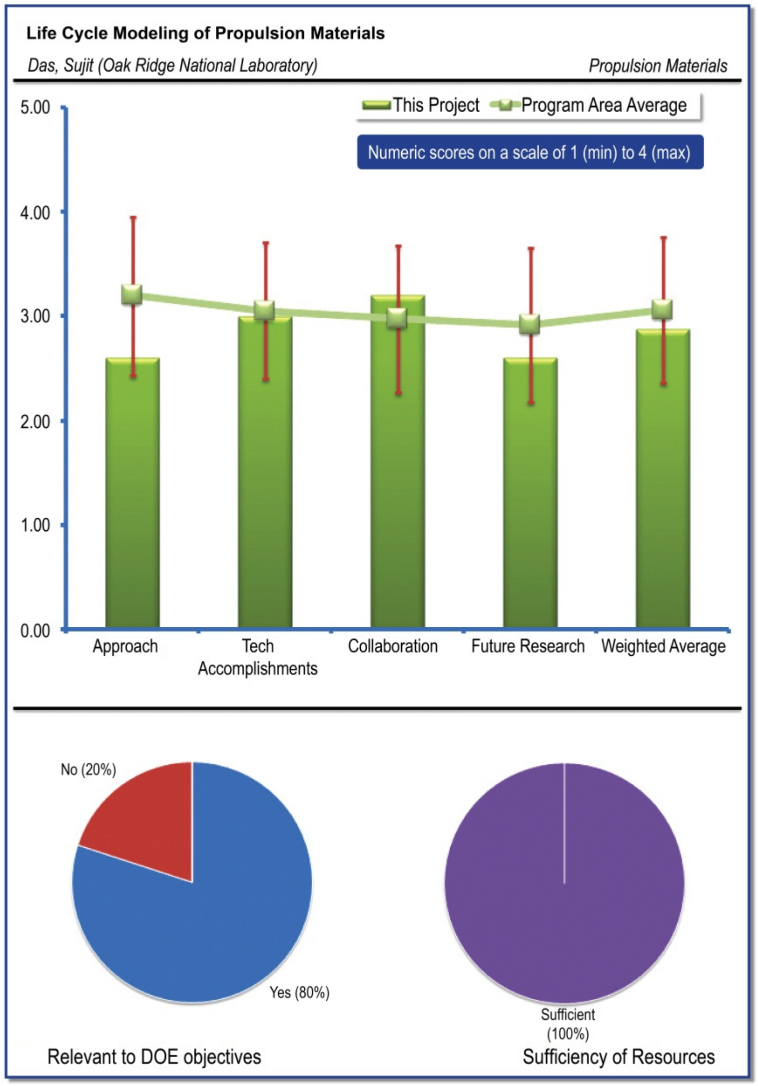
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The first commenter stated that this project was listed as completed in September 2010. Future plans are for development and commercialization by the industrial partner. The second commenter reiterated that this was a completed project, and a third evaluator reported that no follow-on work was presented.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that the Al-oxide coating looks promising. This reviewer does not think the coating’s performance or process was developed as far as would be required for commercial application. The project scope leaves this in the hands of the industrial partner.

Life Cycle Modeling of Propulsion Materials: Das, Sujit (Oak Ridge National Laboratory) – pm034



REVIEWER SAMPLE SIZE

This project had a total of five reviewers.

QUESTION 1: DOES THIS PROJECT SUPPORT THE OVERALL DOE OBJECTIVES? WHY OR WHY NOT?

Only one reviewer directly disputed this project's support of DOE goals. A first reviewer stated that this project looks at the impact of lightweighting versus using lightweight materials on the GHG and fuel consumption of the engines. A second evaluator believed that either downsizing or lightweighting will lead to DOE's objective of improved fuel efficiency. This project attempts to quantify which approach may be better and under what circumstances and assumptions. The project has a second goal of understanding the energy benefits of CF8C+ cast austenitic stainless steel. The third reviewer commented that the project enables a cost optimized choice of future materials options and design principles, which is critical information for bringing the innovations to the market and reducing fuel consumption. The final reviewer said that it was difficult to see how this project supports the DOE goal of petroleum displacement, even indirectly. While life-cycle analysis of the relative fuel consumption/energy/environmental benefits of vehicle lightweighting vs. engine downsizing, etc. is potentially illuminating, this project is unlikely to influence those decisions, which will be made by individual vehicle/engine builders based on a host of factors of which life cycle (LC) is only one. Nonetheless, the stark contrast in life-cycle costs and environmental impacts of engine turbocharging/downsizing vs. engine lightweighting is significant and probably worth considering in other Propulsion Materials projects. The same is true of the project's findings concerning the LC impacts of magnesium in engine construction.

QUESTION 2: WHAT IS YOUR ASSESSMENT OF THE APPROACH TO PERFORMING THE WORK? TO WHAT DEGREE ARE TECHNICAL BARRIERS ADDRESSED? IS THE PROJECT WELL-DESIGNED, FEASIBLE, AND INTEGRATED WITH OTHER EFFORTS?

A variety of comments were made by four reviewers. The first reviewer thought that a lot of assumptions were made in doing the life cycle modeling in determining GHG emission and cost benefits. The second panelist concluded that this project takes a systems level view to the effectiveness of an approach for achieving fuel efficiency. It is important to look at more than one component in isolation. The third evaluator felt the approach to be straightforward, however, a larger sample size for establishing the baseline and downsized engines would increase the insight and value of the outcome of the project. The fourth reviewer was left wondering why one of the project's two focuses was on utility steam and combustion turbine construction materials when the project is sponsored by the Vehicle Technologies Program.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first of four responding panelists thought that good progress was made, especially with respect to the comparison between baseline and downsized. The energy saving prediction for CF8C+ for 2020 to 2025 should take into account that new material developments will occur. Most likely more cost effective material solutions will become available or engine developments may ask for new solutions. The second reviewer concluded that some progress was made in doing life cycle analysis on lightweighting versus downsizing. It is interesting to see that there was only 1% fuel economy improvement by substituting lightweight materials. The second reviewer found it interesting that life- cycle modeling determined the relative energy, GHG emissions, and cost-effectiveness benefits of two competing lightweighting engine design options, i.e., downsized and turbocharged vs. lightweighting using magnesium; F8C+ has been demonstrated successful in several high-temperature applications, including its cost-effectiveness and so a life cycle energy assessment in potential future markets is consequential; and that several analysis levels considered, starting with raw material manufacturing and ending with component use and recycling. The third panelist reported that the project reached a conclusion that engine downsizing is a preferred approach compared to component lightweighting from both energy and cost perspectives. This conclusion is logical and is consistent with how the market is moving.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Responding reviewers saw good collaboration. The first panelist thought that while most of the work seemed to have been done by ORNL, the level of collaboration is appropriate for a project of this nature. The partners are serving as sources of information and review of work. The second observer reported that a large consortium is contributing to this project with a good representation of the value chain. The third reviewer stated that there was good collaboration among several entities: Honeywell Turbo Technologies – identification of market and energy savings potential of CF8C+ in automotive market; Siemens –turbine manufacturer; MetalTek International –high alloy casting components manufacturer; FEV Inc. –turbocharged and diesel automotive engine manufacturer; University of Tennessee, Knoxville, TN –life cycle analysis of alternative lightweight engine designs; and several high alloy raw material and component manufacturing suppliers

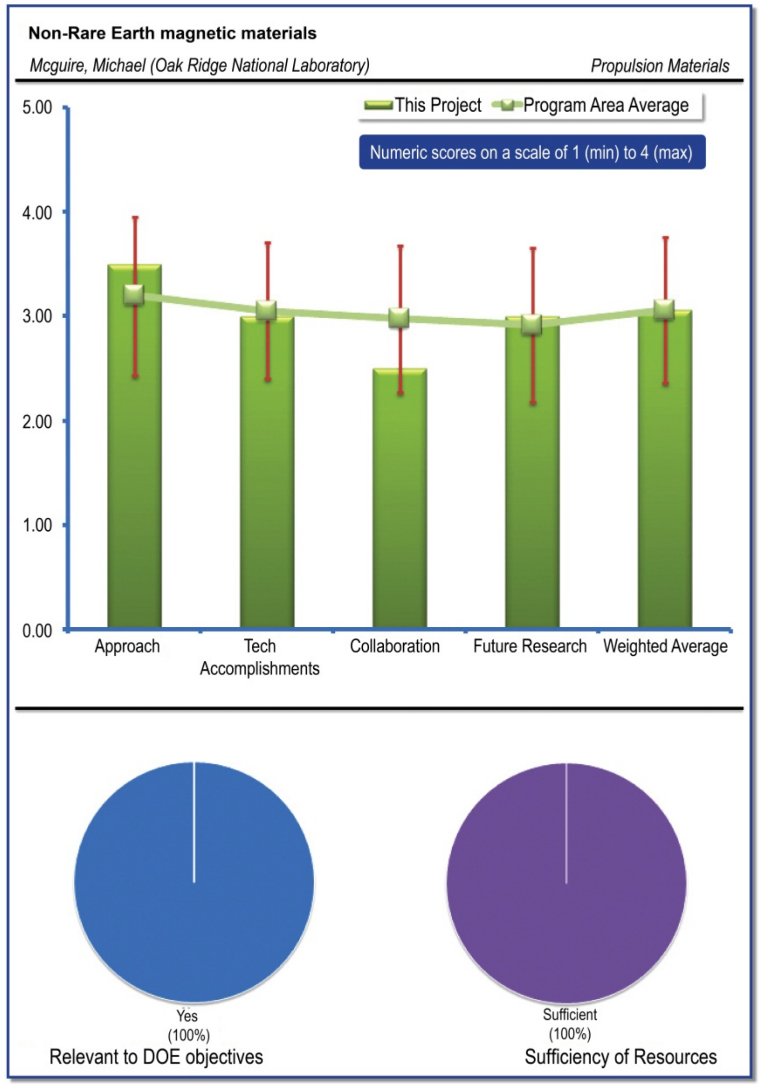
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Four reviewers saw logical plans, although one questioned the premise, and the fifth offered future direction. The first reviewer considered the plans to evaluate the life cycle costs of higher capability materials to be consistent with the industry direction moving towards higher operating temperatures and pressures. The second analyst thought the topics mentioned were of clear interest and built on already available results. For this specific project it was difficult to assess the relation with the plan since it has no clear finishing date. The third observer saw a good future plan including life cycle impacts of alternative materials and materials-processing techniques that enable development of higher-efficiency conventional powertrains for ground transportation; viability of advanced propulsion materials in advanced powertrains such as hybrids and fuel cell vehicles; life cycle analyses considering economic, energy, and environmental impacts of advanced propulsion materials' manufacturing technologies with an emphasis on aluminum, magnesium, titanium, and ceramics; and advanced propulsion materials' potential in heavy-duty vehicles. The fourth panelist expressed continuing concerns regarding the premise of the work itself, although the proposed future research follows logically from the results of work performed to date. The final reviewer suggested that methods for assessing durability and cost-effectiveness needed be considered for future analysis.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One commenter thought the level of resources to be sufficient for a project of this type. Another reviewer said the budget must be sufficient for this amount of analysis. A third reviewer thought funding for work performed to date and proposed future research in this area is at least sufficient, if it is granted that the work contributes meaningfully to the attainment of DOE/EERE goals.

Non-Rare Earth Magnetic Materials: Mcguire, Michael (Oak Ridge National Laboratory) – pm035



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Three evaluators explained how this project supports DOE objectives. The first reviewer thought this project to be highly relevant, supporting DOE goal of petroleum displacement and dependence on petroleum products. The second evaluator stated that reducing or eliminating rare earth materials can have significant impact on reducing the traction motor's cost. The third reviewer explained that high-performance permanent magnets represent are a very large factor in the cost of electric motors for electric and hybrid-electric vehicles, which is a major barrier to their wider adoption. EVs and HEVs, if deployed in significant numbers could effect considerable petroleum displacement. The cost of rare earth elements in turn is a significant factor in the cost of high-performance permanent magnets. Moreover, according to this reviewer, rare earth elements are obtained largely from non-domestic sources at present, and this isn't expected to change much anytime soon. Therefore, determining if effective, domestically available and lower-cost substitutes to these materials can be found is important.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first of three commentators stated that establishing a go/no go decision point in the next year of the project is an excellent idea. By that time, it should be clear whether the project approach is worth pursuing. The second reviewer thought the approach appeared to be technically sound. This reviewer suggested that while trying to identify the magnetic material, investigators should consider how to manufacture the end composition magnet and to what quality control standard. This may be a high risk/high payoff effort, but the effort could only produce a laboratory curiosity if the end product magnet cannot be produced on a large scale. The third panelist claimed not to be an expert on the topic, but it seemed that the material scanning/selection process is done in a methodical well thought through way.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first reviewer reported good progress in producing samples of various materials and quantifying the properties. The second panelist thought that while the overall project is technically sound, the accomplishments suggest significant hurdles to overcome - beginning with the optimum crystal composition. No suggestion on any other elemental combinations. The second reviewer did suggest reviewing any strategic ores for possible sources of scarce elements. The third respondent agreed that, as the author indicates, "It is likely that the most significant advances will come with the discovery of entirely new materials." This program had a good start on addressing this critical issue of non-rare earth element magnetics.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Two reviewers suggested expanding collaboration. The first reviewer thought this effort needs to be more coordinated with the efforts taking place at Ames National Lab trying to solve the same problem. The second reviewer stated that this project seems to be conducted wholly within ORNL and the OR Associated Universities. This is not necessarily a criticism; wider collaboration may not be advisable or necessary.

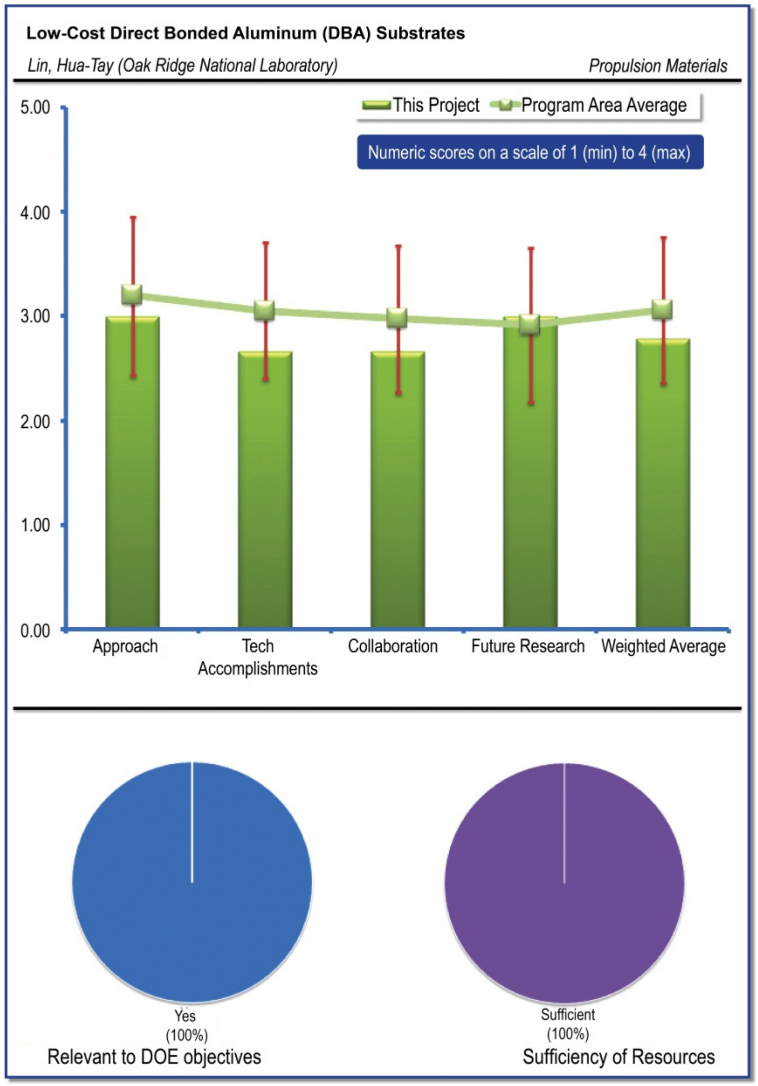
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The first commenter acknowledged that there does not appear to be any great interest at this time. Interest may depend upon achieving an optimum magnetic crystal composition. The second reviewer thought there was good recognition of the possibility of requiring new materials, and planning on doing this in FY2012.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were made on resources.

Low-Cost Direct Bonded Aluminum (DBA) Substrates: Lin, Hua-Tay (Oak Ridge National Laboratory) – pm036



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Two reviewers discussed how the project relates to DOE goals. The first evaluator explained that ensuring the viability of high-power electronics in electric and hybrid-electric vehicles is a key to the feasibility of placing significant numbers of such vehicles in the national fleet. If that can be achieved, considerable petroleum displacement can be expected. A key to the durability and reliable function of heavily loaded power electronics is managing the heat they produce. DBA substrates may play a key role in that function. The second analyst surmised that the main focus is to reduce the cost of DBA substrates used in power electronics. The goal is to develop a low-cost bonding/assembly technique to significantly reduce the cost (a factor of 10 is targeted). This has the potential to reduce the PEV (HEV/PHEV/EV) vehicle costs from $500/vehicle to $50, which will incrementally help to increase PEV adoption, and thus petroleum reduction.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Two respondents described the approach. The first reviewer noted the presenter’s reference to "Use ORNL’s in-house unique processing capabilities to fabricate innovative DBA substrates using a process that is amenable for mass production and that produces high adhesive strength of the ceramic-metal interfaces." However, according to the reviewer, there is no way to determine exactly what the development pathway is, since it is not discussed. The second respondent reported that the project is focused on addressing the two major factors affecting DBA, 1) AIN substrate material fabrication, and 2) Al-AIN bonding techniques. In both cases the goal is to significantly reduce the cost. Collaborations are intended to push the ultimate results into U.S. manufacturing (breaking the Japanese supplier monopoly) to create a low-cost, high-quality local supply for the U.S. power electronics manufacturers and customers. U.S. jobs will also be created by domestic manufacturing base.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

All three reviewers thought it too early to tell the accomplishments, one reviewer said that work on the project had just began, so the progress was fine. The presentation showed the intended work plan, but no results. A second evaluator thought that, strictly speaking, it was probably too early in this project (16% complete) to assess its technical accomplishments. However, the "good" rating is justified prospectively on the basis of the focused and logical approach to the work. The third reviewer agreed that it was too early in the development to evaluate the program. Results were still not there.

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

The first reviewer stated that collaboration outside ORNL is anticipated to commence in the next fiscal year. Analogous to Item 3, above, the score in this category reflects the fact that this project in its very early stages, rather than any perceived deficiency. The second reviewer reported the project team (materials scientists/engineers) is coordinating with the ORNL National Transportation Research Center (NTRC) (engineers) to bring the understanding of the whole vehicle performance. NTRC's direct contacts/existing collaborations with automotive OEs/suppliers gave the project team more direct access to industry for data, samples, and direction. General Motors and Delphi are collaboration targets since they are major U.S. power electronics manufacturers/suppliers.

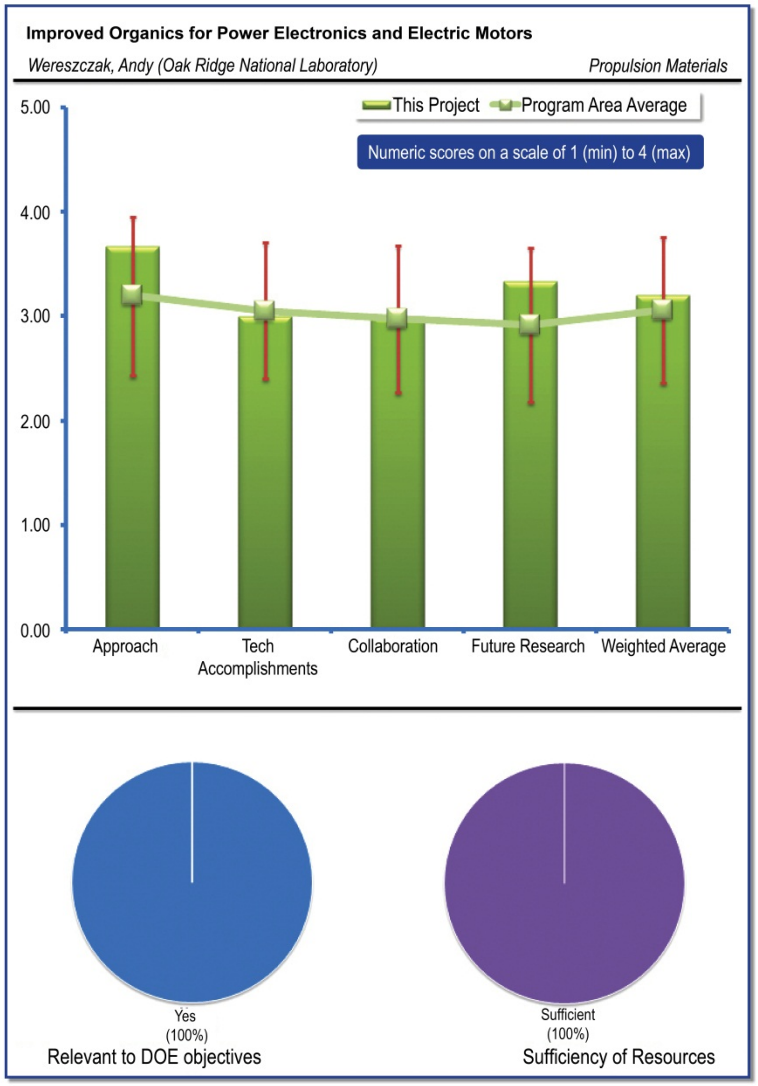
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

One panelist responded that since work on this project just began, all of the proposed work is future work. The proposed research plan looks sound.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

One reviewer believed that resources for current work and work proposed for the next fiscal year are probably sufficient. As substrate fabrication gets going, additional funding might be desirable. The other reviewer relayed that project materials costs were estimated at ~$120K (40%), so the remaining funds cover roughly 0.4 man-years, which seems appropriate for the amount of work and potential benefits. The researcher felt that the goals could be accomplished with this level of funding. Collaborations being pursued with General Motors and Delphi could likely result in cost-shared material donations which would increase usable labor budget.

Improved Organics for Power Electronics and Electric Motors: Wereszczak, Andy (Oak Ridge National Laboratory) – pm037



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first reviewer stated that ensuring the viability of power electronics in electric and hybrid-electric vehicles is a key to the feasibility of placing significant numbers of such vehicles in the national fleet. If that can be achieved, considerable petroleum displacement can be expected. A key to the durability and reliable function of heavily loaded power electronics is managing the heat they produce. Organic molding compounds can be expected to play a key role in that function. The second reviewer concluded that the use of modified high-thermal conductivity epoxies has the potential to allow for significant redesigns to power electronic hardware to simplify the part numbers, part designs/sizes, and cooling schemes. The end result is that the complexity, mass, and cost of power electronics would decrease. As such, the technology being investigated is an enabling technology for design improvements. This reviewer continued that lower cost will incrementally result in higher PEV adoption and thus petroleum reduction. The reduced component size and mass will incrementally result in a smaller more energy efficient vehicle.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first respondent thought the approach appeared to be logically designed. The second reviewer said the approach appeared acceptable to identify materials for thermal management strategies.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first commenter thought that it was too early to evaluate this program. Another evaluator agreed, saying that strictly speaking, it is probably too early in this project (16% complete) to assess its technical accomplishments. However, the "good" rating is justified prospectively on the basis of the focused and logical approach to the work. A third reviewer pointed out that work on the project began in March 2011, so only 2 months of work has occurred, so the progress is fine.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first observer reported that one private-sector collaborator was identified; assessing coordination between that organization and ORNL is not possible based on available information, but it is assumed that ORNL will make good use of the partner's capabilities. The second observer stated that the project team (materials scientists/engineers) is coordinating with the ORNL NTRC (engineers) to bring the understanding of the whole vehicle performance. NTRC's direct contacts/existing collaborations with automotive

OEs/suppliers gave the project team more direct access to industry for data, samples, and direction. According to this reviewer, General Motors is listed as a partner, but is more of an "interested party" in the data and results. The project team will also work with epoxy manufacturers, although this may be on a supplier/customer level.

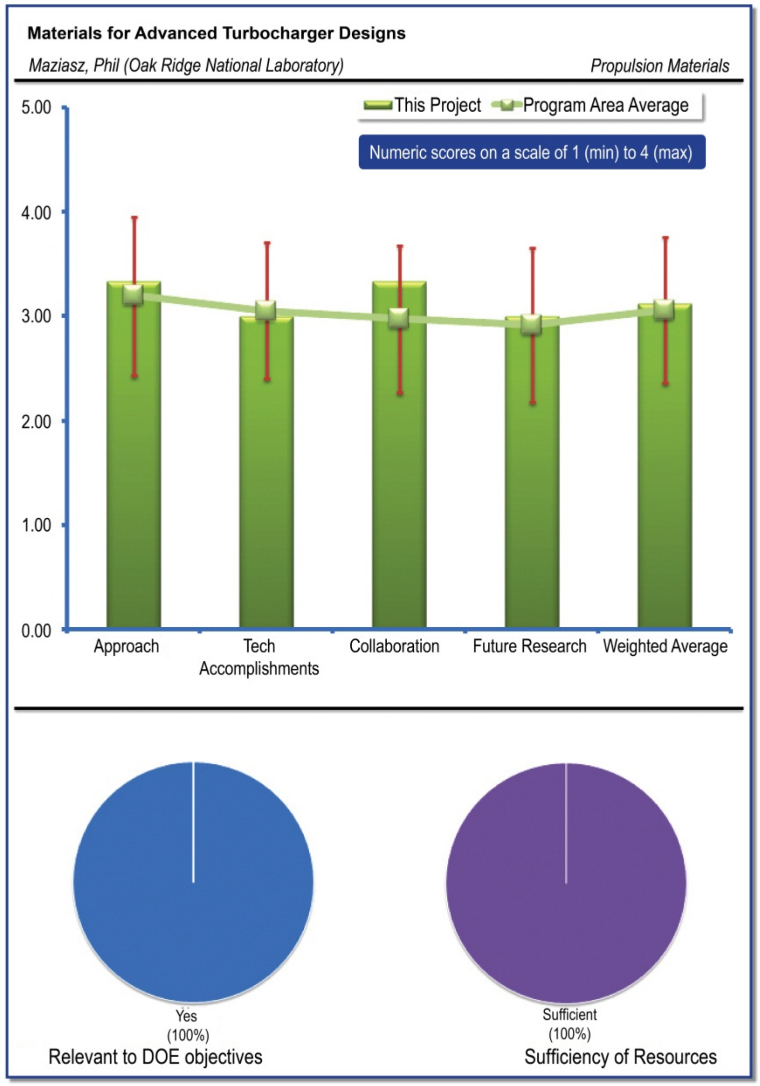
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A commenter stated that since work on this project just began, all of the proposed work is future work. The proposed research plan looks sound.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One panelist reported that project materials costs were estimated at ~$40K, so the remaining funds cover roughly 0.5 man-years, which seems appropriate for the amount of work and potential benefits. The researcher felt that the goals could be accomplished with this level of funding.

Materials for Advanced Turbocharger Designs: Maziasz, Phil (Oak Ridge National Laboratory) – pm038



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first reviewer claimed that this project appeared to be able to directly improve engine efficiencies. The second panelist concluded the project focused on improving the heat resistance of components by means of improving the material properties. This will lead to improved fuel efficiency. The third panelist responded that turbocharging is a thoroughly proven technique for increasing the maximum power density of IC engines and that, in turn, permits significant engine downsizing with concomitant petroleum fuel conservation potential. Raising the temperature tolerance of turbocharger components allows those devices to be applied to more highly stressed (thermally and mechanically) engines, which also increases power density and thermal efficiency. It also allows the weight of the turbo to be decreased, with further fuel conservation benefit.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first respondent thought the approach for this project makes a lot of sense. ORNL appears to have a good understanding of the issue. The second respondent judged the approach to show much emphasis on improving the performance of the housing. An equal important or perhaps even more important aspect is improving the performance of the wheel. No approach is given to improve the performance of the wheel only a study of the residual stresses was mentioned. For the residual stress measurement activity a further experiment could add significant value; measuring the residual stresses after a short time operating the assembly in a turbo application.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first panelist reported that good progress has been made, and an improved design appears inevitable. The second reviewer commented that the material was developed in an earlier project, and a number of material data was already available at the beginning of the project. Only first experiments on measuring residual stresses were available.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first reviewer thought that collaboration appears to be appropriate for the project. The second reviewer reported that only cooperation with Honeywell was mentioned, and that a wider group of potential users of the material could improve the contribution to reduction of fossil fuel import. The third reviewer considered Honeywell to be an obvious choice of industrial partner for this project, who appears to be interested in commercializing the results of this research. Its 50% cost share is also commendable.

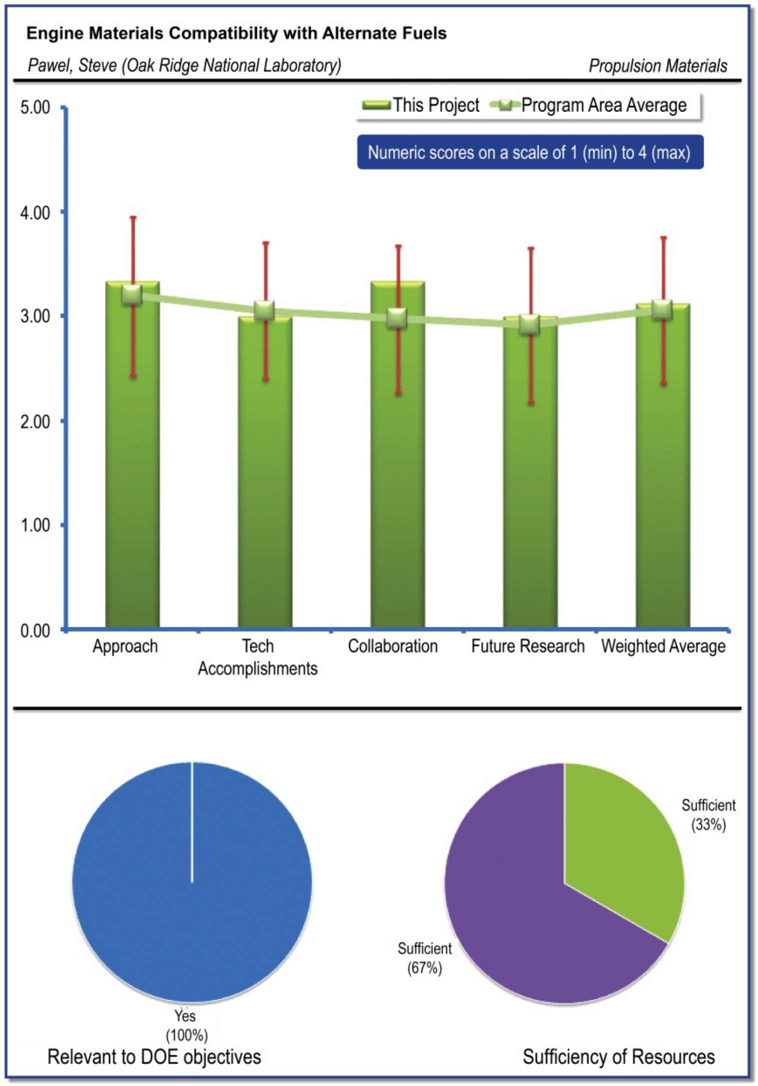
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The first panelist deemed future work to be appropriate. The lion's share of the improvements has already been done, and the validation of the alloy proposal appears to be appropriate. The second panelist concluded that total turbo system improvement measurements are not incorporated.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The first respondent thought resources appear to be appropriate. The second reported that the budget is in agreement with work mentioned.

Engine Materials Compatibility with Alternate Fuels: Pawel, Steve (Oak Ridge National Laboratory) – pm039



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first reviewer concluded that use of alternative (non-petroleum-based) fuels self-evidently supports the objective of petroleum displacement. A second evaluator believed that an understanding of the long-term material effects of alternative fuels (ethanol in this case) on engine components is critical to the long-term market acceptance of ethanol fueled vehicles which reduce petroleum fuel usage. Enabling higher ethanol blend percentages further reduces petroleum usage, so also meets DOE's goals.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first reviewer thought that with respect to the ongoing literature search portion of this project, this reviewer recommended consulting the final report on ethanol fuels prepared for the DOE Alternative Fuels Utilization Program by Union Oil of California. Notwithstanding its age (1979), it represents solid research that may still be of use to this project. If it is no longer available through the National Technical Information Service (NTIS), the reviewer’s personal copy can be made available (Ethanol Fuel Modification for Highway Vehicle Use -Final Report; ALO-3683-T1). The second reviewer considered the combination of lab testing of material coupons and field aged samples to be good. Field test samples are provided by partner USCAR members as well as ORNL track and dynamometer aging. A correlation between the time effect difference between accelerated dyno/track testing and real-world use needs to be developed to ensure results are realistic; the researcher acknowledged this and is including it in the research. This reviewer continue to remark, the in-situ test method will provide interesting real world, and real-time information. The researcher mentioned that the test matrix is limited by the funding, and that additional funding would allow the inclusion of non-metal parts (e.g., hoses and gaskets), post-combustion chamber components, and a wider range of ethanol blends that would include high-level blends. The apparent current focus on lower-level ethanol blends may be too limited and not fully be meeting the intended project goals.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first reviewer reported that work on project started about a year late, so has only been in place for about seven months. The second reviewer said that if this project was started in December 2010, seems too early to be able to evaluate the program.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first panelist thought that major U.S. automakers are obviously excellent choices of collaborators and cost share is good, also. The second panelist explained that a CRADA has been established between ORNL and USCAR (General Motors is prime, Ford and Chrysler also participate). The OEs lead the determination of which parts should be studied. The OEs also contribute new and field-aged representative parts and provide a technical resource to ORNL. The collaboration seems to be well organized and functions well to focus on the industry's needs. The researcher was asked whether they had a direct connection with Brazil to tap into their long experience with high ethanol levels. The researcher responded that they get information (not data) third hand from Brazil (i.e., Brazil original equipment [OE] --> U.S. parent OE --> USCAR --> ORNL). The reviewer did not get the impression that this was effective and that there may be a lot of prior learning by Brazil that can speed the work (and reduce the cost and development time) in the States.

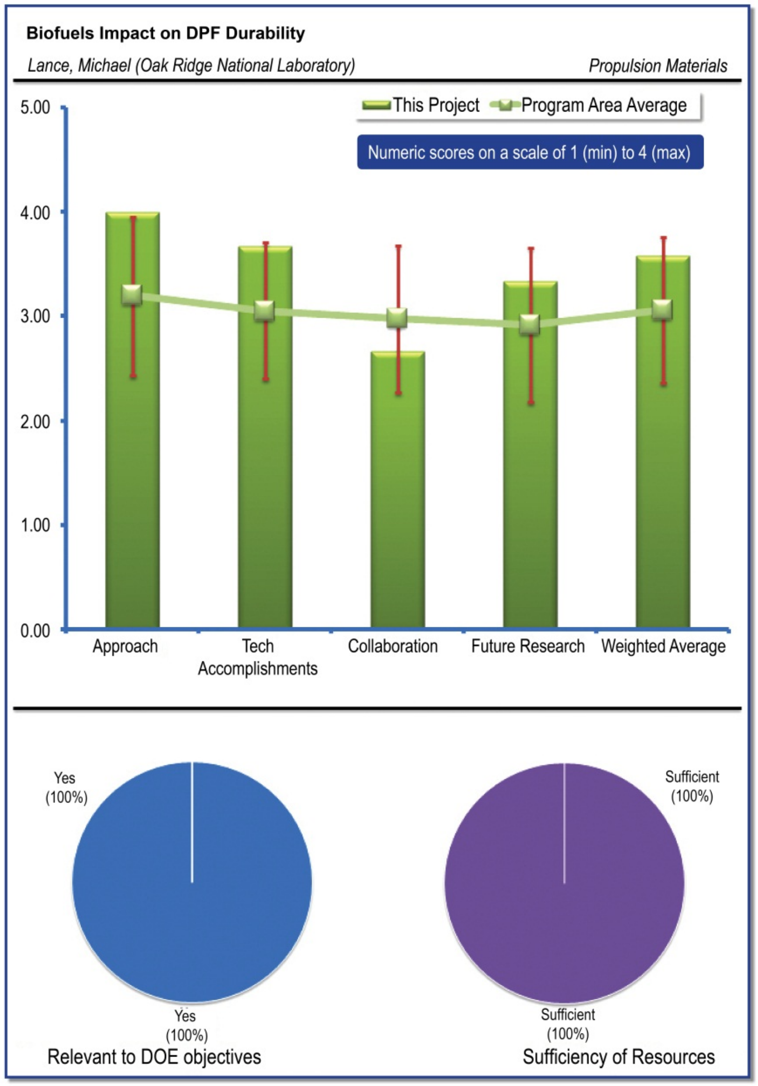
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One evaluator relayed that the researcher mentioned that the test matrix is limited by the funding, so does not include non-metal parts (e.g., hoses and gaskets), post-combustion chamber components, and a wider range of ethanol blends that would include high-level blends. It was implied that including these was necessary, but was not done because of financial constraints.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The first reviewer estimated funding to cover ~0.75 engineer-years, so given the extensive dyno/track sample aging the funding seems appropriate for the work. The researcher mentioned that the test matrix is limited by the funding, and that additional funding would allow the inclusion of non-metal parts (e.g., hoses and gaskets), post-combustion chamber components, and a wider range of ethanol blends that would include high-level blends. It was implied that including these was necessary, but was not done because of financial constraints. This reviewer suggested reevaluating whether these materials and ethanol blends are necessary so the project evaluates all relevant components.

Biofuels Impact on DPF Durability: Lance, Michael (Oak Ridge National Laboratory) – pm040



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first reviewer thought that this project supports the petroleum displacement objective, albeit somewhat indirectly. Diesel-engine vehicles offer the potential for significant petroleum displacement, but must be equipped with PM filters and will assuredly be exposed to alternative fuels during their lives. Therefore, the effects of biodiesel-blended fuel on their emission control systems must be understood and means developed to ameliorate any damaging effects. The second panelist said that compression ignition engines decrease petroleum use, using biofuels in them further reduces petroleum usage, so the project goal to understand the DPF aging/damage from biodiesel is critical to ensure long life to minimize the lifecycle costs for consumers so they choose this powertrain/fuel option.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first respondent said that the approach was good and detailed, using real-world engines to load PM and then performing detailed laboratory analyses to determine the effects. The second respondent deemed the experimental plan to determine the effects of biodiesel blends on engine components to be well laid out. Identifying microstructure and material property changes will be critical to be able to devise strategies to improve engine performance.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first panelist commented that the presentation noted that sodium and potassium are known to be present in biodiesel. This suggests that the alkaline catalysts (NaOH, KOH) used in biodiesel production are not being fully removed from the finished product. Was it conclusively shown that the biodiesel used in the test program met all specifications of ASTM D 6751? The second panelist noted that significant effort and progress has been made.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first reviewer concluded that from the presentation, it was not possible to evaluate the degree of collaboration/coordination with the industrial partners in this project, but those have certainly been well chosen, and it can probably be assumed that good coordination exists between them and ORNL. Another reviewer responded that GM is listed as a project partner, but they are involved only through the sharing of ORNL results to GM because they have an interest in the results. GM is not actively involved. NGK provides ORNL with samples to test, but also is involved by performing characterization tests that ORNL cannot do. Discussions with

NGK regarding corrosion also occur, but it is unclear the level of overall collaboration. For this project, this level of collaboration may be all that is necessary.

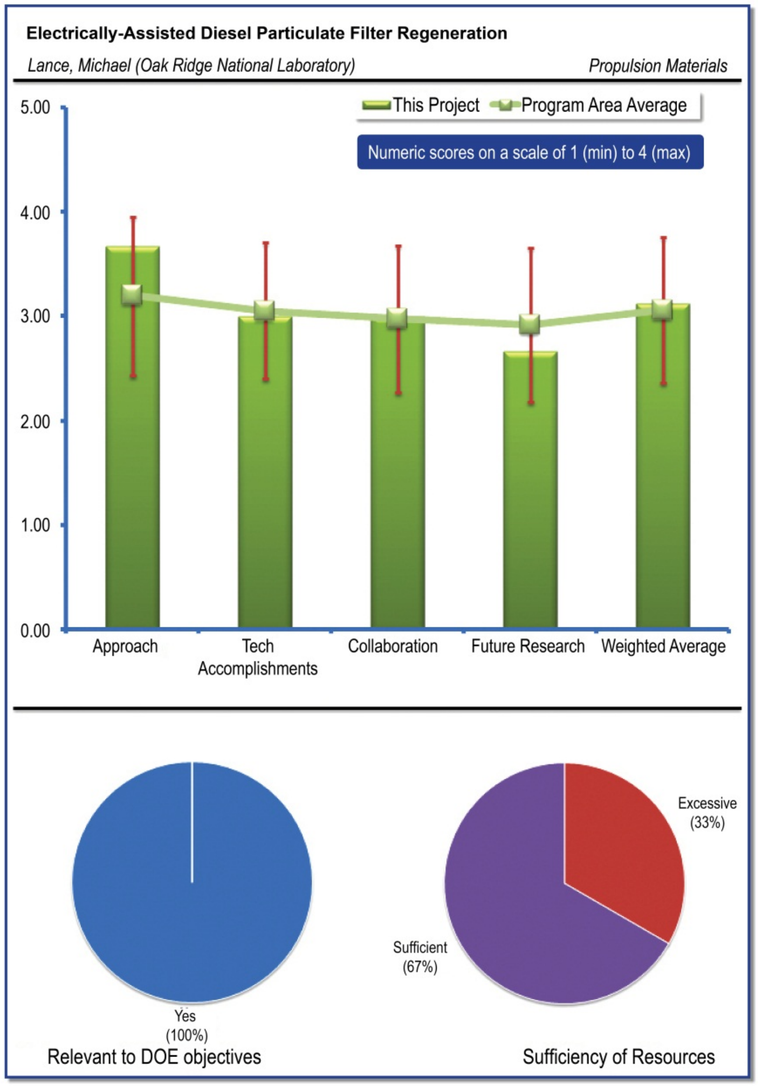
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer predicted that future tasks will focus on DPF degradation and regeneration effects. Given that a significant amount of effort and progress has been made in the first 50% of the project, the remaining tasks do not appear to require the remaining 1.5 years.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The first reviewer found that funding level certainly seemed adequate, at the least. Total ($1.05 M) strikes this reviewer as possibly slightly excessive. The second reviewer relayed that the researcher felt that the funding level was sufficient to accomplish the project goals. Given that there is a lot of engine testing which requires a long time and detailed lab testing, this reviewer agreed that the funding seems appropriate.

Electrically-Assisted Diesel Particulate Filter Regeneration: Lance, Michael (Oak Ridge National Laboratory) – pm041



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first reviewer claimed a significant reduction of the fuel consumption penalty associated with periodic regeneration of DPFs in light-duty vehicles would clearly reduce the petroleum consumption of these already-fuel-efficient vehicles, further increasing their commercial appeal, which could increase their penetration of the national fleet. The second reviewer responded that regeneration DPFs requires additional fuel to heat the DPF and remove particles. The electrically heated DPF has potential to reduce regeneration times and save fuel.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first respondent thought the approach was straightforward and correct. The other respondent was impressed by the very detailed and comprehensive approach. But is it all necessary? GM would seem to have a very promising pre-commercial system in its electrically-assisted diesel particulate filter (EADPF). While it is desirable to understand its operation in detail and to be able to predict such things as its probable life, is such in-depth understanding a prerequisite for successful commercialization?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A panelist responded that the program demonstrated improved DPF regeneration time by 95% with a regeneration efficiency of 95% as well. A direct fuel savings estimate would help to quantify the impact of the savings. It is expected to be about 1% but no data was presented. Fiber optic sensor capability developed may be reused, and knowledge was gained about measuring stress in DPF substrates.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first respondent referred to the note above, that GM would seem to have identified a promising approach to DPF regeneration in LDVs. Likewise, its 50% cost share in the project funding is commendable. It is not clear, however, that GM needs DOE help in testing, developing and commercializing this system. The second panelist listed GM and the University of Wisconsin as collaborators.

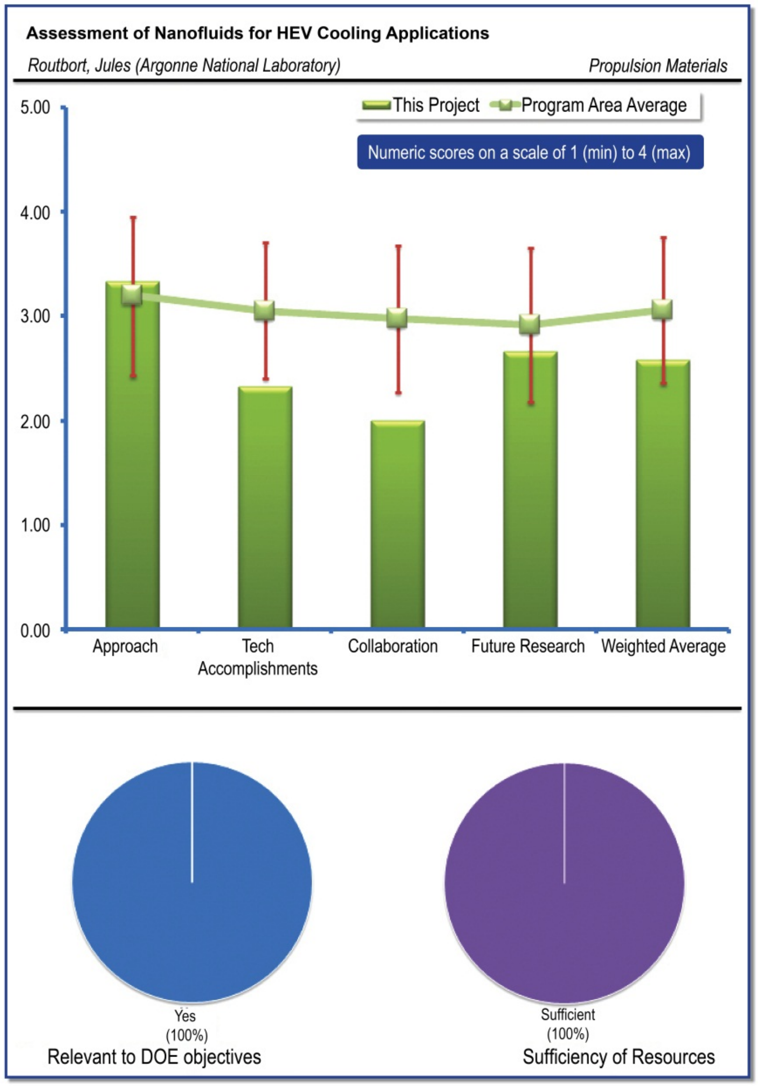
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

The first panelist described the system integration being pursued: Controls, Fuel Penalties for DPF and EADPF (electric option) as well as design properties for as and metallurgy for heater. The future research should also consider operating cost. Is fuel savings per vehicle life expected to pay for the electric heater? Are other technologies better solutions? (e.g., combustion tech. with less PM)

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

The first respondent thought this project well-funded; the other respondent felt that even with industrial partner cost share, the funding devoted to this project seem to be surplus to the requirement for successful commercialization.

Assessment of Nanofluids for HEV Cooling Applications: Routbort, Jules (Argonne National Laboratory) – pm042



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first evaluator believed that thermal management of EV and HEV power electronics is a key to the practicality and optimization of these vehicles, which offer the potential of very significant per-vehicle petroleum displacement. The second evaluator stated that the main project focus is to improve the heat transfer performance used to cool power electronic components. This has the potential to eliminate the low-temperature cooling loop, which reduces the system component count, cost, complexity, and underhood packaging. Reducing PEV (HEV/PHEV/EV) vehicle costs will incrementally help to increase PEV adoption, and thus petroleum reduction. According to this reviewer, the secondary focus (or for a follow-on project) is to evaluate the low-cost nanofluid for engine cooling use. This could further reduce radiator component sizes which could improve vehicle aerodynamics, and thus fuel consumption.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first reviewer considered it difficult to evaluate a project such as this, which is essentially no further along than the very early planning stage, but the approach seems logical and well directed. The second reviewer claimed the approach shown in the presentation only includes the work to-date, not the overall project. Discussions with the presenter show that the completed works, as well as the future work plans, seem to be a well-designed and straightforward method to achieve the goals.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first reviewer clarified that the rating for this question was merely a reflection of the fact that the projects has not actually begun and therefore cannot be expected to have shown "accomplishments and progress" other than the generation of a research plan which, as noted above, seems to be well thought out. The second reviewer noted that the continuing resolution limited the funds and time available to make progress, so only ~$100K has been spent to date. Initial modeling show that a high heat transfer nanofluid coolant has the promise to reach the heat transfer rates required to cool PEV power electronic components. Test quantities of the low-cost graphitic based nanofluid particle developed are being manufactured by Valvoline for ANL to test. Valvoline may become a project partner. If successful, Valvoline may also mass-produce the high heat transfer nanofluid coolant.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first reviewer noted that here again, it should be understood that the rating in this category reflects no deficiency in the project, but merely the fact that it has not begun and research partners have not yet been identified or recruited. The presentation indicated that both will be done as and when the project proceeds. The second reviewer reported that test quantities of the low-cost graphitic based nanofluid particle developed are being manufactured by Valvoline for ANL to test. ANL is in discussions with Valvoline to establish an NDA, as well as to become a project partner by establishing a CRADA. If successful, Valvoline may also mass-produce the high heat transfer nanofluid coolant.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The first reviewer stated that future work plans in the presentation are not well organized or detailed. The presenter elaborated that year 2 goals are essentially the first bullet on Slide 13, and year 3 is bullet 2 on page 13. The direction and plan is focused in the right direction, but the description is very high-level so does give the level of discussion needed.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The first panelist assumed that if the project proceeds, sufficient funding will be allocated to it to ensure its success. The second panelist affirmed that the resources are suitable for simple modeling and fluid evaluation. The more detailed and labor intensive work in years 2 and 3 may require some additional funding to accomplish the project goals.