

**U.S. Environmental Protection Agency
Office of Transportation and Air Quality**

Numerical and Experimental Investigations of New Engine Concepts to Improve Automotive Efficiency and Reduce Emissions: Requests for Applications.

AGENCY: Environmental Protection Agency (EPA)

ACTION: Notice

SUMMARY: This Notice announces the availability of funds and solicits proposals from institutions (such as universities, colleges, and laboratories) and non-profit organizations involved in advanced engine technology development, utilizing state-of-the-art experimental technique and numerical simulations. This effort is to improve the exothermic process of combustion for maximizing fuel economy and simultaneously minimizing pollutant emissions to meet societal expectations for cleaner and more fuel efficient vehicles for the 21st century transportation system. EPA seeks proposals to explore the potential of new engine concepts and technologies to achieve these targets. Proposal planning activities should address and identify key new technologies and analysis to obtain significant reduction in engine emissions and noise, and fuel economy advantage. EPA anticipates awarding a cooperative agreement to one qualified recipient ranging up to \$400,000 over a two-year period.

CATALOGUE OF FEDERAL DOMESTIC ASSISTANCE NUMBER: 66.034

DATES: The deadline for submitting Final Proposals is **March 28, 2003** (that is, they must be postmarked by that date). To allow for efficient management of the competitive process, OTAQ is requesting eligible institutions to submit an informal Intent to Apply by **February 26, 2003**. (Instructions for submitting Intents to Apply and final proposals are found in Section IX. below.) Submission of an Intent to Apply is optional; it is a process management tool that will allow OTAQ to better anticipate the total staff time required for efficient review, evaluation, and selection of submitted proposals.

QUESTIONS/COMMENTS: All questions or comments must be communicated in writing via regular U.S. mail, facsimile, or electronic mail to the persons indicated in "For Further Information Contact" below. All questions and comments must be received by EPA no later than **Feb. 26, 2003**. Responses will be posted on EPA's web site at <http://www.epa.gov/otaq/rfp.htm> within 5 days.

FOR FURTHER INFORMATION CONTACT:

Fakhri Hamady, U.S. EPA Office of Transportation and Air Quality, 2565 Plymouth Rd., Ann Arbor, MI 48105. Telephone (734) 214-4330; Fax (214) 214-4573; or email Hamady.Fakhri@epa.gov.

- or -

Christine Keller, U.S. EPA Office of Transportation and Air Quality, 2565 Plymouth Rd., Ann Arbor, MI 48105, email Keller.Christine@epa.gov.

SUPPLEMENTARY INFORMATION:

Eligible Entities: Eligible entities will only include non-profit institutions (universities, colleges and laboratories) actively involved with advanced engine technology development. "Non-profit" is defined by OMB in Circular A-122 (<http://www.whitehouse.gov/omb/circulars/a122/a122.html>). Eligible institutions must already be engaged in some form of research, development, testing and implementation of advanced technology related to internal combustion engines and/or air quality issues. EPA particularly desires that institutions (such as universities, colleges, and laboratories) apply, in the expectation that their proposals would have a high potential to benefit engine development by applying advanced instrumentation and computational fluid dynamic technique. "For-Profit" organizations are ineligible under this program.

Title: "Numerical and Experimental Investigations of New Engine Concepts to Improve Automotive Efficiency and Reduce Emissions: Requests for Applications"

Background:

New technologies are required in many fields of engine development in order to meet societal expectations in the 21st century, such as preservation of the global environment and effective utilization of natural resources. For this reason, the future engine must be cleaner and more fuel efficient than existing engines. While alternatives to internal combustion engine are continuing to be proposed, it will remain as the mainstream power plant for the next decade or so. This suggests that the engine technology needs to be reviewed from basics, including fundamental structure and thermodynamics to achieve energy, environmental and economic benefits.

This Request for Applications (RFA) relates to EPA's involvement with the Clean Automotive Technology Program (CATP) applicable to vehicles with high-efficiency hybrid systems. The CATP program includes short-term goals such as improved manufacturing capabilities and compliance with emissions, fuel economy, and safety regulations. The most visionary goal, however, is to develop and evaluate advanced engines as power plants for future concept vehicles with greater fuel efficiency than today's vehicles while meeting or exceeding current emission standards. The National Vehicle and Fuel Emissions Laboratory in Ann Arbor, Michigan, does not have the capability to investigate, design, fabricate, and analyze the feasibility of new concept engine components to achieve the program goals. In addition, this RFA is to encourage basic and applied research in engine technologies that could make significant contribution to make the field of engine development extremely dynamic and challenging.

EPA's Office of Transportation and Air Quality (OTAQ) introduces this RFA to non-profit institutions to initiate a cooperative agreement to investigate the combustion chamber design of an engine where the exothermic transformation of energy takes place in a turbulent flow field. It is important to understand the combustion process in order to reach the goal of clean more efficient engine. The investigation will consider the effect of the bowl-in-piston geometry on fuel-air mixing and combustion in direct injection engines. The influence of in-cylinder fuel spray, fuel injection timing and duration, fuel nozzle geometry, ignition timing for best performance, and intake and exhaust ports shape on the combustion process will be investigated. The technology that will be investigated as part of this effort will be of benefit to directly injected engines that use hydrocarbon

fuels. In particular stratified charge gasoline and diesel engines can benefit by the development of tools that allow a good evaluation of fuel-air mixing and combustion process.

The in-cylinder mixture preparation in direct injection engines is determined by the injection system, the combustion chamber shape, and the flow field of the compressed air. The bulk motion and the local turbulent structure within the flow field are seldom known. It is known that small direct injection engines require swirl. This is usually accomplished by designing intake ports that impart a swirling motion to inducted air into the cylinder. The performance of direct injection engine is strongly dependent on the bowl-in-piston shape. However, the interactions between the fuel spray, the flow in the bowl, and combustion are not well understood. Experimental efforts have investigated the effects of combustion chamber shape on the combustion process. The results of these studies showed that the combustion chamber design significantly influences the combustion burn rate. However, because not all of the important parameters that affect combustion could be measured, it was difficult to interpret the results. Hence numerical simulations in engines are becoming more accepted as an adjunct in investigating the design of engines

Therefore, OTAQ seeks to support demonstration projects, ranging up to \$200,000 yearly per award (depending upon the project proposal) and other assistance. OTAQ intends that the cooperative grants will go to national institutions, or non-profit organizations to further develop the internal combustion engine technology. OTAQ encourages applicants to explore innovative approaches for engine development to enhance the execution of the exothermic process of combustion in the engine cylinder. A controlled execution of the combustion process in the engine is in effect non-existent.

This RFA supports the Environmental Protection Agency's Clean Air Act, Section 103 (b)(3). In addition to the applicant eligibility requirements discussed herein, the Agency must assure that a proposal selected for funding meet two "threshold determinations" for funding; in this context:

- It must address the methods, approaches, identify new technology and analysis to obtain significant reduction in engine emissions and noise, and fuel economy advantage; and
- It must consist of such activities as research, investigations, experiments, modeling, demonstrations, and similar activities.

Demonstration projects should provide systematic procedure for engine development, which includes thermodynamic and thermochemical analysis combined with in cylinder treatment of the turbulent flow field and projects are consistent with the accepted activities.

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Numerical and Experimental Investigations of New Engine Concepts to Improve Automotive Efficiency and Reduce Emissions: Requests for Applications

I. Overview and Deadlines

A. Overview:

In this notice, OTAQ is soliciting proposals from non-profit institutions to work on engine developments for the 21st century transportation system. Proposal planning activities should address and identify key new technologies and analysis to obtain significant reduction in engine emissions and noise, and fuel economy advantage. Project activities will involve characterizing in-cylinder air-fuel mixing, fuel spray dynamics and subsequent combustion events, by using advanced instrument technologies and computational tools. Precise mixture control by means of advanced direct fuel injection systems and controlled combustion may change significantly the engine technology. The important elements of controlled combustion is short exothermic reaction process, and minimum contact with walls during exothermic reactions. For example, if the wall heat loss is reduced by a small factor the benefits of the fuel economy and emissions would be significant. Based on this we need to exert our efforts to make our engines more energy efficient and much less polluting, while promoting the combined use of electrical energy

OTAQ is interested in proposals to explore the potential of new engine concepts and technologies to achieve these targets, particularly controlled combustion, emissions and noise reduction, and to expand education and training opportunities at research facilities. An important aspect of the evaluation of proposals will be an assessment of the technique, innovative technology, and their potential effectiveness to improve fuel economy and reduce emissions.

B. What are the deadlines for this competition?

In order to efficiently manage the selection process, OTAQ requests that an informal "Intent to Apply" be sent by **February 26, 2003** to the contact names listed under "For Further Information Contact." An "Intent to Apply" simply states in the form of electronic mail or facsimile that your organization intends to submit a proposal to be received by the deadline. Submitting an "Intent to Apply" does not commit an organization to submit a final proposal. The "Intent to Apply" is an optional submission; those not submitting an "Intent to Apply" may still apply by the deadline.

The deadline for submitting completed final proposals (original and six copies, plus one fully-completed and signed Application for Federal Assistance, is **March 28, 2003**. The Office of Transportation and Air Quality expects to complete the Evaluation/Selection process by April 21.

II. Eligible Organizations

C. Who is eligible to submit proposals?

Eligibility is defined under Section 103 (b)(3) of the Clean Air Act the Administrator is authorized to: “make grants to air pollution control agencies, to other public or nonprofit private agencies, institutions and organizations...” "Non-profit" is defined by OMB in Circular A-122.

III. Funding Issues

D. What is the amount of available funding?

Approximately \$200,000 is anticipated to be available the first year for this competition with another \$200,000 anticipated for the second year. The project will be funded incrementally every six (6) months.

E. How many agreements will EPA award in this competition?

Subject to the availability of funds, and the quality of proposals submitted, EPA plans to fund one highly qualified proposal. EPA reserves the right to make no award under this solicitation.

F. Are matching funds required?

No.

IV. Program Emphasis

This program is designed to provide funding for demonstration projects to improve the exothermic process of combustion for maximizing fuel economy and simultaneously minimizing pollutant emissions to meet societal expectations for cleaner and more fuel efficient vehicles for the 21st century transportation system. Innovative approaches of particular interest to OTAQ encourage the application of new technologies and analysis to obtain significant reduction in emissions, and fuel economy advantage. Elements that EPA is especially interested in seeing in proposals include the following (although strong proposals that contain elements other than these will certainly be considered):

Multidimensional modeling of in-cylinder flow and combustion process - In this effort, fuel-air mixing and combustion process will be simulated to provide insightful data on the in-cylinder flow motion and its interaction with the fuel spray dynamics, and subsequent combustion events. Several engine combustion chamber shapes, valves arrangement, fuel injection systems will be considered in this effort. Commercially available codes could be used for in-cylinder flow studies, however particular emphasis must be focus on the accuracy of results including mesh generation and adaptive meshing technique to adapt to the nature of the physical problem that is being simulated. Also, grid independence is to be verified by using grid refinement and error estimation.

Experimental work - In-cylinder fuel-air mixing, and combustion will be characterized and measured using different laser based technique or others. This will require mapping the flow field during the engine cycle and quantifying the variability of the flow motion. By controlling both the flow motion and its variability, a more favorable initial condition for combustion can be obtained, thus increasing the efficiency of combustion process. Experimental results will be compared with the numerical results for validation under same engine speed and boundary conditions as the simulations.

Firing Engine - A modular single cylinder engine assembly is required to test new concept engines. This will provide a means for evaluating the influence that different combustion chamber configurations have on engine performance and emissions as well as investigation of the combustion process through the use of cylinder pressure diagnostics. The proposal should demonstrate the capability and expertise to design and build full range of engine configurations for the project.

Combustion Analysis - To improve fuel efficiency of internal combustion engine is to study the behaviors in which fuel is consumed and make modifications in the combustion process based on this analysis. Evaluation of the combustion process can be challenging however, new innovative methods could enable better understanding of the phenomena taking place inside the engine cylinder at the start and during combustion process. What takes place in the combustion chamber is an exothermic chemical reactions occurring within a turbulent flow field. One may, therefore be able to refine the execution of the combustion process by controlling this field.

V. Selection Criteria

Each eligible proposal (section VIII. N., below, summarizes basic requirements for eligibility) will be evaluated according to the criteria set forth below. Proposals, which are best able to directly and explicitly address the review criteria will have a greater likelihood of being selected for award in this competition. Each proposal will be evaluated for scientific and technical merit.

G. Review Criteria

The goals of the demonstration project are to advance the understanding of the exothermic combustion process in engines, improve the control of the combustion, and enhance in-cylinder fuel air distribution. Applications will be rated by a Selection Committee against the following criteria and weighted as indicated below.

Significance (25%)

Approach (20%)

Innovation (10%)

Investigator (20%)

Environment (25%)

- **Significance.** Applicants proposal should demonstrate the significant advances and impact on engine technology developments, environmental benefits, and effective utilization of natural resources.

- Approach. Applicants proposal should demonstrate the analytical, engineering, and scientific approaches and methods adequately developed, and well integrated to the aims of the project. The applicants should demonstrate well-planned and documented evidence of achieving the research goals, and disseminate the technology developed.
- Innovation. Applicants proposal should discuss new approaches, explore new research paradigms, or represent new concepts that combine engineering and sciences. New approaches or concepts that could solve current scientific or technical problems in novel way.
- Investigators. Applicants proposal should demonstrate that the principal investigator is capable of coordinating and managing effectively the proposed work and partners.
- Environment. Applicants proposal should demonstrate that the scientific and technological environment in which the work will be done contribute to the probability of success. And, the proposed work takes advantage of the unique features of the scientific environment or employ useful collaborative arrangements within the partnership.

VI. Evaluation and Selection

H. How does the evaluation process work?

The EPA Evaluation Team will be chosen in such a way that it can address a full range of engine technology developments and air quality matters. The Evaluation Team will base its evaluation solely on the criteria referenced in this Notice. Completed evaluations will be referred to a Selection Committee representing OTAQ staff and managers who are responsible for further consideration and final selection. Selected proposals will be submitted to EPA's grants office for final approval for award. Applicants will be notified promptly, but not to exceed 60 days, after this process concerning their proposal's status. EPA reserves the right to reject all applications and make no awards. Disputes will be handled under 40 CFR 30.63.

VII. Proposals

I. What must be included in the proposal?

The proposal must contain a narrative with a work plan, letters of commitment from partners, and signed and completed federal assistance application forms ("Application for Federal Assistance and Budget Information, SF424 and SF424A"). (Please do not use binders or spiral binding for your submission.) The narrative, which should be approximately 5-10 pages in length, must explicitly address how the proposal meets each of the evaluation criteria. Again, in the course of describing how it meets the criteria, the narrative must include:

- (1) a detailed project summary - description of specific actions and methods to be undertaken, and the responsible institutions, including estimated time line for each task,
- (2) the associated work products to be developed (e.g., partnership agreements),

- (3) an explanation of project benefits,
- (4) an explanation of how project outcomes (e.g., fuel economy and emissions benefits) will be designed for re-investment,
- (5) a detailed budget--clearly explain how funds will be used,
- (6) a detailed explanation of how the project success shall be evaluated,
- (7) the projected time frame for project from initiation through completion,
- (8) project contact(s) (must provide name, organization, telephone, facsimile, and electronic mail), and
- (9) a description of the roles of the applicant and partners.
- (10) biographical information of the key personnel

In addition to the narrative, the proposal should include a signed letter of commitment from each partner institution that briefly summarizes its roles and goals in the partnership.

EPA financial assistance procedures require that the official, signed, and completed federal assistance application forms ("Application for Federal Assistance and Budget Information") be submitted by all applicants with their proposals. For those in need of guidance in filling out these forms, an Application Kit for Federal Assistance (which includes the forms) can be obtained from EPA's Grants Administration Division at (202) 564-5305. These forms can also be downloaded from the following website: www.whitehouse.gov/omb/grants/#forms.

Applicants should clearly mark information they consider confidential, and EPA will make final confidentiality decisions in accordance with Agency regulations at 40 CFR Part 2, Subpart B.

VIII. Other Items of Interest

J. Does this funding expire at the end of Fiscal Year 2003? Will two-year projects be considered?

Funding does not expire at the end of Fiscal Year 2003. If a proposal with a two-year project period is submitted, OTAQ requires that the budget and cost estimate be designed to indicate what will be accomplished in each of the first and second years. Each year will be funded in 6 month intervals and the budget/cost estimates must reflect this. However, the total amount of the grant does not change if the project period extends to two years.

K. May an eligible institution submit more than one proposal?

Yes. However, more than one proposal may be submitted only if the proposals are for different projects.

L. May an eligible institution submit a proposal for this fiscal year, even if the organization were previously awarded funding under another program?

Yes. Applicants awarded funding in previous competitions may submit new proposals to fund a different project. As mentioned previously, this program is designed to provide funding for demonstration projects. Awards will not be given to extend or supplement an ongoing program if the proposal adds nothing that is new in some significant way.

M. May an eligible organization resubmit a proposal which was previously submitted to another competition for funding, but was not selected?

Yes. However, those proposals will be measured against the evaluation criteria described above.

N. What will cause a proposal to be considered ineligible or non-responsive to this solicitation?

A proposal will be determined to be ineligible if :

(1) it is not submitted by a national institution, or non-profit organization involved with engine technology developments or air quality issues, or

A proposal will be considered non responsive if:

(1) it does not address each criterion and each component outlined in Sections V. G. and VII. I., above, or

(2) it lacks the completed and signed forms "Application for Federal Assistance and Budget Information," or

(3) it is received or postmarked by the U. S. Postal Service after the deadline.

O. Will letters of recommendation or commendation help a proposal during its evaluation?

No. However, letters from partners expressing their commitment to the proposed project will strengthen an application's standing.

P. What rules will govern performance of the cooperative agreement?

Institutions and non-profit organizations receiving EPA financial assistance are subject to 40 CFR Part 30 and OMB Circular A-122.

Q. What is the nature of EPA's anticipated substantial involvement in the cooperative agreement?

While the Agency will negotiate precise terms and conditions relating to substantial involvement as part of the award process, EPA expects to closely monitor the successful applicant(s) performance, collaborate during the performance of the scope of work, approve the substantive terms of proposed contracts, approve the qualifications of key personnel, and review and comment on reports prepared under the cooperative agreement. EPA will not select employees or contractors employed by the recipient(s) and the final decision on the content of reports rests with the recipient(s).

IX. How to Apply

R. How does one apply?

Intents to Apply may take the form of electronic mail, facsimile or telephone call to the contacts listed under "For Further Information Contact." Include organization, contact, telephone number, and project title/subject. Please submit informal Intents to Apply by **February 26, 2003**. Submission of an Intent to Apply or a final proposal does not guarantee funding.

COMPLETED APPLICATION PACKAGES must be postmarked or received via regular U.S. mail or express mail on or before **March 28, 2003** (please provide original proposal + six copies-no binders or spiral binding-plus one signed and completed "Application for Federal Assistance and Budget Information", addressed to:

Regular Mail

Fakhri Hamady (ATD)
U.S. EPA Office of Transportation and Air Quality
2565 Plymouth Rd.
Ann Arbor, MI 48105

2. Express Delivery

Fakhri Hamady (ATD)
U.S. EPA Office of Transportation and Air Quality
2565 Plymouth Rd.
Ann Arbor, MI 48105
(734) 214-4330

--DEADLINE FOR COMPLETED FINAL PROPOSALS--

Proposals must be received or postmarked no later than midnight on

March 28, 2003

Christopher Grundler, Deputy Director
Office of Transportation and Air Quality
Environmental Protection Agency