State of California
AIR RESOURCES BOARD

Resolution 06-54

December 7, 2006

Agenda Item No.: 06-11-2

WHEREAS, the Air Resources Board has been directed to carry out an effective research program in conjunction with its efforts to combat air pollution, pursuant to Health and Safety Code Sections 39700 through 39705;

WHEREAS, a proposal Number 106, entitled “Development and Demonstration of a Low Emissions Four Stroke Outboard Marine Engine Utilizing Catalyst Technology,” has been submitted by Mercury Marine, in response to the 2006 Innovative Clean Air Technologies (ICAT) Program solicitation;

WHEREAS, the proposal has been independently reviewed for technical and business merit by highly qualified individuals; and

WHEREAS, the Research Division staff and the Executive Officer and Deputy Executive Officers have reviewed and recommend for funding:

> Proposal Number 106, entitled “Development and Demonstration of a Low Emissions Four Stroke Outboard Marine Engine Utilizing Catalyst Technology,” submitted by Mercury Marine for a total amount not to exceed $475,000.

NOW, THEREFORE BE IT RESOLVED, that the Air Resources Board, pursuant to the authority granted by Health and Safety Code Section 39703, hereby approves the following:

> Proposal Number 106, entitled “Development and Demonstration of a Low Emissions Four Stroke Outboard Marine Engine Utilizing Catalyst Technology,” submitted by Mercury Marine, for a total amount not to exceed $475,000.

BE IT FURTHER RESOLVED, that the Executive Officer is hereby authorized to initiate administrative procedures and execute all necessary documents and agreements for the efforts proposed herein, and as described in Attachment A, in an amount not to exceed $475,000.

I hereby certify that the above is a true and correct copy of Resolution 06-54, as adopted by the Air Resources Board.

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Lori Andreoni, Clerk of the Board

ATTACHMENT A

Innovative Clean Air Technologies (ICAT) Grant Proposal:

"Development and Demonstration of a Low Emissions Four Stroke Outboard Marine Engine Utilizing Catalyst Technology"

Background

Marine propulsion engines have recently become a focus of emissions reductions. Outboard marine engines have been subjected to tightening emissions regulations that have resulted in the elimination, in California, of the traditional two-stroke outboard engine, due to the high emissions of two-strokes. In recent years, all outboard manufacturers have gone to other technologies, such as four stroke engines. Further reductions in emissions will require the use of exhaust system aftertreatment, such as catalytic converters. The use of catalytic converters in marine pleasure craft applications is a very challenging application, as these applications use water-cooled exhaust systems. The catalytic converters generally require higher exhaust temperatures than found in water-cooled exhaust systems. In addition, any water contact with the catalyst could result in its catastrophic failure. An intensive development program will be needed to adapt catalyst technology to four-stroke outboard marine applications.

Objective

The objective of this program will be to demonstrate the feasibility of closed-loop catalyst technology to reduce emissions from four-stroke outboard marine engines.

Methods

Mercury Marine will start with a full analysis of requirements, challenges, expectations, and design considerations of equipping a four-stroke outboard engine with closed-loop catalyst technology. On the basis of this work, a prototype system will be developed, manufactured, and tested in order to make initial assessments on the performance and durability of the system. Any changes or refinements will be made to the system, which will then be tested for 100 hours to determine long-term durability and saltwater compatibility of the catalyst system operated under customer conditions.

Expected Results

It is expected that at the end of the project, Mercury Marine will have demonstrated the feasibility of catalyst technology for four-stroke outboard engines, and will have built a four stroke outboard engine with the lowest emissions ever.

Significance to the Board

The demonstration of catalyst technology for four-stroke outboard engines would allow the ARB to consider additional regulations to reduce emissions from outboard marine engines.

Applicant: Mercury Marine

Project Period: April 2007 to July 2009

Principal Investigator: Mark Riechers

ICAT Funding: $475,000

Co-funding: $664,540

Past Experience with This Principal Investigator:

None.

Prior ICAT Funding to 2006

Year	2005	2004	2003
Funding	0	0	0

B U D G E T S U M M A R Y

Mercury Marine

"Development and Demonstration of a Low Emissions Four Stroke Outboard Marine Engine Utilizing Catalyst Technology"

Direct Costs and Benefits	**ICAT**	**Total**
1. Labor	$ 0	$278,494
2. Employee Fringe Benefits	$ 0	$ 55,032
3. Subcontractors	$289,000	$453,920
4. Equipment	$ 0	$ 0
5. Travel and Subsistence	$ 4,000	$ 4,000
6. Materials and Supplies	$182,000	$202,000
7. Other Direct Costs	$ 0	$ 0
Total	$475,000	$993,446
Indirect Costs		
1. Overhead	$ 0	$146,094
2. Other Indirect Costs	$ 0	$ 0
Total	$ 0	$146,094
Total Project Costs	**$475,000**	**$1,139,540**

S U B C O N T R A C T O R S' B U D G E T S U M M A R Y

Subcontractor: Various subsidiaries of Mercury Marine

Subcontractor Tasks: Subcontractor will create the CAD design models and component drawings that will be used to create the design and develop the individual component parts, including major castings. The subcontractor will perform the design analysis of system, including running of heat transfer model to predict coolant heat rejection and heat transfer characteristics. Computational fluid dynamics analysis of the catalyst and exhaust system will also be performed by the subcontractor. The subcontractor will conduct dynamometer testing on the demonstrator engine to determine the emissions reduction potential of the catalyst system and to gain some initial information on the effects of the catalyst system on other mechanical engine systems. The subcontractor will conduct engine calibration testing, and finally conduct endurance testing to determine durability of the catalyst system.

DIRECT COSTS AND BENEFITS		**ICAT**	**Total**
1.	Labor	$175,000	$241,920
2.	Employee Fringe Benefits	$ 36,000	$ 49,000
3.	Subcontractors	$ 0	$ 0
4.	Equipment	$ 0	$ 0
5.	Travel and Subsistence	$ 2,000	$ 3,000
6.	Materials and Supplies	$ 76,000	$102,000
7.	Other Direct Costs	$ 0	$ 0
	Total Direct Costs	$289,000	$395,920
INDIRECT COSTS			
1.	Overhead	$ 0	$ 58,000
2.	Other Indirect Costs	$ 0	$ 0
	Total Indirect Costs	$ 0	$ 58,000
TOTAL SUBCONTRACTOR COSTS		**$289,000**	**$453,920**