Amendment 0003

Solicitation Number: ONRBAA 13-013

Gas Turbine Upgrades for Reduced Total Ownership Cost (TOC) and Improved Ship Impact

Date: 08 July 2013

The purpose of Amendment 0003 under ONRBAA 13-013, is the following:

A. to revise Section I. 6 Table 1 note as follows:
"Note: * The **high** temperature turbine inlet gas temperature corresponding to these power turbine inlet temperatures is 600°F+ of the given power inlet temperature on the chart."

B. to add the following information at the end of Section I. 6 entitled "Research Opportunity Description":

Burner Rig Materials Screening Test:

It is preferred that the hot corrosion resistance of all materials be screened in three separate test environments.

Test Environment 1: This is a test to evaluate the low temperature hot corrosion (LTHC) performance of the candidate materials. It is the typical 1300^{o}F test, run for 500 to 1000hours with thermal cycling to room temperature every 24 hrs. Depending on the individual contractor's equipment, valid test results can be obtained by operating at a temperature of 1300 ^{o}F.

Test Environment 2: This is a test to evaluate the high temperature hot corrosion (HTHC) performance of the candidate materials. It is the typical 1650 ^{o}F test, run for 500 to 1000 hours with thermal cycling to room temperature every 24 hrs. Due to the need to maintain the presence of molten Na_2SO_4 (melting point of 1625 ^{o}F) for the formation of HTHC conditions, this test must be run in a tighter temperature range than a LTHC test. Temperatures above 1700 ^{o}F will result in too much of an oxidation component in the results. Thus, the acceptable temperature chosen is 1650^{o}F.

Test Environment 3: This test will be used to screen materials to their response to a mixture of corrosion/oxidation environments. It is believed that a mixed mode will be more simulative of the more aggressive conditions that are beginning to be experienced by shipboard gas turbine engines. Until recently, most of the corrosion seen in the engines was type 2 (LTHC). Now there is evidence that the corrosion is shifting more to

type 1(HTHC) with a significant oxidation component. As a materials screening tool, the burner rig (or a furnace based test) can rank materials to their resistance to a mixed mode environment. It is not a very good toll for predicting absolute life in any particular engine. With this in mind, a mixed mode test should begin with a period of time in LTHC conditions, since the engine after any start-up will of necessity have to spend some time in the LTHC environment. Under cruise conditions the engine might spend a significant period of time within HTHC conditions, which should follow the period of time within the LTHC conditions. The third period would be a short burst of full power demanded of the engine.

So in a 24 hour period the following burner rig cycle is proposed:

Step 1: 7 hours of LTHC – 1300 ^{o}F
Step 2: 14 hours of HTHC – 1650 ^{o}F
Step 3: 1 hour of oxidation at 1800 ^{o}F
Step 4: 2 hours to cool down to room temperature, inspect test specimens

(At this time it is recognized that if one rig is used that there will be a lag time when operating between 1300 ^{o}F and 1650 ^{o}F, between 1650 ^{o}F and 1800 ^{o}F, and between 1800 ^{o}F and 1300 ^{o}F. There is also a question of one rig longevity when operating in this mode). Consequently, this profile is expected to be tested as soon as possible.

Step 5: Repeat steps 1 through 4.

Total test time at temperatures: 500 to 1000 hours (subject to future considerations).

C. to answer questions submitted during Industry Day and via email:

Industry Day Questions

1. Q. Is the Navy looking at backfit only?
A. We are looking for backfit and forward fit.

2. Q. Does the Navy expect the upgrade package to change the core of the engine?
A. No. The engine core configuration should remain the same. All new material components are expected to be form, fit, and function replacements. If configuration changes are necessary to install the new material components, this should be indicated along with cost impact in the proposal.

3. Q. Does Rene 80 have to be used as the alloy baseline if the engine that is the focus of the bidder's effort does not use Rene 80?
A. The bidder can use the alloy that is first stage blade alloy in the engine that is the focus of their effort. If possible it is desirable that Rene 80 also be used as a baseline in their testing.

4. Q. Is there a target upgrade package cost?
A. No.

5. Q. How many upgrade packages will you want?
A. We will need one complete upgrade package, and we are willing to consider separately priced options for extra sets of complete or partial upgrade packages.

6. Q. Do you want pricing based on the quantities of engines upgraded in a typical year?
A. Yes, we want pricing based on a quantity approach.

7. Q. Slide 11 (Shifler Presentation): How long is the program?
A. The Program is four years plus one year of testing. See ONR BAA13-013, Section I,6, Table 2 and Section II.

8. Q. Is the Navy planning on a Fleet evaluation or just a land based engine test?
A. Within the constraints of this BAA we are only planning on a land based engine test.

9. Q. What will be the TRL level of the Large Engine upgrade package if no full engine test is performed?
A. TRL-5.

10. Q. Is the Navy looking at only LM2500?
A. The following six engines are of current interest to this program: the Rolls Royce MT30, the Rolls Royce MT5 (and MT5 derivatives used or planned for the Navy), the Rolls Royce MT7, the GE38, the GE LM2500+, and the GE LM500. An Offeror's proposal should address one or more of these engines which are in the 3 to 5 MW range or approximately 20 to 40 MW range.

11. Q. Can you elaborate on what the deliverables are for the small engine?
A. For an engine in the 3 to 5 MW range, the deliverables are an actual engine upgrade package that includes all new parts and the corresponding technical data needed to produce or acquire follow on upgrade packages. The materials and components in the upgrade package will be based on materials and parts that have been subjected to appropriate laboratory testing. The upgrade package should include: high temperature capable marinized rotor, marinized coatings for blades and vanes, and marinized single crystal alloys that have met the alloy/ coatings metrics.

12. Q. For the small engine task, when will the parts for the engine package be needed?
A. They will need to be delivered by the end of FY18.

13. Q. Should the winning contractor provide one upgrade package for one generator set (small engine)?

A. Yes. The contractor should provide one upgrade package for one generator set (small engine). This should include all necessary parts for engine installation. The proposal should also indicate and provide option for critical spares.

14. Q. Slide 25 and 26 (Shifler Presentation): How will the universities participate in the developments?

A. Those with burner rigs will be used for independent testing and evaluating of developments.

15. Q. Is there a consortium of universities involved? If so, what universities?

A. No. There is not a consortium of universities. However, a list of universities with burner rigs includes: University of California (Irvine), University of Pittsburg and University of Virginia. Furthermore, it takes approximately one-year to set up a burner rig and obtain experience on evaluating the results. Any other university with burner rig capabilities may include their contact information under the Interested Parties section of this BAA in FBO.

16. Q. How well does burner rig testing predict material performance in an engine?

A. The burner rig test is used for the ranking of materials for resistance to various types of hot corrosion conditions. When the conditions in the burner rig are shown (through comparison with actual engine exposed hardware) to reproduce the engine hot corrosion environment of interest, the rankings will remain the same during rainbow testing in an engine. Without substantial engine experience with a particular type of operating profile, the burner rig can only provide a relative ranking of materials; it does not predict a specific engine life for the materials.

17. Q. How will the proposals be evaluated?

A. Proposals will be evaluated in accordance with ONR BAA13-013, Section V, entitled “Evaluation Information.”

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18. Q. If White Papers are submitted, how should they be submitted?

A. See ONR BAA13-013, Section IV entitled “Application and Submission Information,” specifically subsections 1, 2a and 6.

19. Q. How long do proposers have to submit questions?

A. See ONR BAA13-013, Section I, 7.

20. Q. When it says rotor in the BAA does this mean the same as disc?

A. Yes.

21. Q. Would the bidder be responsible for installing the upgrade package in the test engine?

A. No. We will arrange for the work to be done by a depot that services our engines.

22. Q. Do you expect to get actual blade/vanes and rotors considering the time needed for alloy development?

A. Yes. For the small engine package, we expect to get the actual parts as needed to run an engine test. These parts could include blades, vanes, and rotor(s).

23. Q. Are we looking for the same peak temperatures as we have in the engines as used today and just more time at the higher engine of the temperature range, or are we planning on raising the peak operating temperatures?

A. We expect the peak temperatures to stay the same. We want the new materials to be able to spend more time at the higher end of the temperature range without degrading current MTBR's (Mean Time Between Removals) for the engines being considered.

24. Q. Do universities submit white papers directly to the Program Manager?

A. Correct. White papers must be submitted to the Program Manager. See specific mailing directions under ONR BAA 13-0013, Section IV, 6.

25. Q. May a prime offeror propose a university(ies) as a subcontractor?

A. A prime offeror may propose a university(ies) as a subcontractor. However, both the Prime Offeror and subcontractor(s) are responsible for identifying export controlled work. A foreign university(ies) or foreign person(s) may be precluded from performing under export controlled work.

For certain research projects, it may be possible that although the research being performed by the prime contractor is restricted research, a subcontractor may be conducting "contracted fundamental research." In those cases, it is the ***prime contractor's responsibility*** in the proposal to identify and describe the subcontracted unclassified research and include a statement confirming that the work has been scoped, negotiated, and determined to be fundamental research according to the prime contractor and research performer.

Questions since INDUSTRY DAY

26. Q. Materials upgrade package from LM500. Could it be run at conditions Navy is interested in?

A 1900 F is maximum temperature of interest.

27. Q. Is 1900 F max for corrosion tests?

A. At this time, yes.

28. Q. LM500, LM2500 are focused on corrosion and oxidation. Are you looking for new materials?

A. We want to improve hot section materials for gas turbine engines with as sustained temperature capability above that of existing materials. We have identified 3 areas in the BAA that the Navy believes that need improvement. If there are other areas in the engine that would compromise engine life below the target MTBR listed in the BAA, let the

Navy know. The program would like to avoid the use of TBCs. However, with respect to TBCs, indicate the technical rationale for why TBCs would be needed in the proposed Navy operational profile.