Request for Information – NNA12ALTTPSL-AMD

Alternate TPS / Alternate Architectures to Carbon Phenolic

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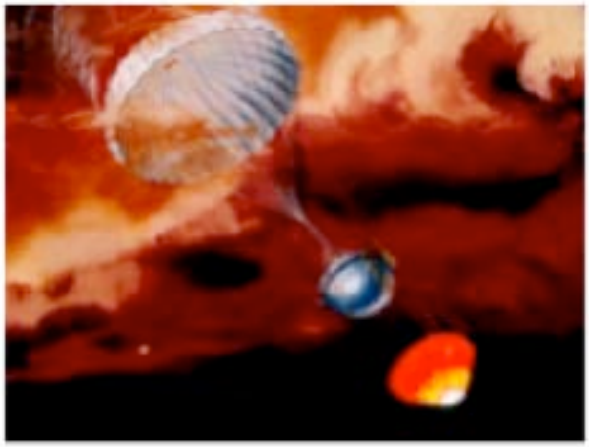
National Aeronautics and Space Administration
Ames Research Center
Moffett Field, California

1.0 INTRODUCTION

1.1 GENERAL INFORMATION



To date NASA has utilized carbon phenolic (CP) heatshields for its most demanding reentry missions, Pioneer Venus (PV) and Galileo (mission to Jupiter). These heat shields consisted of a Tape Wrapped Carbon Phenolic (TWCP) frustum and a Chop Molded Carbon Phenolic (CMCP) spherical nose. TWCP has uses beyond NASA thermal protection system (TPS) requirements, such as in rocket nozzles; however, CMCP is essentially a NASA-unique CP material that has very few other applications. It has been more than 30 years since NASA has flown a mission requiring CMCP TPS materials and therefore industry's capability to support CMCP fabrication now and in the future is unclear.

NASA has a significant interest in robust and efficient TPS materials and/or architectures for future planetary probe missions. The recently released Decadal Survey findings show that the Planetary Science community has prioritized missions to Venus, Saturn and Uranus. In addition, a Mars Sample Return (MSR) mission is being considered that will require a highly reliable TPS in order to meet the planetary protection requirements upon Earth return. Previous MSR mission studies have baselined CP as their TPS material. The Decadal survey findings can be found at:

http://sites.nationalacademies.org/SSB/CurrentProjects/ssb_052412

Mission and/or technical assessment studies in support of the Planetary Sciences Decadal Survey can be found at:

http://sites.nationalacademies.org/SSB/SSB_059331

Decadal Survey mission studies of interest related to this Request for Information (RFI) are listed below. A summary of the peak stagnation conditions for each mission is given in Table 1.

1) Venus Mobile Explorer Mission Concept Study
2) Venus Intrepid Tessera Lander Concept Study
3) Saturn Atmospheric Entry Probe Trade Study
4) Saturn Atmospheric Entry Probe Mission Concept Study

5) Uranus and Neptune Orbiter and Probe Concept Studies

Table 1 – Summary of peak stagnation conditions for missions of interest.

Peak Stagnation Point Conditions	Venus Mission			Saturn		Neptune/Uranus	
	Direct	Aerocapture	From Orbit	Prograde	Retrograde	Direct	Aerocapture
B Coef (kg/m^2)	193.0	114.0	114.0	256.0	256.0	260.0	498.0
V_e (km/s)	11.6	11.2	10.2	26.8	46.4	~29	~29
q_{conv} (W/cm^2)	2,300	500	340	~3000	~15000	8,000	6600-7400
q_{rad} (W/cm^2)	2,500	700	25	~0	~5000	4,000	3800-7400
q_{total} (W/cm^2)	4,700	1,200	360	~3000	~20000	12,000	10400-14800
P_{stag} (atm)	10.0	0.3	0.3	1.4	10.0	<5	<1

In a series of white papers,[1,2,3] the TPS community has proposed that the primary candidate for these missions is the heritage FM 5055 carbon (heritage carbon phenolic or HCP) that was used for Galileo (Jupiter) entry probe. FM 5055 uses carbon cloth derived from Avtex rayon, which is no longer in production. Pioneer Venus (PV) utilized similar TWCP and CMCP materials however a different rayon precursor was utilized in the manufacturing of the carbon cloth. NASA has a limited stockpile of the heritage Avtex rayon. However, due to reliability requirements, this supply has been reserved by SMD for the MSR mission, therefore other missions identified above will require an alternate solution.

The baseline missions identified in the Decadal Survey have assumed CP heat shield TPS with sizes ranging from 1 to 3.5 meters in diameter. However, it has been nearly 30 years since NASA has designed and flown a planetary mission requiring very high heat flux-capable heat shield materials. Consequently, NASA is investigating the possibility of replacing heritage carbon phenolic with a modern CP that uses currently available rayon sources. In addition NASA wishes to evaluate the mission suitability and current maturity (TRL) of other TPS material and architecture options beyond the traditional heritage like TWCP and CMCP materials.

The three broad alternate approaches of interest to NASA are: 1) Alternate to Avtex-rayon based heritage carbon phenolic using another fiber (but following essentially the same heritage tape wrap and chop molding processes), or 2) New TPS materials that can meet or exceed the performance requirements for the missions listed above, or 3) new entry vehicle architectures that can accomplish the some or all of the above missions successfully without reliance on new extreme environment TPS. NASA has assessed option 1 or the past few years with the help of the US aerospace industry. The focus of this Request for Information is on options 2 and 3.

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[1] White Paper to the NRC Decadal Survey Outer Planets Sub-Panel
[2] White Paper to the NRC Decadal Survey Sub-Panels Mars and Outer Planet Satellites
[3] White Paper to the NRC Decadal Survey Inner Planets Sub-Panel
Note: The listed white papers can be found here: http://solarsystem.nasa.gov/2013decadal/whitepapers.cfm

In order to find a cost effective, efficient, sustainable and robust solution that supports both near and long term missions, NASA seeks to assess the following options:

1) **Existing industrial capabilities for TPS solutions that could replace CP (both chop molded and tape wrapped CP) while still meeting the peak stagnation conditions for missions shown in Table 1. We are interested in concepts at all technology readiness levels.**

   and

2) **Novel re-entry architectures (vs. the standard ballistic 45-degree blunt sphere-cone) that are capable of performing the missions listed in Table 1, without the need for fully dense CP (low ballistic coefficient architectures are an example). Such architectures would inherently result in lower heat fluxes upon entry than those given in Table 1 for 45-degree sphere-cones.**

In the coming decade, NASA plans to select one or more of the Science Missions discussed in the Decadal Survey on a competed basis under the Discovery, New Frontier or Flagship class mission proposal processes. The competed proposals will have the challenge of proposing mature technologies that are compatible with the mission science objectives while also risk and cost balanced. Given the consolidation of the industrial base and the potential for challenges in obtaining or processing alternate rayon based CP, there is a clear need to assess the availability of alternate materials or alternate architectures that can meet these mission requirements. Responses to this RFI will help NASA to develop appropriate investment strategies.

This RFI describes the requirements in support of the initial planning phase of heat shield development for NASA's most challenging future reentry missions. NASA's long-term goal is to have a well-established industrial capability ready and available to manufacture heat shields for its multiple exploration missions across the next several decades. What NASA needs is data to understand risks involved in current manufacturing capabilities that include tools, machinery, processes and expertise, and sustainability.

It should be understood that there is no explicit or implied commitment for future procurements in this action.

1.2 SCOPE AND OBJECTIVES

Responses to this RFI should address the specific questions outlined below, as applicable to your proposed concept.

1. What is your past experience in providing entry grade heat shield TPS or entry system hardware?

2. What is your current capability in heat shield relevant TPS manufacturing?
    i. Personnel (number of personnel and number of years of experience)
    ii. Associated product assurance certifications and processing equipment
    iii. Certifiable process procedures and specifications

3. For alternate TPS materials (not traditional heritage like tape wrapped and/or chop molded "carbon phenolic") using the 45-degree sphere cone architecture:
    i. Please describe the TPS material.
    ii. For which of the mission conditions in Table 1 do you believe this material is capable of performing? What is the basis for your understanding of the material's performance capability?
    iii. What thermal performance testing has this material undergone? Can you supply test results or reports?
    iv. What additional data do you have for this material? Can you provide it to NASA?

4. If you have an alternate TPS architecture to the typical blunt sphere-cone, please describe it and why you would recommend it. Why do you believe its performance would be applicable to the entry conditions described in Table 1?

5. What is the technology readiness level of your alternate material or architecture? What is the basis for this assessment? Describe any applications or flights for which it has been used or intended.

6. Figure 1 shows the design of one of the Pioneer Venus probes' CP heat shields, consisting of a CMCP nose cap and a TWCP frustum. This probe had a diameter of 1.4m (~56 inches). NASA has interest in missions that would look at scaling this design from 1m max diameter up to 3.5m max diameter.
    i. For alternate TPS materials and architectures what size of a heat shield would be required to meet the missions in Table 1?
    ii. Within this size range what capabilities do you currently have for the alternate TPS manufacturing?

iii. What challenges do you foresee with scale-up of the TPS manufacturing? How do you plan to mitigate these challenges?

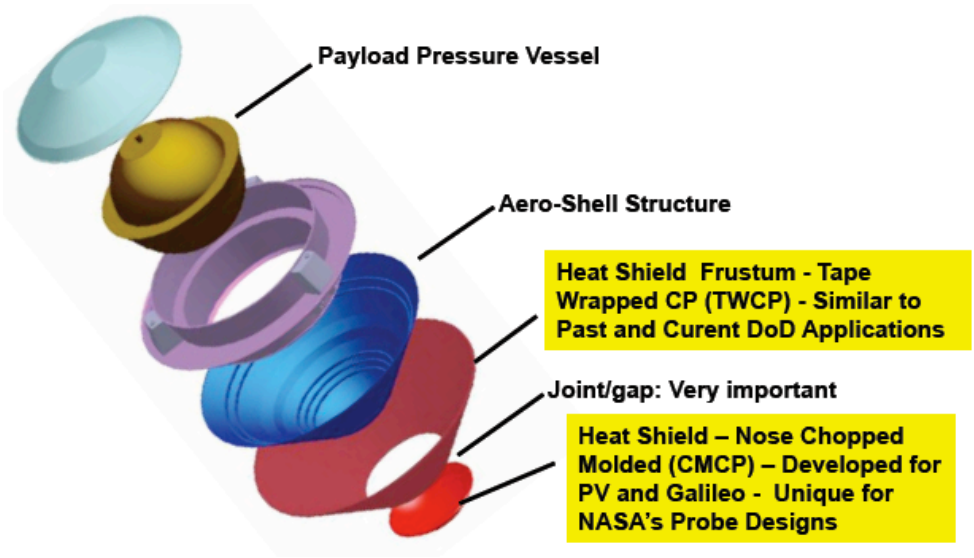

Figure 1 - Exploded view of a typical blunt sphere-cone entry probe.

7. What are your identified top challenges and risks in the development of yoru materials or architectures to TRL 6?

8. Are there challenges to providing sustained supplies of the raw materials needed for these new TPS materials and/or architectures?

9. Do you have any other data that shows your TPS or novel architecture will meet the mission requirements?

1.3 FORMAT

Electronic format (Microsoft® Word or Adobe PDF)

1.4 ADDITIONAL INFORMATION

All notices pertaining to this RFI will be posted at the NASA Ames Research Center (ARC) Procurement website at:

http://server-mpo.arc.nasa.gov/Services/Proc/home.tml

Interested firms are requested to submit their capability statements and responses to the questions in Section 1.2 above, as well as any comments on the acquisition approach via email to the Contracting Officer,

Marianne.Shelley@nasa.gov

no later than the date and time indicated in the synopsis at the ARC procurement website. Include RFI # NNA12ALTTPSL-AMD in any communication subject line.

This preliminary information is being made available for planning purposes only, subject to FAR Clause 52.215-3, entitled "Request for Information or Solicitation for Planning Purposes." This is a request for information only and does not constitute a commitment, implied or otherwise, that NASA Ames Research Center (ARC) will take procurement action in this matter. Further, neither NASA ARC nor the Government will be responsible for any cost incurred in furnishing this information. NASA ARC is issuing this RFI to gain a better understanding of industry capabilities and to assess the current state of the technology.

Detailed requirements for a future acquisition have not been finalized, nor have the specifics for the acquisition strategy been determined. NASA intends to use the results of this market research to aid in the making of these final decisions. Any future procurement resulting from this RFI is contingent upon the availability of appropriated funds.

Although all comments received will be carefully reviewed and considered for inclusion in a later action, the initiators of this request make no commitment to include any particular recommendations.

Following this initial feedback, NASA may conduct one-on-one meetings with potential contractors. These meetings will allow for exchange of information and will provide an opportunity for potential offerors to provide feedback on the Government's requirements and its acquisition approach.

All information received in response to this RFI that is marked "Proprietary" will be handled and protected accordingly. As applicable, NASA may provide Proprietary information to its support service contractors who are under an obligation to keep third-party Proprietary information in confidence. By submitting a response to this RFI, the responder is deemed to have consented to release of Proprietary information to such NASA support service contractors.