Discovery 2010 Announcement of Opportunity Q&A
Updated September 3 2010

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Other questions may be addressed to Michael New, Discovery Program Scientist, michael.h.new@nasa.gov. Questions (which may be abridged for brevity and paraphrased to ensure anonymity) and answers will be posted at the above URL twice a week, sorted by category and entered into the change log below.

Note: When an answer is revised, the number of the question will be listed in a blue, bold, italicized font in the log.

Categories of Questions

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Log of Questions

2009

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2010

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Science

S-1 ***On Page B-27, item 6b of Requirement B-64 of the Draft AO states that "The [sample] plan shall demonstrate that at least 75% of the returned sample shall be preserved for future studies." It is assumed that "future studies" pertains to any studies conducted beyond the preliminary examination by the science team. In the case of certain types of a non-standard or fragile sample (for example, a gaseous or volatile-rich sample), it may be desirable to make a major portion of this sample available to the broader scientific community for analyses soon after sample return since long-term storage would likely compromise its integrity. Does Requirement B-64 allow for an early release of all or most of such a sample to the broader scientific community, i.e., essentially concurrent with the preliminary examination phase?***

Part of the sample plan is a description of plans to maintain the integrity of any returned samples while in curation. If it could be demonstrated that maintaining sample integrity was impossible, then proposer's might propose an early release strategy which would then be negotiated with the Astromaterials Curator and NASA HQ after selection.

Technology

T-1 Regarding the new technology elements, such as NEXT, it was stated in the proposers conference charts that the associated credit to the proposers was approximately 1/2 of the total development costs for that technology. The question is: development to what level? TRL 6 or to flight ready?

Estimates of the costs for development to flight readiness were used.

T-2 Can NASA explicitly define the aerocapture provision; specifically, to differentiate it from aerobraking by stating the maximum number of passes through the atmosphere that can be undertaken, and whether it applies to just the initial capture orbit or if it requires reaching the final operational orbit? (For example, if a proposer proposes using aerocapture to establish an initial, highly elliptical orbit, and then uses aerobraking and/or propulsive methods to move into a closer orbit, would they still qualify for the $20M subsidy?)

This is clarified in the Program Library document entitled *In-Space Propulsion Technologies Minimum Demonstration Requirements.*

T-3 Does infusion of NASA developed technology within the proposal give a proposer additional credit during any part of the review and/or selection process?

None other than those described in the AO: cost cap incentives and the assumption, by NASA, of the development risk.

T-4 Please clarify the cost cap allocation for use of the NASA-developed technology. For example, if a project baselines the AMBR engine with another engine as back-up and then later in Phase A or Phase B switches to the back-up engine, is the project's cost cap reduced by $5M? And similarly, if a project baselines another engine, but plans a trade study in Phase A to further evaluate the AMBR engine, and then switches their baseline to the AMBR engine in either Phase A or Phase B, does the project's cost cap receive an increase of $5M?

Use of NASA-developed technology must be proposed in the initial, Step 1, proposal in order to qualify for the cost cap increase. Descoping a NASA-developed technology after selection will result in the loss of any associated cost cap increases.

T-5 ***Can you direct me to any briefing documents or other literature that would discuss the general technical readiness and/or design guidelines,* etc*. that would allow us to understand both the costs and benefits of NASA-developed, in-space propulsion technology (AMBR, NEXT, and aerocapture)?***

Reference documents for the three ISPT technologies (Aerocapture, NEXT, and AMBR) have been, or soon will be, posted to the Discovery Program library (http://discovery.larc.nasa.gov/dpl.html). The Aerocapture document on the Discovery program library and the two references below may address a number of your questions related to general technical readiness and benefits.

1. Munk, M. M. and Moon, S. A., "Aerocapture Technology Development Overview." IEEE Aerospace Conference Paper #1447, Big Sky, Montana, March, 2008.
2. Jeffery L. Hall, Muriel A. Noca and Robert W. Bailey, "Cost-Benefit Analysis of the Aerocapture Mission Set", Journal of Spacecraft and Rockets, Vol. 42, No. 2, pp 309-320.

Detailed technical questions or discussions related to use of aerocapture technologies on a particular mission concept should be directed to an Aerocapture POC at NASA LaRC, Jeffrey Herath (jeffrey.a.herath@nasa gov, 757-864-1098)

To assist with design guidelines, the ISPT project has developed the Aerocapture Quicklook tool. The tool provides a capability for rapid and accurate modeling of aerocapture disciplines (geometry, aerodynamics, trajectory, heating, and TPS sizing) at any solar system body with an atmosphere in order to determine aeroshell requirements. An Aerocapture Quicklook Tool reference document has been, or soon will be, posted to the Discovery Program library.

T-6 ***Is it possible to get both the Aerocapture "lander" incentive for using the materials and the Aerocapture "orbiter" incentive for demonstrating the aerocapture maneuver?***

No, it's either one incentive or the other.

T-7 **When does the use of these technologies have to be declared? If they are not part of the baseline in Round 1, can they be declared in Round 2, when more trades have been done?**

See the response to T-4

T-8 [Our mission is considering] a carbon-carbon ACC-6 outer shell backed by a Calcarb insulator. This aeroshell design is a self-supporting hot structure (no "cold structure" acreage support internally). Would this qualify for the aerocapture "lander" cost cap incentive?

This is clarified in the Program Library document entitled *In-Space Propulsion Technologies Minimum Demonstration Requirements.*

T-9 Would heritage chopped, molded carbon Phenolic (CMCP) that is currently not at TRL=6 be a material that would fall under the definition of materials ISPT is investing in for aerocapture?

No, ISPT has not previously made investments in CMCP, so its use would not be included in either of the aerocapture incentives.

T-10 What materials/families would fall under the "aerocapture" umbrella, and are there any that have been tested to TRL=6. If so, is there data available for us to digest concerning performance of these materials?

The materials that ISPT has tested are: Advanced Carbon-Carbon (hot structure) with Calcarb backing, SLA-561V alternatives on top of structures made of composite facesheets and composite, instead of Aluminum, core (higher temp capability). ISPT has also tested ARA's SRAM and PhenCarb families. In the case of Carbon-Carbon and PhenCarb, they have been tested to 1300 W/cm^2. Final reports for these tests and/or test matrices may be provided upon request.

T-11 Does an aerocapture maneuver have to be utilized as part of the mission architecture in order to be qualified for the Infusion incentive?

No. This is clarified in the Program Library document entitled *In-Space Propulsion Technologies Minimum Demonstration Requirements.*

T-12 How will ISPT support/guide the rationale for including the infusion of the ISPT investments in the Discovery proposal?

The ISPT office will support all questions or requests for ISPT generated data/information in a consistent manner. ISPT will not provide any guidance regarding the rationale of including the infusion of ISPT investments in any specific Discovery proposal. A proposer will need to review what has already been published in open literature or through the use of the Aerocapture Quicklook Tool, and determine that rationale for themselves for their specific mission.

T-13 Will support letters be available from the ISPT office?

No. The ISPT Office will not partner directly with any proposer. The aerocapture technology expertise resides at LaRC, ARC, and industry as potential partnering entities, and not ISPT directly. ISPT will direct potential proposers to applicable technology points of contacts for anything proposal specific or related to potential partnership opportunities.

T-14 What technical information and models are available to perform TPS (thickness, recession, etc) and structural sizing? If none are available, what guidance is recommended for performing TPS/heatshield sizing for the Step 1 proposal?

The best approach for obtaining technical information is to contact the experts who designed and tested these technologies (see contact information in question T-17). NASA is an alternative source for specific TPS sizing models for SLA-561V, SRAM, and PhenCarb materials. The POC for this work is Jeffrey Herath,(Jeffrey.A.Herath@nasa.gov).

T-15 Since many of the TPS systems, are noted as "hot/warm" structures, what models or data are available to define the inner bondline and structures temperatures are so the influence on attached or adjacent hardware can be assessed?

There are several options for obtaining models and data for hot/warm structural sizing. Proposers are encouraged to use information in the available documents (see question T-16) to develop preliminary designs. The experts who designed and tested these technologies (see contact information in question T-17) can answer questions not addressed in the available documents. Some technical questions may require little or no analysis to answer, so contacting these experts and getting feedback relative to the context of the application may result in an adequate answer for Step 1. If more work is necessary, detailed system characteristics are available, to be used as inputs to models developed by the proposal teams. These can be obtained by contacting the technical POCs listed in question T-18.

T-16 Is there a report or document that describes the range of testing that has been performed for the various TPS/heatshield combinations to aid in project planning of the final flight certification needed for the selected TPS/heatshield combination?

A variety of reports and conference papers are available through the In-Space Propulsion Technology office; contact David J. Anderson at Glenn Research (david.j.anderson@nasa.gov). Please note that some reports are ITAR-restricted.

T-17 Who are the POCs at the various industrial providers to perform the structural and TPS sizing for the representative environments?

Lockheed Martin Space Systems:
William Willcockson
william.h.willcockson@lmco.com
(303) 977-5094

Applied Research Associates:
William Congdon
bcongdon@msn.com
(303) 699-7737

ATK/Composite Optics:
Mark Pryor
Mark.Pryor@ATK.com
(858) 621-7376

Ball Aerospace (for GN&C testbed inquiries):
James Masciarelli
jmasciar@ball.com
(303) 939-5146

T-18 We are interested in using one of the In-Space derived TPS and heatshield structures as our baseline. To develop and submit the proposal, we need the programmatic information regarding pricing, schedule, and descriptions of the necessary additional development efforts. Who are the POCs at the various industrial providers to provide the programmatic information necessary (cost, schedule, and letter of commitment) to support the proposal development?

The programmatic information will be derived from technical information provided by the technical POCs listed in question T-17. These technical experts have project management experience and are knowledgeable about programmatic aspects of the development. We expect that the technical POCs will contact and coordinate with those individuals within the companies who need to be involved in pricing, letters of commitment, *etc.*

T-19 If a government entity were to be managing the contract for the procurement of the TPS/heatshield for a proposal, how would the contract be established with the TPS/heatshield structure providers? Would the contract be a sole-source? If sole-source, what would be the basis for the sole-source justification? Would the In-Space Propulsion Technology Program hold the contract, or can it be held/managed by our local procurement office?

In all cases, contracts would be developed, funded and managed by the implementing organization of the mission. The In-Space Propulsion Technology program would not implement *any* contracts for a mission.

If the implementing organization were a government entity, then a sole-source procurement would be necessary. In that case, the justification would be made on the basis of previous, specific developments under the In-Space Propulsion Technology Program.

T-20 Is it true that the Discovery AO will only encourage the use of NEXT if it is a "mission enabler" and not a "mission enhancement"?

No, that is not correct. Technology infusion incentives are offered for the use of the NEXT ion propulsion system, the AMBR advanced bi-propellant engine, and aerocapture technologies whether they are enabling or enhancing. Only the use of the Advanced Stirling Radio-isotope Generator must be enabling.

T-21 The Program Library document "In-Space Propulsion Technologies Minimum Demonstration Requirements" indicates that the aerocapture (lander) cost cap incentive is only available to proposals that use an unsupported Hot Structure. Would some form of partial credit be offered for using the advanced Carbon-Carbon system (ACC-6 Carbon-Carbon with Calcarb VF) bonded to a supporting substructure?

The supplemental document "In-Space Propulsion Technologies Minimum Demonstration Requirements for the Discovery 2010 AO," dated February 26, 2010, states that: "To be considered an acceptable demonstration, these materials [the advanced Carbon-Carbon system] need to be applied in a relevant heating environment (over 300 W/cm^2 heat flux) and the C-C and Calcarb construction must be employed. Using C-C as a secondary structure is not an acceptable modification." This language does not preclude the use of a backup or secondary structure as long as the C-C/Calcarb system functions as the heatshield and outer mold line of the vehicle. Therefore, the use of a supporting substructure would qualify for the full incentive.

T-22 Does NASA intend to put in place a process that would allow proposers to run their concept by the ISP technology program office (and NASA Discovery Program Office) for their review and, if applicable, the ISP technology program office (and NASA) would produce a letter of "certification of applicability" that the proposer could include in their proposal as evidence that the concept qualifies for the technology cost credit?

A formal pre-certification review by ISPT to produce a letter of "certificate of applicability" will not be made available. A forthcoming clarification to Requirement 89 of the AO will indicate that in describing the application of the chosen NASA-developed technology, an analysis showing how the proposed use meets the minimum demonstration guidelines for that chosen technology should be included.

T-23 If a proposer is using an unsupported Advanced Carbon-Carbon (ACC) heat shield insulated with a Calcarb foam* (i.e., *"hot" structure for the spacecraft) and it could see a peak heat flux of >200 W/cm^2 during a planetary atmospheric entry, does this qualify for the ISP credit? Page 3, subtopic a of the document entitled "In-Space Propulsion Technologies Minimum Demonstration Requirements for the Discovery 2010 AO, February 26, 2010" only refers to requirements for a hot structure that is bonded to a structure. It did not specify the requirements for an unsupported hot structure. In this context, it is noted that the document entitled "Aerocapture for Discovery Missions Briefing prepared for Discovery AO participants, June, 2010" states that unsupported hot structures should be used at heating rates less than 300 W/cm^2.

The intent for use of the Carbon-Carbon (C-C) "hot structure" technology is to have the C-C used as a vehicle outer mold line during atmospheric entry, regardless of whether the C-C/Calcarb system is supported by a secondary structure. For this first flight application, the incentive does not specify a heating level associated with the supported and unsupported implementations. During testing, the technology developer found that the system performed well up to about 300 W/cm^2 when unsupported, and up to 700 W/cm^2 when supported. The real requirement for the incentive is expose the C-C system to a "significant" heating environment. That significant heating environment is intended to be a heat flux in the range that makes this technology valuable to the mission. In other words, if the heat flux is below 100 W/cm^2, there are probably high-heritage solutions, but over about 200 W/cm^2, the new technology begins to fill a gap in capability, and that is where NASA would like to see it applied. The exact heating level for a given Discovery mission is a prediction with some level of uncertainty on it, so adequate margins should be taken into consideration when applying the new technology. *Considering all of those points, applying the C-C system as the outer mold line in a predicted environment of 200-300 W/cm^2 appears to fulfill the incentive requirements.*

T-24 Is it possible to still receive the $19M incentive if we do not demonstrate a fully capable PPU, i.e., we simplify the PPU design, currently capable of accepting 80-160V by fixing the operating range?

The Discovery AO states that NASA is responsible for developing the NEXT PPU to TRL 6. NASA is committed to ensuring the NEXT PPU is at TRL 6 by PDR. Proposers however are also permitted to include in their proposal if they have identified any back-up options. It is up to a proposer to decide on whether they choose to carry an alternate PPU option through to spacecraft PDR. An alternate back-up PPU concept would be required to meet the performance necessary to meet the minimum science floor. An alternate back-up PPU concept would need to demonstrate TRL 6 in the relevant NEXT operating environments or include a technology development plan to achieve TRL 6 by PDR, and then would need to be qualified/re-qualified to the NEXT operating environment. If NASA were unable to deliver a NEXT PPU to TRL 6 by PDR, then an alternate back-up PPU concept would be deemed an acceptable substitution at PDR and the proposer would be able to keep the full NEXT cost incentive. Therefore, a proposal that baselined the use of an alternate PPU *would not be eligible for the $19M cost cap incentive.*

Management

M-1 Requiring the same 25% unencumbered reserve in Phase E as in Phases B-D does not seem to consider the difference in degree of risk between the development and operations phase, nor variations in the duration for Phase E. Shouldn't this requirement be altered, say to only 15%?

Recent experience has demonstrated that ground and flight software development are often partially delayed until Phase E in planetary missions. Moreover, recent cost overruns in operating missions have indicated that the community's ability to predict Phase E costs is not as strong as once thought. Therefore, a higher level of reserve has been deemed appropriate and 25% is in line with the recent cost overruns.

M-2 Is earned value management required for science operations in Phase E?

NM 7120-81 does not require earned value management in Phase E.

M-3 There is some verbiage in the NM 7120-81 that says that "reserves" is an "obsolete term"… yet the AO specifically uses the term reserves. Should we switch everything in our proposal over the new term "UFE" (Unfunded Future Expense)?

No, do not switch from the word "reserves" to "UFE". The two terms refer to different things. Reserves are funds held at the project level to deal with "unknown, unknowns." The AO defines what is meant by "reserves" in its glossary on page C-4 . UFE refers to funds held at the program level to cover those potential costs captured by "Joint Confidence Level" estimates that are above the funds held by the projects in the program.

Proposals

P-1 Where are the appropriate NASA data archive policies and practices documented/stated as referred to in page 11, section 4.4.3 of the Draft AO?

Documentation and tools for NASA Planetary Data System may be found at http://pds.nasa.gov/tools/index.shtml. For other NASA archives, please contact the archive directly.

P-2 What are the definitions and differences among the various science team enhancements referenced —guest observer programs, general [sic] observer programs, participating scientist programs, and interdisciplinary scientist programs?

A "guest observer program" or "general observer program" solicits for proposals from non-team members to utilize the data collected by a mission for objectives different from those of the mission. Guest observers are usually also able to request specific observations. Guest observer programs are solicited after launch. A "participating scientist program" or interdisciplinary scientist program" solicits for new mission science team members, associated with specific mission instruments or specific science investigations, usually to augment the science expertise of the team. Participating scientists and interdisciplinary scientists are full members of the mission science team. Depending on the length of the mission, participating scientists or interdisciplinary scientists can be selected either before a mission launches or during the operational phase. The different terms are used by different communities (*e.g.* planetary science, astrophysics, heliophysics, and Earth science). Note that the AO requires the proposal to define these terms as applied to the proposed investigation.

P-3 ***Are NASA-funded contributions restricted to exclude all of SMD efforts, as stated in Section 5.5.6, no matter which program in SMD funded the contribution?***

Yes.

P-4 ***On page ii of the Draft AO, the cost cap is based on $425M in FY10 dollars. However, on page 31, the Phase A cost is capped at $3M in RY dollars. Should the Phase A cost be consistent with the cost cap dollars and all be done in FY10 dollars?***

No. The Phase A funding of $3M will be in whatever year is appropriate given the selection date.

P-5 ***Table B3 in the Draft AO is to be shown in RY dollars per fiscal year/phase. Would you like to see Table B3 in FY10 dollars by fiscal year/phase as well?***

For each phase, the table also asks for the FY10 total.

P-6 ***Can the references to launch date in the Draft AO be updated to remove any ambiguity:***

- ***a. Requirement 85 says that we shall propose a "launch readiness date (LRD) no later than 12/31/16".***
- ***b. Section 3 says the "Launch Deadline" in NLT than 12/31/16.***
- ***c. Appendix G Requirements crosswalk for requirement 85 says "Latest primary launch date".***
- ***d. Appendix F Compliance Checklist item 24 says "launch date prior to launch deadline".***

All have been changed to refer to “launch readiness date.” See Question O-2.

P-7 ***Can proposer’s use extra/additional pages in any location in the proposal independent of the source of the extra page count?***

Extra pages may be used anywhere in Sections D – G up to a total of 10 pages per Table B-2 and its footnotes in the Draft AO.

P-8 The first line of requirement B-40 in the Draft AO refers to "schedule foldout(s)," suggesting the possibility of multiple foldouts. Later in the requirement, two references are made to a "schedule foldout" (singular), as does the Proposal Structure and Page Limits table in requirement B-4. Are multiple schedule foldouts permitted and do they not count against the page limits?

The requirement has been clarified to allow for multiple schedule foldouts as needed. Concision, however, is preferred.

P-9 Are Requirement 76, third paragraph, and Requirement 77 of the Draft AO duplications?

Requirement 76 does not have a third paragraph; it consists only of a single sentence. Requirement 77 is the requirement implied by the paragraph preceding it. All requirements in this AO are marked as such so there may be requirements that appear duplicative of other AO text.

P-10 Table 2 on page 31 of the Draft AO lists the "Adjusted Cost Cap" for using various NASA-developed technology, yet for the very first item, "ASRG", it shows the adjusted cost cap to be exactly the same as the regular cost cap. Is this a typo?

No. As discussed at the Potential Bidders' Conference, this is not an error.

P-11 Can a project manager and a project manager alternate be named to more than one proposal?

Yes, they may be on more than one proposal.

P-12 Shouldn't the science investigation address both the NASA strategic goals [2.1] and the Discovery program goals and objectives [2.2]? As now worded, Requirement 4 of the Draft AO refers only to "program science objectives", whereas the NASA goals seem more all-inclusive.

Indeed, the science investigation should address both NASA's and the Discovery Program's goals.

P-13 ***List of References described in Appendix B of the Draft AO requires that a proposer includes an externally accessible URL to institutional guiding documents such as Flight Project Practices if such documents are cited. In some cases these documents are proprietary and/or export controlled. It is not possible to make such documents available in the open literature. To satisfy this requirement, however, a website could be created which allows a secure log-in from a designated individual, say the NASA Discovery POC, who would then disseminate the document as the POC saw fit, complying of course with any special marking language. All that would be required from NASA would be the name, affiliation, citizenship, and email address of the Discovery POC. Would such an arrangement be acceptable?***

The POCs for the AO are Dr. Michael New and Dr. Carlos Liceaga, PE. Both are US citizens and, as Civil Servants, are bound by their oath of office to protect trade secrets.

P-14 ***If a respondee to an AO submitted (within the overall allowable page allocation) an optional instrument or a mission element (e.g., a probe) that was an enhancement to the Baseline but not required to meet the AO baseline science/mission goals and objectives would NASA:***

- ***a. Remove the optional section and evaluate the Baseline proposal only?***
- ***b. Review the Baseline proposal and then the option as a separate, independent submittal?***
- ***c. Evaluate the optional section independently and if selected by NASA consider it as having been competed for any future procurement or addition to the Baseline?***

The Phase A for the option would be funded using a portion of the baseline Phase A funding and used to study and determine the impact on the science and mission resources before evaluating a continuance into later mission phases?

If it is within the cap, then it's a descope-able piece of hardware like any other; no such hardware is allowed to be outside the cost cap.

This answer has been modified by the answer to P-27.

P-15 The Draft AO requires 55 hard copies of the Step 1 proposal as well as electronic copies on CD-ROM. Given the financial and environmental costs of producing so many hardcopies, will NASA consider waiving the requirement for so many hardcopies and instead accept electronic copies only, which could be validated to conform to the ISO PDF/A standard?

Not at this time. NASA is performing pilot tests of all-electronic AO submissions with the ExoMars Trace Gas Orbiter AO. Once that evaluation is complete and the impacts of all-electronic AO proposals have been assessed, a decision will be made on whether to standardize AO submissions to a new, all-electronic format.

P-16 Is it possible to retain the same page count for the various sections used in the final New Frontiers AO for the Discovery AO?

No.

P-17 Should the ITA support of the Project Systems Engineer and Chief S&MA Officer be shown as contributed costs in Table B3?

The ITA function is funded independently of projects (and independently of programs for that matter), so proposals should not report the costs for ITA support in Table B3, at all. ITA is part of NASA's cost of managing the project.

P-18 Could example science and mission traceability matrices (B1 and B2 in the Draft AO) be shown for missions that return samples as well as only data?

Tables B1 and B2 in the Draft AO are generic templates. NASA expects the proposer to modify them as necessary to describe their mission. Proposers are also welcome to include a third matrix if that is what they need to explain their traceability.

P-19 For some types of missions, it is not clear whether some information should be placed in Section E or F. Could guidance be provided as to which types of reviewers evaluate which sections?

All reviewers read the whole proposal and NASA will not give any guidance on the content of Sections E and F.

P-20 Does the 1% minimum for Education/Public Outreach apply to Principal Investigator-managed cost with or without reserves? Or does it actually apply to the PI-managed cost cap, as stated in the AO for student collaborations?

It actually applies to the PI-Managed Mission Cost Cap to prevent recursive calculations. The final AO has been corrected.

P-21 Should leaders for optional student collaboration experiments be listed as co-investigators, collaborators, or "other professionals"?

Section 5.4 of the Draft AO defines the roles of co-investigators and collaborators.

P-22 Is there any advantage to proposing capabilities that could be valuable to future NASA missions, such as adding dosimeters to better understand radiation impact?

No, however contributed investigations supported by non-SMD funding are allowed.

P-23 Requirement B-54 of the Draft AO states that the proposal "shall provide details of the development schedule of the student collaboration." How much detail is required?

In the Step 1 proposal, any SC will be evaluated only for the impact it has on overall mission feasibility to the extent that it is not separable. Sufficient schedule detail should be provided to demonstrate that the SC can be incorporated into the mission on a nonimpact basis and is clearly separable from the rest of the proposed effort.

P-24 What is the current NASA philosophy, practice or policy regarding using the dollar value of funded schedule reserve when computing the total funded reserves in preparing a response to an AO? I have seen where it can be added to other funds and I have seen where it must be kept separate.

The Discovery 2010 AO is based on the Standard AO. In the standard AO, there are separate requirements for adequate funded schedule reserves and adequate cost reserves. Schedule reserve cannot be counted toward cost reserve.

P-25 May Centaur or Delta upper-stage, long-term residual fuel storage and/or use by fuel cells to power the primary payload be used if they are provided by the Exploration Systems Mission Directorate or the Air Force?

In the absence of further technical details, a comprehensive answer is not possible. However, any modifications to a standard upper stage will raise mission assurance and range safety concerns that the project will have to address. Moreover, any modifications may also affect the ability of the mission to satisfy orbital debris requirements. Any contributed hardware would count against the contribution limit. See Section 5.6.7 of the AO for details.

P-26 Which document takes precedence if there are differences in information - the draft AO or the community announcements or notices on the web or FAQs? Is there a hierarchy or is it simply whatever is most recent?

The final Discovery 2010 AO takes precedence over all other documents. Comments in this Q&A document should not alter statements made in the final AO, merely clarify them.

P-27 Is it possible to propose an SEO that includes provision of a cruise phase instrument that is contributed to the Discovery mission?

Section 5.1.6 of the Discovery AO allows SEOs to be proposed. However SEOS are contemplated as non-flight hardware enhancements that make use of the Discovery mission beyond the proposed baseline investigation. The AO reflects that policy where it states that: "Funding requested for SEO activities prior to Phase E should be minimized." However you may propose the accommodations for an SEO instrument if the instrument is funded outside of the Discovery program. The Discovery proposal must include sufficient detailed information on accommodating the optional cruise phase instrument so that TMC can assess the feasibility of the proposed development plan both with and without the instrument. The limits on the length of the section describing the SEO remain unchanged. [This modifies Q&A P-14.]

P-28 Why doesn't the Discovery AO permit an all-electronic submission (upload a PDF of the proposal into NSPIRES), as was permitted by the recent AO for ExoMars Trace Gas Orbiter Instrument proposals, instead of requiring that 65 paper copies of the proposal be delivered to NASA?

Requiring an all-electronic proposal submission for the ExoMars Trace Gas Orbiter (EMTGO) Instruments AO was a pilot program to determine whether electronic proposal submission was appropriate for AOs. Although electronic proposals work fine for ROSES proposals, SMD has determined that it is not appropriate for AO proposals for several reasons:

- The proposals are more complex than ROSES proposals and require more study. Reviewers make notes on the pages and in the margins.
- Paper copies give reviewers the ability to cross-reference multiple pages simultaneously.
- Many reviewers cannot read complex text off computer screens.
- Many EMTGO proposals contained figures with small text; this made electronic review difficult and printed copies illegible.

SMD has determined that most reviewers make paper copies anyway. Nearly all the EMTGO reviewers used paper proposals that they printed themselves on printers of varying quality. If paper copies were not submitted by the proposers, then NASA would need to produce bound paper copies for reviewers. This would delay the start of the evaluation process because these would need to be produced after the proposal due date. In addition, this removes quality control of paper copies from the proposers.

P-29 We request clarification of the intent of the note at the bottom of page B-2 in reference to the table on "Proposed Structure And Page Limits of the AO" that states "the extra pages may be distributed between Sections D-G as desired". For example, may a proposer use one extra page for each science instrument and use the left over page (from the 2 page/instrument allowance) in the flight element section. Is the following example page allocation acceptable: 5 pages for 5 instruments, 1 page for SEO and 4 pages for each of two flight elements?

Yes, that is correct. A total of 10 extra pages may be added to the proposal with no more than 2 of these describing any SEO, 2 describing each instrument, and 2 describing each flight element. Therefore, the example allocation is acceptable.

P-30 The Discovery 2010 AO page count rules allow 2 pages per instrument. Is it acceptable to allocate 2 pages to a radio science investigation to describe the instrument which includes the spacecraft telecom subsystem operating in concert with the DSN to achieve the science objectives?

If the radio science investigation requires a modification or addition to the spacecraft telecom subsystem, then the extra 2 pages may be used to describe those modifications. If the spacecraft telecom subsystem can participate in the radio science investigation without modification, then no "radio science instrument" exists and so no extra pages may be allocated.

P-31 In Section 4.2 of the Draft AO, the following statement is made: "Until the final AO is released, Aerospace Corporation has no limitation and is permitted to participate fully in all proposal activities." This statement is not included in the Final AO. Can proposers assume that this statement still holds?

The restrictions on Aerospace Corporation's activities are detailed in Section 4.2.1 of the AO.

P-32 Requirement B-24 states that "Non-funded members of the science team shall be identified in the proposal as collaborators (see Section 5.4 of this AO). The role of collaborators may be defined and justified." Is there a requirement to include resumes of non-funded collaborators who are part of the science team?

Based on the wording of that requirement, the resumes of all members of the science team must be included in the proposal.

P-33 Draft CSR Guidelines in the Program Library say on p.2: "CSRs are due by 4 p.m. Eastern Time, November 26, 2011" and "The target date for this continuation decision (i.e. "down-selection") is April 7, 2012." The Discovery AO says on p.4: "Phase A Concept Study Reports due (target): February 2012. Down-selection of investigation(s) for flight (target): June 2012" Which is correct?

Please follow the instructions in the AO. The Draft CSR Guidelines are not completely up-to-date and are provided to give a sense of the effort to be required in Phase A.

P-34 In Requirement B-40, sentence #4, the word "foldout" in the draft AO changed to the word "chart" in the final AO. Does this change indicate proposer(s) are required to include an additional chart in the schedule narrative section, along with the required foldout(s) and required summary on the fact sheet? Can you clarify the definition of this "chart" or is it merely the schedule foldouts as required?

The word "chart" was meant to refer to the graphical display of the schedule. It is synonymous with "foldout(s)".

P-35 Can the Discovery AO be linked in NSPIRES at this time to allow us to start proposal cover sheet generation and begin team member confirmations? (Discovery AO is available as NOI but not as a proposal). The summer will be a particularly challenging time period to get team members linked in to proposals.

NSPIRES cover-sheet generation will be enabled soon.

P-36 For missions proposing ASRGs, what is the correct responses for the following NOI questions in NSPIRES:

1. ***Does This Project Have an Actual or Potential Impact on the Environment?***
2. ***Has an Exemption Been Authorized or an Environmental Assessment (EA) or an Environmental Impact Statement (EIS) Been Performed?***

The correct answer to Question 1 is "yes" and the correct answer to Question 2 is "no."

P-37 Section 5.9.3 in the Body of the AO (Req 89 & 90) and Appendix B (Req B-72) only reference three NASA-developed technologies, NEXT, AMBR and Aerocapture, as explicitly requiring discussion in Appendix J.13. Even though the ASRG is one of the NASA-developed technologies listed in the AO, it does not appear to be required to be addressed in Appendix J.13. Please confirm that there is no requirement for the NASA-developed ASRG technology to be addressed, per Req 89, 90 or B-72, in Appendix J.13.

The lack of an explicit mention of the ASRG in Requirements 89 and 90 was an oversight and will be corrected in a forthcoming amendment to the AO. Investigations proposing the use of the ASRG *should* describe the infusion plan for the ASRG technology in Appendix J.13 of their proposal.

P-38 There still seems to be some confusion on the extra page allocations in the Discovery AO due to the note at the bottom of Table B-2 which states that "extra pages may be distributed between sections D-G as desired". If one only uses a single page (of the 2 page allocation) for an SEO, can the unused extra page from the SEO allocation be used anywhere in D, E, F or G to address any topic?

Yes. See the answer to question P-42.

P-39 Are Letters of Commitment required for NASA-provided services? For example, would a Letter of Commitment be needed from the Mars Program Office regarding communications relay support for a Mars lander mission?

With regard to DSN services, the paragraph after requirement 31 says "Where the use of NASA's network services is clearly within the capabilities and capacities described in the NASA's Mission Operations and Communications Services document, no Letter of Commitment is required from the NASA network provider." For other NASA-provided services, a Letter of Commitment will be needed if the availability of that service is not publicly stated (such as on a website or facilities documentation), or where the proposed use goes beyond the publicly stated availability.

P-40 Where in the proposal should we discuss the Phase A tasks we will complete? We were not able to determine from the AO where the reviewers would like to see this list.

The AO does not request a draft SOW for Phase A. However, it would be a good idea to have one ready in case of selection.

P-41 Is a scientist who is essential to an optional SC experiment considered "an investigator who plays who plays a necessary role in the investigation?" Is it better to (1) list such individuals as collaborators and expect them to do free work for us in Phase A, or (2) make them Co-Is with funding only in Phase A, pending later decisions? The same question applies to a scientist needed for a Phase A trade study, but who may or may not have an essential role in the flight project, depending on the outcome of that study.

Any scientist considered "essential" to any part of a proposal is "an investigator who plays a necessary role in the investigation." Although an SC is optional and may not be selected even if the rest of the proposal is selected, proposers should assume for this purpose that the SC will be selected along with the mission. How, and when, such a person's efforts are supported is an issue to be negotiated between the scientist and the proposal PI. One consideration in such a negotiation is to ensure the scientist's participation and how to demonstrate that commitment in the proposal.

P-42 ***We request clarification of the intent of the note at the bottom of page B-2 in reference to the table on Proposed Structure And Page Limits of the AO that states that "the extra pages may be distributed between Sections D-G as desired." For example, may a proposer use one extra page for each science instrument and use the left over page (from the 2 page/instrument allowance) in the flight element section. Is the following example page allocation acceptable: 5 pages for 5 instruments, 1 page for SEO and 4 pages for each of two flight elements?***

According to the table on page B-2 of the AO, 25 pages are allowed for Sections D and E and 25 pages are allowed for Sections F and G. Up to 10 extra pages may be added to Sections D-G according to the formula:

```
(# extra pages) = min[ 2*(# instruments)
                     + 2*(# flight elements)
                     + if("SEO present",2,0),  10 ]
```

where if(EXPR,A,B) equals "A" if EXPR is true and "B" otherwise and "SEO present" means that the proposal contains at least one Science Enhancement Opportunity (SEO). Although the extra pages were intended for the discussion of the instruments, flight elements and SEO(s), there is no such restriction in the AO. In the questioner's example, the 5 instruments, 2 flight elements and an SEO would allow 10 pages to be added to Sections D-G (for a total of 60 pages for the four sections) in any manner the proposer might wish. On the other hand, a proposal with 2 instruments, a single flight element and no SEO would only be allowed 6 extra pages.

P-43 ***The Phase A guideline document says there may be a funded bridge phase. Is that within the $425 Million?***

Yes. This bridge phase exists so you don't lose time while we negotiate your contract. Proposers should note that Phase A ends at the end of the Step 2 competition.

P-44 ***Is the post-submission compliance check a pass-fail or can proposers fix any problems found?***

You can't fix a compliance issue after proposals are due. NASA can request a clarification, however. The compliance checklist is listed in the AO as Appendix F and the items considered are all pretty straightforward.

P-45 In terms of the use of new technology, there are two appendices J.13 and J.14. If you are using an ASRG you are supposed to do both of those?

Yes. The appendixes answer two different questions. J.14 is your explanation for why you can't do your mission without an ASRG. J.13 is where you describe how the ASRG will be infused into your mission (working with Program Office, *etc.*)

P-46 Requirement B-70 states: "The discussion of each element shall include…for any proposed elements with substantial design heritage, a comparison of the cost of the heritage items to the proposed cost." Please clarify what is meant by "substantial" design heritage.

"Substantial design heritage" means that the proposal is claiming cost savings from an element's design history.

P-47 The NSPIRES pull down list for proposal start and end dates only goes out to 2020. My mission's end date is after this. What should I do?

Please enter an end date that is either one day after your start date or is December 31, 2020. Either of these dates will make it obvious that we must look within the body of your proposal for your actual end date.

P-48 Does the $100K cost associated with missions "Within scope of NASA Routine Payload Environmental Assessment" shown in Table 1, page 21 of the Discovery 2010 AO, apply to all missions? Does this mean that missions with no nuclear sources/material are essentially capped at $424.9M and not $425M?

The $100K cost only applies to missions that are within the scope of the NASA Routine Payload Environmental Assessment (RPEA). The costs in Table 1 are not cumulative. So, a "vanilla" mission effectively has a cost cap of $424.9M while a non-nuclear, restricted Earth-return, sample return mission has an effective cost cap of $412M ($425M - $13M) assuming that no technology infusion incentives apply.

P-49 How should the costs in Table 1 (Launch Approval) on page 21 and Table 3 (non-standard launch services) on page 41 be interpreted for a mission that uses ASRGs and RHUs? Is it correct that a mission with ASRGs and RHUs has have to carry $20M for ASRG Launch Approval plus $20M in non-standard launch services for the RHUs?

As shown in the tables, a mission using both ASRGs and RHUs needs to carry $20M for Launch Approval and $0 for non-standard launch services. A mission carrying RHUs *only,* however, would need to carry $20M for launch approval and $20M for non-standard launch services. The Discovery Program will provide the funds needed for non-standard launch services for missions using ASRGs.

P-50 We are entering information for the NSPIRES cover sheet for Discovery mission proposals. In addition to a Project Manager, our proposals also contain a Project Manager Alternate. We notice there is not a drop-down menu item for a Project Manager Alternate. What should be done?

When adding your Project Manager *Alternate* to the Proposal Team element in the NSPIRES Cover Page, please choose Project Manager in the Assigned Roles pull down menu. NSPIRES will not raise an error if there are two project managers named on a single proposal. The proposal, of course, must describe which will be the alternate.

P-51 On August 3, 2010, Amendment 2 was issued regarding Clarification of Two AO Requirements. Requirement 89 was updated to include ASRG technology. The requirement asks for a description of the application of ASRG technology for the mission, including how the proposed use meets the minimum demonstration guidelines for the chosen technology. In the Discovery Project Library, there is a document entitled "In-Space Propulsion Technologies Minimum Demonstration Requirements". However, this document does not have any information regarding minimum demonstration guidelines for ASRG. So, is there a set of minimum demonstration guidelines for use of the ASRG technology for Discovery missions?

No, there are no minimum demonstration requirements for the ASRG.

P-52 ***On August 16, 2010, Amendment 3 was issued which added Requirement B-30A requiring the provision of sufficient data to permit an independent assessment of the proposed mission design and trajectory. Among the data requested were the date/time of each trajectory event with a brief event description (e.g., Launch, Gravity Assist, Fly-by, Rendezvous, Mid-Course Burn) and the appropriate data for the event (e.g., flyby altitude, flyby angle, flyby/intercept velocity, delta-v magnitude for three different scenarios corresponding to the opening, mid-point, and closing time of the proposed launch window. For proposals with multiple, backup launch windows, must event data also be provided for all three scenarios?***

Event data need not be provided for backup launch windows, just the prime launch window.

P-53 ***Req. B-30A asks for "flyby angle." What does that mean?***

The term "flyby angle" was intended to represent the B-plane angle associated with a gravity assist. However, given the multiple ways and different conventions under which "flyby angle" might be specified, proposers may elect to provide pre- and post-flyby spacecraft state vectors to eliminate any ambiguity.

P-54 ***In Table B3 (TOTAL MISSION COST FUNDING PROFILE), should the phase A costs only appear in the phase A line or should they also appear in the element-by-element breakdown as well?***

The intention is to get all Phase A costs on the Phase A line, with costs beyond Phase A costs broken out by WBS element.

P-55 ***The recent change in NSPIRES on how NASA civil servant salaries are handled looks like it does not pertain to the Discovery proposals. It looks like it is just ROSES proposals. Could you confirm that this change is not in effect for Discovery proposals?***

You are correct: those changes only apply to ROSES proposals. Instructions for handling CS salaries and overheads are contained in the AO (Section 5.6.6).

Launch Vehicles and Secondary Payloads

LV-1 What is meant in Appendix B, Requirement B-31, Page B-14 of the Draft AO, by the phrase "C3, heliocentric and/or declination?"

The phrase "C3, heliocentric and/or declination" are attributes of a mission's launch and are offered as examples of the type of information proposals should contain to demonstrate a mission's compatibility with all available launch vehicle families.

LV-2 If Table 3 [in the Draft AO] is indeed in $RY, please provide a year-by-year profile of the expenditures.

~~This table will be rewritten and the costs expressed in FY10 dollars~~. In the final AO, this table has been renumbered as Table 2 and the costs are expressed in FY 2010 dollars.

LV-3 Which launch vehicles families should proposers consider to comply with Requirement 88 of Draft AO?

The Atlas, Delta, and Falcon families are currently on, or on-ramped for, the NASA launch services contract.

LV-4 Would secondary launch opportunities (multiple, small spacecraft on an ESPA-ring, for example) be allowable in the upcoming Discovery round?

At this time, Discovery missions must be primary payloads.

LV-5 Requirement 87 of the Draft AO states that launch delay costs as a result of spacecraft or payload delays are not a standard launch service and must be funded out of the PI-managed mission cost. Who pays for a delay caused by the NEPA process?

The project must pay the costs.

LV-6 What does "compatibility" with a launch vehicle family mean?

In the context of the Discovery 2010 AO, compatibility with a launch vehicle family means:

1. the proposed spacecraft can physically fit inside of the launch vehicle family's payload shroud,
2. the proposed spacecraft can be mated to the launch vehicle family's payload adaptor (or demonstrate funding to develop a specific payload adapter), and
3. the proposed spacecraft will not be damaged by the expected launch environment of the launch vehicle family.

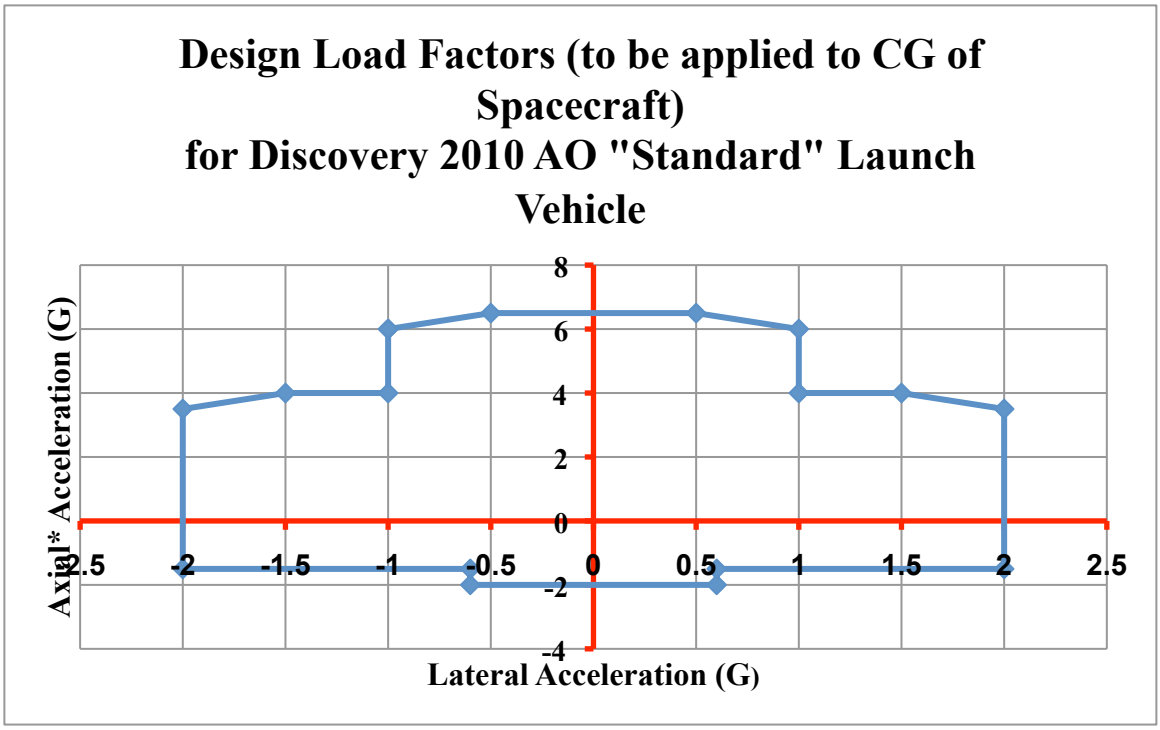
In this context, compatibility does not imply that a mission's performance requirements must be modified in order to meet the capability of each launch vehicle in a launch vehicle family. In other words, the *mission* will drive the spacecraft mass and orbit requirements. The spacecraft must remain compatible with all vehicles that can meet its performance requirements.

LV-7 If a proposed mission can use a launch vehicle with lower performance than the "standard" performance class, will a credit be given thereby raising the cost cap?

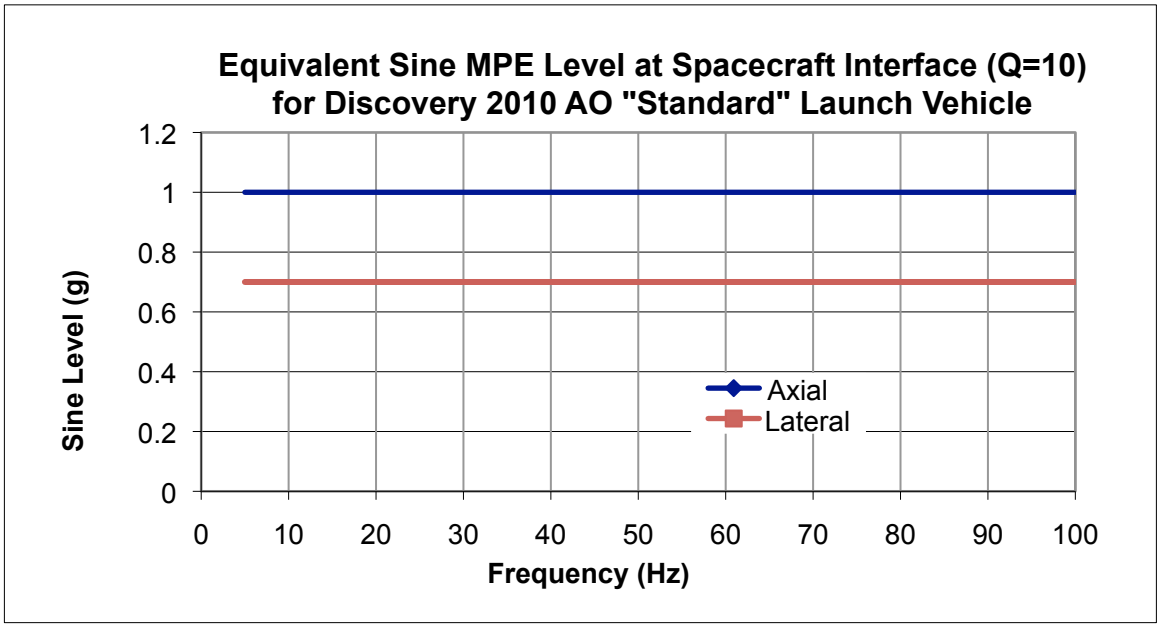
No. Table 3 of the Draft AO contains the costs to proposers of launch vehicles of varying performance. The standard launch vehicle to be offered is the lowest performing launch vehicle available to proposers.

LV-8 How can proposers demonstrate compatibility with a launch vehicle that has not had many, or any, launches yet?

Practically, this is only an issue for proposals designing to use the "standard" performance launch vehicle available under the Discovery 2010 AO. Below, are graphs and tables providing composite dynamic loads and environments based on 3 vehicles: Atlas-V-401, Delta-IV-Medium (4040), and Falcon-9. Please keep in mind that all Falcon-9 dynamic environments and loads could be updated after their first launch. NASA will provide updated information if there are any updates that impact the envelope environment.



* Positive axial load factor denotes compression



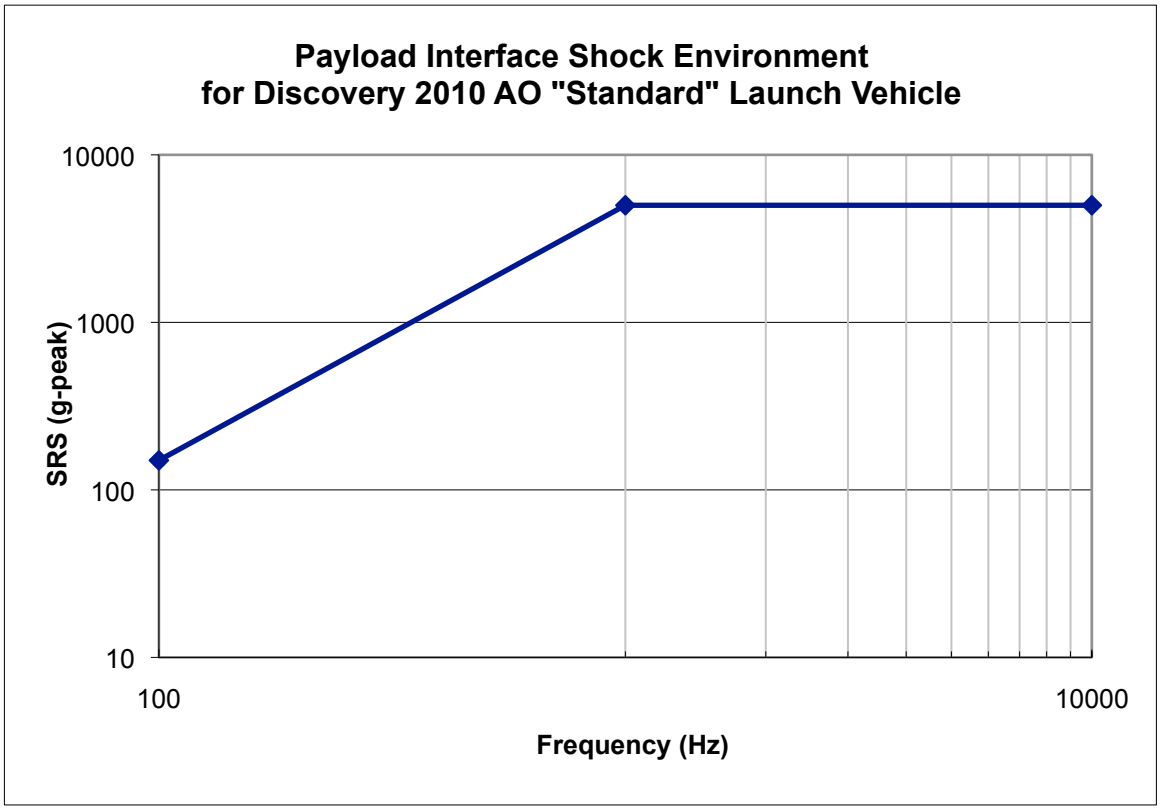
Please note that for acoustics, two tables are provided: one titled Vehicle "A" and the other Vehicle "B". It happens that Vehicle "B" provides their acoustic environment defined as full octave band Sound Pressure Level (SPL) rather than the typical 1/3 octave band SPL.

Acoustic MPE Levels

Acoustic Environment for Discovery 2010 AO "Standard" Launch Vehicle "A"		
Frequency (Hz)	**1/3 Octave Band SPL (dB)**	**to compute OASPL**
25	114	2.51189E+11
31.5	119.5	8.91251E+11
40	125.2	3.31131E+12
50	125.2	3.31131E+12
63	126.3	4.2658E+12
80	128	6.30957E+12
100	129	7.94328E+12
125	130	1E+13
160	130	1E+13
200	130	1E+13
250	130	1E+13
315	130	1E+13
400	129.5	8.91251E+12
500	128	6.30957E+12
630	125	3.16228E+12
800	123	1.99526E+12
1000	121	1.25893E+12
1250	119.5	8.91251E+11
1600	118	6.30957E+11
Frequency (Hz)	**1/3 Octave Band SPL (dB)**	**to compute OASPL**
2000	116.5	4.46684E+11
2500	115	3.16228E+11
3150	113.5	2.23872E+11
4000	112	1.58489E+11
5000	110.5	1.12202E+11
6300	109	79432823472
8000	107.5	56234132519
10000	106	39810717055
Overall SPL (dB)		140.0379397

Acoustic Environment for Discovery 2010 AO "Standard" Launch Vehicle "B"		
Frequency (Hz)	**Full Octave Band SPL (dB)**	**to compute OASPL**
31.5	128	6.30957E+12
63	131	1.25893E+13
125	135.2	3.31131E+13
250	133.6	2.29087E+13
500	130.3	1.07152E+13
1000	126	3.98107E+12
2000	120	1E+12
4000	116	3.98107E+11

Overall SPL (dB)	139.5911292



Frequency (Hz)	SRS (g-peak)
100	150
1000	5000
10000	5000

LV-9 ***May the PI fly a primary spacecraft and a secondary spacecraft with Aeroshell that separate after TCM-1 and/or fly to their destination and then separate into two spacecraft?***

A comprehensive answer is not possible without more details; for example, is the proposed mission similar to Cassini-Huygens with both spacecraft contained within the same launch vehicle fairing or would modifications be needed to the launch vehicle or its fairing? Are the proposed spacecraft part of the same mission? Are the spacecraft going to the same destination? Currently, NASA does not possess a dual payload adaptor for intermediate-class launch vehicles, however, some early development work has been performed. If required for a mission, the development and certification would have to be funded by the mission.

LV-10 Where do S/C perform their standard integration flow at KSC? How long is the standard flow and is there a cost for longer integration flows?

Most S/C are processed through a commercial facility for their offline flow (*e.g.,* Astrotech at KSC). Alternatively, payloads that have nuclear generators or that have planetary protection requirements, are processed at a NASA facility, the Payload Hazardous Servicing Facility (PHSF). Generally, the standard flow is 14 weeks. For more time in the payload processing facility, the project will need to set aside some funds. A WAG at the cost of this is $100K/week.

LV-11 Can the ASRG processing occur at Astrotech, or does one need to propose a different facility?

There is a dedicated facility on KSC, the RTG Facility, which is designed for processing nuclear generators. Typically, the generator is processed off-line in the RTG facility and meets up with the S/C at the pad or Vertical Integration Facility (VIF) (sometimes there is a S/C fit-check earlier in the PHSF). The cost of the use of the RTG Facility is included in the nuclear costs covered in the AO.

LV-12 I've "heard" that there are new, lower, performance numbers for the EELV family of launch vehicles. Can you confirm or deny this?

ULA recently released to the public updated Earth-escape performance data for the Atlas V 401 and 551. However, through the structure of the AO, NASA is committing to providing proposers with the performance capabilities described in the Launch Services Information Summary. Proposers should use the information in the AO and the Program Library in deciding on which launch vehicle performance *class* is appropriate for their investigation.

LV-13 If our launch configuration requires a stack-up of more than one adapter, will all adapters be included in the launch services cost or will any adapters after the first be the responsibility of the PI for costing purposes? If only one is included in the launch vehicle cost, can NASA provide a cost for each adapter?

In the absence of further technical details, a comprehensive answer is not possible. However, from the launch vehicle point of view, there is only one separating interface. In the past, if multiple separations were necessary, missions purchased their own separation system. In any case, NASA doesn't have prices on-contract for different adapters and/or adapter pieces. If there is a unique mission interface, it would be specified in the Launch Service Task Order (LSTO) and launch vehicle vendors would bid their own solution. Most likely, the mission would not tell the LV how to manage the interface, but would just specify their side of it. This has potential to be a Mission Unique to be charged to the mission. Moreover, depending on how complex a configuration is needed, even if it is an assembly of existing parts, there is still the potential for costs to the mission if use of the adaptor requires analysis or test to verify the integrity of the assembly in the proposed application.

LV-14 Must proposals carry extra mass margin to account for uncertainties in LV performance?

No. Proposals need to maintain whatever mass contingency and margin is consistent with their organization's design principles. No extra margin for launch vehicle capability uncertainties needs to be maintained. (In other words, if the AO promises a certain performance for a certain cost to the proposer, the Discovery Program in concert with LSP will provide that capability for that cost to the proposer.)

LV-15 If you have an ASRG mission, there is only one launch vehicle that has been nuclear rated, right?

NASA's policy is that any launch vehicle can be made sufficiently safe for launching radioisotope power systems. Therefore, proposers should not assume that only one type of launch vehicle is available to ASRG-powered missions.

LV-16 If a mission were to require the use of an upper stage, how would it be procured and what would the role of the Launch Services Program be?

Missions requiring the use of an upper stage must procure it themselves; the Launch Services Program has no vehicle for procuring an upper stage. The Launch Services Program would provide advice based on past experience, though, to missions procuring their own upper stage. Missions requiring the use of an ASRG *and* an upper stage must budget for the integration of that upper stage by the Launch Services Program, including possible modifications to the overall flight termination system.

International Participation

I-1 NASA describes in the Draft AO non-US contribution and PI/Co-I participation; are there any financial restrictions for a US hardware developer that is licensed to sell foreign-built hardware in the US? An example: Acme USA, Inc. owns the exclusive license to sell a road runner detector, designed and built by Verminator, GmbH of Germany This hardware, while built in Germany, is a product of a US company; what are the limitations, if any (does this fall into the 1/3 cap)?

If the hardware is being purchased from a company — foreign or domestic — then the contribution limit does not apply. If a non-US entity is providing the hardware free of charge to NASA, then it constitutes a contribution and the 1/3 limit applies.

I-2 Could a contributed element be considered a Science Enhancement Opportunity (SEO)?

Yes.

ASRGs and RHUs

AR-1 When is the ASRG fueled relative to its integration with the spacecraft or launch vehicle? Are there any special safety concerns?

The ASRG will be fueled at the Idaho National Laboratory, tested, and then shipped to the launch site. Once fueled, an ASRG controller must be continuously connected to the ASRG and fully functioning. The fueled (and operating) ASRG will be integrated with the spacecraft at the launch site. Please see the Space Radioisotope Power Systems: Advanced Stirling Radioisotope Generator and the Space Radioisotope Power Systems: Safety Fact Sheets in the Program Library.

AR-2 Will qualification of the ASRG to the selected project requirements be part of the GFE or does the project have to cost a yet unknown qualification or delta qualification for flight?

The ASRG will be qualified to the requirements contained in Interface Control Document and Characterization Data for the Advanced Stirling Radioisotope Generator (see Program Library). The CDR for the ASRG is well before any possible PDR for a mission selected under this AO so proposers will not be able to propose modifications or alternate qualifications beyond those described in the Program Library document.

AR-3 What is the sparing philosophy for the ASRG given that two units will be available for flight? If both units are flown in the proposed mission configuration, is there a 3rd flight spare provided by NASA as GFE?

NASA and DOE will provide two fueled and qualified ASRGs by no later than March 2014. It is up to the proposer to choose whether to use one as a flight spare or to fly both. If both are used as flight units, a third flight spare will not be produced.

AR-4 ***Will the Nuclear Launch Safety Approval (NLSA) or National Environmental Protection Act (NEPA) costs be paid for by NASA as services or does the project pay for this?***

~~It is currently expected that the project will have to pay for those parts of NEPA and NLSA documentation and analyses that require specific information regarding mission and spacecraft design~~. The costs associated with NEPA, NLSA, and nuclear launch services for missions proposing to use ASRGs will be limited to a firm, fixed cost of $20M (FY10). NEPA and NLSA documentation and analyses will require specific information regarding mission and spacecraft design. In particular, the following will have to be developed by, or with the input of the project:

- Mission/Spacecraft Alternative Studies for the NEPA process.
- Mission/Spacecraft Trade Studies to evaluate potential nuclear safety-related design changes
- Mission and Spacecraft Design Information for Databook(s)
- Mission sub-orbital and out-of-orbit radiological contingency plans
- Project participation in developing and implementing a risk communications plan for the mission

NASA will pay for the non-mission specific portions as well as the preparation of the NEPA documents, databooks, safety analyses, launch site contingency plans, and risk communication products.

AR-5 ***Are engineering models and simulators of ASRG interfaces included in the list of GFE items and if so, when will they be available?***

Three physical models/simulators will be supplied as GFE. They include and static mass model with representative center of gravity and moment of inertia, a thermal simulator with both conductive ASRG/SC attachment point and radiative properties and an electrical interface. Their design is intentionally held until later in the program to allow for interaction with the S/C designer to assure that the correct level of detail, commensurate with the intended use is designed into each of the models.

AR-6 ***At the Potential Bidders Conference, the NEPA Officer from NASA, Ms. Callister, presented that the costs associated with NEPA was $1-5M, yet the Draft AO specifies ASRG-enabled mission must allocate $17M for NEPA in their costs. Why are these values significantly different?***

The $1-5M was for NEPA compliance only. The $17M in the AO is for both NEPA and PD/NSC-25 compliance. This latter number may change in the final AO.

AR-7 ***Section 2.2 of the ASRG Information Summary document in the Program Library states that the Radio-isotope Power Systems Program Office (RPSPO) "will assist proposers in determining ASRG performance for specific sites on Mars and other destinations". We would like to solicit that assistance for our specific mission scenario. In addition to assessing ASRG power output, can the RPSPO provide an ASRG thermal model for incorporation into our detailed spacecraft thermal model so that configuration effects can be properly accounted for?***

Yes, the RPSPO will provide a thermal model upon request (due to export control requirements) and will be able to assist you. Please contact Robert Cataldo, at NASA's Glenn Research Center (Telephone: 216.977.7082; E-mail: Robert.L.Cataldo@nasa.gov) as described in Section 5.9.3 of the Draft AO.

AR-8 ***The first paragraph of Section 2.2 of the* ASRG Information Summary *in the Program Library document states that "Proposers should use…a system mass of 25 kg for planning purposes…" Using the definitions of Requirement B-34 on page B-16, should the 25 kg identified for the ASRG mass be used for the "current best estimate" or the "max expected?"***

The updated current best estimate (CBE) with design margin is 28.0 kg. The mass has grown due to additional levied requirements by NASA. The Program is holding a 5% reserve on the 28 kg, thus 29.5 kg should be used for planning purposes. This reserve will be released as the ASRG design gates PDR and CDR are achieved.

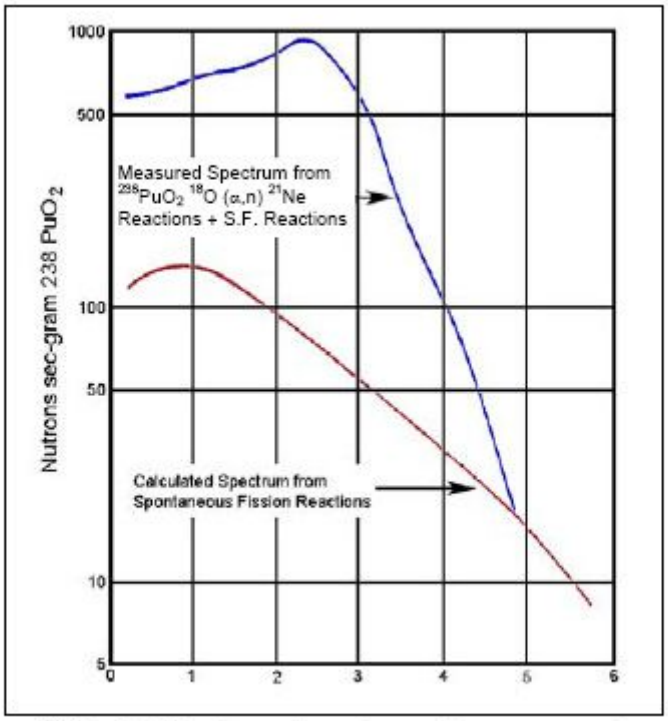
Margin is defined here to accommodate design known unknowns and reserve is for accommodating unknown unknowns. The masses for the ASRG to spacecraft (S/C) mounting plate and controller cable are not included since these items are mission or S/C specific.

AR-9 ***Are the costs in Table 4 for NEPA/NLSA compliance in FY 2010 dollars?***

Yes, the table is indeed in FY10 dollars.

AR-10 Is information available regarding the neutron flux energy spectrum produced by a fueled ASRG so that one could model the effects of neutrons interacting with the spacecraft?

The average neutron spectrum information for Pu-238 fuel used in radioisotope power systems is shown below. It is for the fuel only, and does not include shielding effects of the GPHS module or the generator itself. The reason this is described as "average" information is that it will vary somewhat with the composition and age of the fuel used. The actual heat sources that would be used in the ASRGs have not yet been manufactured. It should be used only for general spectral distribution information. The total neutron production rate is likely to be on the order of 6000 neutrons/sec-g Pu-238.



$^{238}PuO_2$ Neutron Spectrum Components

AR-11 ***The updated ASRG functional description document mentions we can interface directly with a manifold and use our own external pump system for thermal management. In that case, can the fins be removed?***

~~Yes, the fins could be removed in the ASRG flight configuration, however this method of cooling will be required for all phases of the ASRG, *i.e.*, ground operations, fueling process, qualification testing, spacecraft integration, *etc*. A new Concept of Operations will be needed to accommodate this feature. Adequate time and resources to plan for a complex spacecraft integration process and to develop the Concept of Operations to maintain ground cooling without the fins will need to be included in any proposal.~~

No, the fins may not be removed in that case.

AR-12 ***At the Potential Bidders Conference, it was mentioned that the ASRG controller will be separate from the ASRG. What is the maximum distance that the controller can be separated from the ASRG, and how might this affect the overall integration flow?***

The maximum distance is ~1.8 m (6 ft) from the ASRG mounting location to the controller mounting location as measured along a distance on the spacecraft surface where the cable is attached. Addition cable length will accommodate connections to the ASRG and the controller. The cable mass estimate is 1.7 kg/m including margin.

AR-13 ***Can NASA provide additional detail on the anticipated RHU integration process at the launch site?***

The overhead of having RHU's on site is considerable. Once the RHUs are at KSC, there is increased security and health monitoring in effect, which adds burden to the whole final assembly and testing process (cost and schedule). For example, for MER, the RHU's were stored in the PHSF where the s/c were being processed. They were placed in a safe and the area was roped off to the extent required for a safe exposure limit. Once the RHUs are installed on the s/c, stricter Security and Safety controls are put in place.

These additional security and safety precautions will be reduced if the RHUs are brought to KSC and integrated to the spacecraft at the latest time possible.

AR-14 ***When can the RHUs be integrated with the spacecraft (in payload processing facility prior to encapsulation, at launch pad in encapsulated fairing, etc.)?***

There is no prescribed time to install RHUs while at the launch site. This is typically driven by the spacecraft final integration and test schedule. Also see AR-13.

AR-15 ***What means of attachment to the spacecraft are permitted or acceptable for RHUs? Are there approved designs that can be used or adapted?***

Galileo, Pathfinder, Cassini and MER all used RHUs. Any means for attachment that conforms to normal mechanical engineering standards and minimizes exposure to installers per ALARA practices should be acceptable. Prior attachments for RHUs involved putting a cover over the RHU and then bolting the cover to the area where the heat is required. Cassini used a variable RHU, in that a louvered device was used. These designs could be provided if required.

AR-16 ***Are RHU simulators available for spacecraft thermal vacuum testing at the factory prior to arrival at the launch site? If not is a suitable design available?***

No. RHUs can be simulated easily with electrical resistance heaters. There is no known standard design available.

AR-17 ***Are the ASRG NEPA and launch support costs shown in the draft AO independent of any other mission-specific parameters such as schedule, trajectory type, etc?***

~~No. While the costs were based on consideration of the range of mission-specific parameters involved with previous RPS/RHU missions, certain parameters such as trajectory type, timing of PDR/CDR and timing for integrating the spacecraft with the ASRG at the launch site can affect ASRG NEPA and launch approval/support costs.~~

The costs associated with NEPA, NLSA, and nuclear launch services for missions proposing to use ASRGs will be reduced to a firm, fixed cost of $20M (FY10)

AR-18 ***Do the stated costs for NEPA and NLSA include project management overhead and reserves?***

They include project management overhead but not reserves; however, reserves for NEPA and launch approval costs under the control of the Program Executive are held at NASA HQ.

AR-19 ***The ASRG ICD lists high- and low-power states. Are these options we can select?***

No. This is the range of output power that corresponds to the high and low ends of the thermal power specified for the General Purpose Heat Sources.

AR-20 ***For the DSMCE studies, it was stated that ASRG risks would not downgrade the technical, management and cost evaluation, but this did not appear to be stated in the draft AO. Is that still the policy, and can more detail be provided on this policy?***

The appropriate use of the ASRG and planning for NEPA and NLSA compliance will be evaluated. Risks associated with the ASRG technology, itself, will not be.

AR-21 ***What, if any, are the costs for non-standard launch services associated with radioactive calibration sources for instruments, where the A2 mission multiple is less than 10? Are these sources within the scope of NASA Routine Payment Environmental Assessment?***

The NASA Routine Payload Environmental Assessment allows for the use of radioactive calibration sources for instruments where the A2 mission multiple is less than 10.

AR-22 ***Can you provide additional technical information on the electrical system of the ASRG?***

We are in the early conceptual design phase with new requirements, and the current description of the system and operation concept is in the AO Library, ASRG Functional Description dated December 2009. Additional detailed information should be available for the Step 2 proposal process.

AR-23 ***Can you estimate the performance of the ASRG on the surface of Titan?***

The ASRG is chemically compatible with the constituents in the Titan atmosphere. The internal volume is vented and will be immersed in the 1500 mbar, mostly nitrogen atmosphere at -178 C. Heat is rejected primarily by convection instead of by radiating as in a vacuum. The thermal analysis is rather involved, but the power estimate, with all things considered, would be in the range of 110-125 We. Some thermal insulation would be required to raise the rejection temperature and also some heat needs to be provided to the controller.

AR-24 ***We have seen multiple documents and version of ASRG ICDs / Function Description Specifications. One is a draft ASRG ICD (912IC001299 Rev 5, dated Aug 2008). Another is an ASRG Function Description (912IC002144 Rev 5, dated Dec 2009). Can you please verify which document number/revision contains the latest interface information to be used for the Discovery AO? Has the Functional Description superseded the ICD or is an updated ICD expected?***

Use only the current document in the AO library at the time the final AO is released.

AR-25 ***Is the ASRG System Specification (912SS001296) available for the Discovery AO proposers?***

No. This document is in development and not appropriate for use by proposers.

AR-26 ***Is the ASRG Design and Test Environment Specification (912ES001297) available for the Discovery AO proposers?***

No. This document is in development and not appropriate for use by proposers.

AR-27 ***Are the dynamic disturbance curves in Sec. 5.2 of the ASRG Functional Description (912IC002144 Rev 5, dated Dec 2009) analytical worst-case curves or are these based on measured test data?***

Dynamic disturbance was tested using the engineering unit ASRG, which differs from the flight design. The curves are analytical worst case, but they have been validated using this limited test data.

Note that the *ASRG Functional Description* Library document has been deprecated. It has been replaced by the *ASRG User Interface Control Document (ICD)* (912IC002085).

AR-28 ***The dynamic disturbance curves in Sec. 5.2 of the ASRG Functional Description (912IC002144 Rev 5, dated Dec 2009) seem to cut off at 35 Hz. Is this meant to imply that the disturbance is not reduced for lower mounting frequencies or is this assuming a minimum LV frequency cutoff?***

This is a minimum cutoff, but not related to the launch vehicle. The frequency referred to is a characteristic of the mounting interface between the ASRG housing and the spacecraft. The required interface characteristics are defined in section 5.1.3 of the ASRG Functional Description.

Note that the *ASRG Functional Description* Library document has been deprecated. It has been replaced by the *ASRG User Interface Control Document (ICD)* (912IC002085).

AR-29 ***For the ASRG mounting interface, is there a conduction value in (W/C) that should be used? Is there a linear conduction value (in W/C) from the interior heat source to the exterior shell that can be used for thermal math modeling purposes? Is there also a radiation conduction value (in W/K^4) from the interior heat source to the exterior shell that can be used for thermal math modeling purposes?***

It is not appropriate to consider W/C or W/K^4 from the heat source to the exterior wall of ASRG for thermal modeling. Typical ASRG nominal fuel loading is 2*250 Wt. Subtracting that from the electrical power output (Figure 4.2-2 of 912IC002144) is the waste heat that is available for thermal control via radiation. Another option is the use of active cooling loop as described in Section 6.6 of the Functional Description.

Since there is no definition for the spacecraft structural interface definition, the assumption for the thermal interface to the spacecraft has been with radiation coupling to layers of thermal insulation blanket. Depending on mission environment, the average inboard dome temperature facing the spacecraft is between 10°C and 35°C.

AR-30 ***Is there an overall heat capacity value for the ASRGs in (W hr/lb C), or similar units, that can be used for thermal math modeling purposes?***

It is not appropriate to use ASRG heat capacity for thermal control, as the external environment affects the operation condition of the ASRG (see Section 6.0 of 912IC002144 on the temperature limit).

Note that the *ASRG Functional Description* Library document has been deprecated. It has been replaced by the *ASRG User Interface Control Document (ICD)* (912IC002085).

AR-31 How much does the vibration spectrum change as the unit ages?

This has not been tested. However there are no known aging conditions of the Advanced Stirling Converter (ASC) that would alter the vibration spectrum.

AR-32 Can NASA offer advice on vibration isolation technology that can help reduce the vibration spectrum under all operating conditions?

Yes, NASA will provide advice on vibration isolation technologies. The specific NASA assistance to be provided is discussed in the AO Library document; Discovery ASRG Information Summary 6/3/10.

AR-33 Are variable stroke designs available for use in the Discovery program? If so, how do the vibration properties of the unit change as a function of stroke?

It is not clear here what is meant by "variable stroke designs." The ASRG controls its own stroke to ensure that it provides full power output matching the bus voltage. Commands may be sent to alter the stroke over the ASRG life, in order to continue drawing maximum power as the heat source decays. There are no other known reasons the stroke should be adjusted by the spacecraft, but such matters would be considered during development of the mission ConOps. The vibration changes associated with such changes would be minimal, as both ASCs are synchronized by the controller to minimize vibration.

AR-34 In some technical papers on ASRG, reference has been made to a digital logic controller that provides lower harmonic content in the vibration spectrum. Is this controller available and, if so, is it on a path to flight qualification consistent with the Discovery schedule?

The reference to lower harmonic content is unclear. However, the controller unit is a subsystem of the ASRG, being designed and qualified as part of the ASRG, like all other subsystems. It is electrically connected to, and delivered as part of, the ASRG. It will not be provided separately or on a different schedule. Although it has a separate mounting interface, it should be treated as an integral ASRG component that cannot be electrically disconnected from the balance of the generator once fueled.

AR-35 What is the maximum power output of an ASRG during launch (Refer to 4.2.2 of the ASRG Functional Description, 912IC002144, Rev 5)?

The maximum is the same as under any other conditions. This section simply requires that the value not drop below 80% of nominal during the launch sequence, to ensure that the spacecraft has adequate power through this phase.

Note that the *ASRG Functional Description* Library document has been deprecated. It has been replaced by the *ASRG User Interface Control Document (ICD)* (912IC002085).

AR-36 During launch does the ASRG use its internal or external shunts (Refer to 4.2.2 of the ASRG Functional Description, 912IC002144, Rev 5)?

The system does not use shunts unless the spacecraft fails to take the ASRG power. This should only occur during a spacecraft fault, as the ASRG shunts are not designed for routine power management. The ASRG only has one set of shunts, mounted on the outboard end of the ASRG housing.

Note that the *ASRG Functional Description* Library document has been deprecated. It has been replaced by the *ASRG User Interface Control Document (ICD)* (912IC002085).

AR-37 When the ASRG returns to 100% of the prelaunch power within 30 seconds after separation – what is the absolute value and how dependent is it on temperature (Refer to 4.2.3 of the ASRG Functional Description, 912IC002144, Rev 5)?

This is a complex question. There is no single answer to the question of "absolute value." This calculation is based on a variety of factors, to include albedo, insolation, ambient temperature, spacecraft layout (*i.e.,* aeroshell or other heat sink differences) and fuel loading. Please refer to Section 4.2.1 for a more complete discussion of the factors that affect output power. A thermal model A thermal model of the ASRG can be obtained by contacting Robert.L.Cataldo@nasa.gov.

Note that the *ASRG Functional Description* Library document has been deprecated. It has been replaced by the *ASRG User Interface Control Document (ICD)* (912IC002085).

AR-38 ***Although the ASRG Functional Description recommends that the host S/C provide switching provisions to connect/disconnect the ASRG to/from the SV power bus, does the ASRG also have its own internal mechanism for connecting/disconnecting (Refer to 4.2.5.1 of the ASRG Functional Description, 912IC002144, Rev 5)?***

The ASRG does not disconnect itself to protect the spacecraft bus. If this feature is needed, the spacecraft must implement it. It does have a feature to protect itself from bus faults, while providing a limited power supply for the spacecraft to use in recovery.

Note that the *ASRG Functional Description* Library document has been deprecated. It has been replaced by the *ASRG User Interface Control Document (ICD)* (912IC002085).

AR-39 ***Is it acceptable for the mission to launch with the ASRG disconnected from the spacecraft?***

No, that would not be acceptable.

AR-40 ***During an Under Voltage the ASRG electrically disconnects itself…(Refer to 4.2.5.3 of the ASRG Functional Description, 912IC—2144, Rev 5. The same section also states that "while disconnected, the ASRG will supply some power to assist the SV power bus recovery". How does this work –*** **i.e.,** ***the ASRG is disconnected, but some current (2 amps) is still available to the SV (Refer to 4.2.5.3 of the ASRG Functional Description, 912IC002144, Rev 5).***

"Disconnected" is not the right word to describe this operating mode. The updated paragraph should read:

While in the under-voltage mode, the ASRG will supply some power to assist the SV power bus recovery. The ASRG will pulse-width modulate the disconnect switch on/off time, controlling the peak current. Its behavior in the under-voltage mode approximates a current limited buck-type switching power converter. ASRG internal control is maintained by sharing/trimming between the ASRG internal shunts and the current limited output.

The latest estimate of this RMS current is 1.75 amps, rather than 2 amps.

Note that the *ASRG Functional Description* Library document has been deprecated. It has been replaced by the *ASRG User Interface Control Document (ICD)* (912IC002085).

AR-41 How does the ASRG self-dissipate mode work (Refer to 4.2.3 of the ASRG User ICD, 912IC001299, dated 8/08)?

Proposers should use only the ASRG information provided in the AO library. The referenced document from 2008 is obsolete. The terminology "self-dissipate mode" is not used on the project. This is presumed to refer to ASRG's required capability to divert power to its shunts during bus transients. This is an off-normal, automated action by the ASRG to protect itself when the bus voltage is outside the tolerable range. The shunts are not designed for routine spacecraft power management.

Note that the *ASRG Functional Description* Library document has been deprecated. It has been replaced by the *ASRG User Interface Control Document (ICD)* (912IC002085).

AR-42 Is the voltage sense local or does it need to be remote (Refer to 4.2.4.2.1 of the ASRG User ICD, 912IC001299, dated 8/08)?

The voltage is sensed by the ASRG at its output connector. No additional spacecraft accommodation is required.

Note that the *ASRG Functional Description* Library document has been deprecated. It has been replaced by the *ASRG User Interface Control Document (ICD)* (912IC002085).

AR-43 Does the ACU (ASC Controller Unit) get power from an external source (GSE or the SV) or does it only get power once the ASRG is producing electrical power? The ACU electrical interfaces do not seem to indicate a power input to the ACU.

The ASRG will be delivered to the launch site operating. Its controller is a non-separable subsystem that will already be electrically connected at delivery. Once fueled, the ASRG will operate continuously, with its controller subsystem electrically connected to the balance of the generator, over its entire life cycle.

AR-44 Are the Cmax and 1Meg ohm elements designed to prevent dc coupling from the EPS to the ASRG controller (Refer to Figure 4.6-1 of the ASRG User ICD, 912IC001299, dated 8/08)?

The referenced document from 2008 is obsolete. The specific referenced diagram is also obsolete.

The ASRG will use a standard power system grounding approach, consistent with the NASA Standard (NASA-HBK-4001 and NASA-STD-4003).

AR-45 How long before launch does the PRD safety pin need to be removed (Refer to 5.1.7.2 of the ASRG User ICD, 912IC001299, dated 8/08)?

This is the last step in the ASRG installation sequence, after the spacecraft is on the launch vehicle. The detailed installation process will be defined in consultation with the mission, but this step is typically among the last to be performed before the payload fairing is closed.

Note that the *ASRG Functional Description* Library document has been deprecated. It has been replaced by the *ASRG User Interface Control Document (ICD)* (912IC002085).

AR-46 Can the ASRG safely ride inside of an aeroshell?

The ASRG can survive the thermal and dynamic environments defined in the ASRG Functional Description document located in the AO Library. These environments are defined at the interfaces between the spacecraft and the ASRG. These interface requirements are independent of specific spacecraft features such as aeroshells. It is up to the spacecraft designer to ensure that the ASRG, as implemented for the specific mission, remains within these limits over all mission phases. There are no known reasons why the ASRG could not be used within an aeroshell, so long as the ASRG remains within its operating limits, particularly the thermal limits.

AR-47 Does Glenn provide a non-plutonium EDU ASRG(s) or an ASRG emulators for I7T testing? Is the test unit suitable for vibration, EMI and Thermal/Vac testing?

See AR-5.

AR-48 Is the ASRG is qualified for launch on a spinning upper stage, similar to the Delta II Star 48 third stage used for a number of planetary launches?

The ASRG can be considered qualified for a specific use or application given the ASRG dynamic structural environment is within the limits specified in the ASRG Functional Description document found in the AO Library.

AR-49 How many RHUs are available?

Currently 20 RHUs have been set aside for the use of the Discovery Program. Overall, there are 60 in stock that are producing 1 W or more.

AR-50 ***According to the Program Library document "ASRG Information Summary", two fueled ASRGs will be available for integration starting March 2014. This is far earlier than responders to the Discovery 2010 AO solicitation will be able to launch. Will the ASRGs be fueled on a schedule that is unique to each mission to ensure that the electrical power available at BOM is 133 W (assuming 5% programmatic reserve has already been taken)? If not, what assumption for BOL electrical power should the proposer make?***

Most of the power loss is due to the decay of 238Pu and therefore this decay starts following its production and not when the unit is fueled. Please see figure 4.2-1 in the ASRG User ICD for anticipated power output verses a particular launch date. The NASA RPS Program Office recommends a 5% reserve on this power value based on the ASRG PDR and CDR scheduled dates. Please see the ASRG Information Summary for details on both power and mass reserves.

AR-51 ***At what point in the launch operations flow will the flight ASRGs be available for integration with the spacecraft?***

ASRG delivery to KSC is planned for 4th quarter 2014. Please check the AO Library for ASRG schedule updates. For details of the integration flow at the launch site, please see the answers to LV-10 and LV-11.

AR-52 ***Will an ASRG engineering unit be made available to the project for early electrical, mechanical and thermal interface testing?***

Please see the answer to AR-5.

AR-53 ***For missions proposing ASRGs, what are the correct responses for the following NOI questions in NSPIRES:***

1. ***Does This Project Have an Actual or Potential Impact on the Environment?***
2. ***Has an Exemption Been Authorized or an Environmental Assessment (EA) or an Environmental Impact Statement (EIS) Been Performed?***

The correct answers are:

1. Yes
2. No

AR-54 ***Which is the correct Advanced Stirling Radioisotope Generator (ASRG) mass? The one presented at the pre-proposal conference or the one in the library?***

The ASRG mass shown at the pre-proposal conference was correct. The one in the library had not been updated after the new ASRG User Interface Control Document was posted but that has now been corrected in the ASRG Information Summary.

AR-55 ***The ASRG User ICD references three documents on Concepts of Operation: LM ASRG PIR #088, LM ASRG PIR #099, and LM ASRG PIR #100. When will these documents be made available to proposers?***

It is not anticipated that these documents will be completed before proposals are due.

AR-56 ***What are the telemetry data requirements, volume and/or rate, which must be dedicated to engineering data about the ASRG in order to support demonstration requirements for the ASRGs? How much data will be returned to Earth?***

The ASRG will use MIL-STD-1553B DATA BUS INTERCONNECT to transmit data. The telemetry currently has 1 data packet, 33 x 20 bit words.

During normal mission operations it is anticipated that data would be made available once a day. However, during events such as; launch, stage separations, planetary flybys, planetary landings, etc., data would be requested at shorter intervals. In addition, a look-up table would define ranges for the ASRG engineering data such that when data indicate off nominal values the mission will also transmit telemetry at shorter intervals.

Telecommunications

C-1 ***Does NASA's stated desire to use only one 34m DSN antenna mean:***

- ***a. One antenna at one site only (e.g. at Goldstone) with 30-40% coverage per day, or***
- ***b. One antenna at each of the three DSN sites – potentially 100% coverage during key mission times – if only using one antenna at a time (i.e. no overlapping coverage from different sites)?***

One antenna means "one at a time." So antennae at multiple sites can be used singly (except during hand-offs) to provide 100% coverage per day.

C-2 ***If accommodating Ka-band communication requires modification to payload design, considerable additional costs, and will not significantly increase science data return, does this justify using X-band communications with a payload already designed for this?***

No.

C-3 Does the exception for non-normal operations apply to 70m as well as arrayed 34m antennas? For example, can a project propose using arrayed 34m antennas for critical operations or science data downlink if the need is demonstrated?

Yes, the rule applies to arrays of 34m antennae — they may not be used for science data downlink.

C-4 Is there any substantive difference intended between the use of the two terms science data return and science telemetry as used in Section 5.2.5 and Requirement 35 of the Draft AO?

There is no difference between the meanings of the terms intended.

C-5 Is it correct that radiometric tracking data collected for navigation and for radio science is not considered "science telemetry?"

Yes, that is correct.

C-6 Is it correct that a flight system may use X-band for non-science-telemetry purposes in place of Ka-band?

Yes, that is correct. TT&C data may be transmitted using X-band.

C-7 Suppose that non-Ka band GFE telecom hardware resides at a NASA Center. If a proposal can make use of this GFE, at significant cost savings to the proposed mission, with no reduction in science data returned, does this qualify as a justification for non-Ka-band communications?

No.

C-8 Understanding that the availability of Mars orbiters cannot be guaranteed, is there a reason that MAVEN was not included as a potential relay asset in Section 5.9.3 of the Draft AO?

No, that was an oversight.

C-9 Is a Letter of Support needed from the National Radio Astronomy Observatory (NRAO) since NASA funds the use of NRAO's resources (e.g., VLBA) for missions that require them?

NASA no longer has an agreement with NRAO to provide navigation and tracking services with the VLBA (or any other NRAO facility). NASA has established that the DSN is sufficient to meet NASA's known requirements. NRAO services have been removed from the DRAFT Space Communications and Navigation (SCAN) document that is posted in the Discovery AO Library. Those services are no longer being offered by NASA as GFE.

Should a proposer require navigation or communications services beyond those offered by NASA and described in the SCAN document in the Discovery AO Library, they will need to propose those services as a partnering, contributed, or procured arrangement within her proposal. Like any other non-GFE contributed or purchased service that one proposes, the proposer will need to work out arrangements with that provider and describe them in the proposal.

C-10 Can arrays of 34m antennae, as described in the Decadal Survey Whitepaper "Future Plans for the Deep Space Network," be employed for non-emergency science data downlink?

No. The single 34m antenna rule for non-emergency data downlink applies in this case.

C-11 If X-band is needed for the mission and also enables return of 100% of the science data, is that sufficient justification for not adding a redundant Ka-band system?

No, that is not sufficient justification. Missions must conform to Recommendation 23-1 of the Space Frequency Coordination Group: X-band users should be limited to using 12 MHz of spectrum in deep space and 8 MHz at Mars.

C-12 Will two-way Doppler tracking using Ka-band be available by the launch deadline? If not, is a need for two-way Doppler sufficient justification for using X-band instead of Ka-band for the science downlink?

Two-way Doppler for X-up/Ka-down is available today at DSS-25, -26, -34, -54, & -55. It will also be available at DSS-35 when it goes operational in October of 2014. Ka-up/Ka-down two-way Doppler will be available at DSS-25 only, in 2011; only DSS-25 will have a Ka-band uplink. Delta-DOR is not done two-way, since the antenna must move off of the spacecraft to track the quasar (thus breaking the two-way link). Ka-band Delta-DOR capability exists at the above-mentioned antennas, and was demonstrated with MRO prior to the failure of the spacecraft's Ka-band system.

C-13 Was it the intention of the clarification [NASA Discovery Program Community Announcement (NNH10ZDA006J)] to allow any Discovery mission to use X-band, without prejudice, so long as it follows SFCG Recommendation 23-1?

Yes, that was the intent.

C-14 Will a proposal which uses X-band and which follows SFCG Recommendation 23-1 have any risk of being judged to have a weakness or being judged to be non-compliant by a TMC reviewer solely due to their choice of X-band for all their telemetry?

If a proposal chooses to use X-band for all of its telemetry (science data and housekeeping data), and this use does not exceed the bandwidth limits set by SFCG Recommendation 23-1, then that fact alone will not cause the proposal to be judged as non-compliant or given a weakness.

C-15 Would the answers to questions C-2 and C-7 be different if the questions had included the proviso that the missions also follow SFCG Recommendation 23-1?

Yes. Bandwidth usage is an acceptable reason for choosing X-band telemetry. Choosing to use X-band for all telemetry because it would reduce mission cost is not an acceptable justification.

C-16 If X-band is required for high-precision two way tracking that currently available Ka-band systems cannot provide, is it acceptable to also propose X-band as the primary wavelength for telecommunications (data downlink) with Ka-band only as an upgrade option possibly with an appropriate increase in cost contingency?

No, that is not an acceptable justification for using X-band for science data downlink. The radiometric precision of an X-up/Ka-down configuration is expected to be higher (given reasonable assumptions on received signal strength and spacecraft performance) than an X-up/X-down configuration. Depending on the mission scenario, the presence of both X-band and Ka-band downlinks should result in even higher precision. For more information on Ka-band tracking, please see the answer to question C-12.

C-17 Is the restriction on the use of 70m antennae meant to apply to short duration (up to 1 month) Venus* in situ *missions that require direct-to-Earth telemetry using S-band for science data return and simultaneous radio science for atmospheric wind measurements?

If there is a scientific requirement for the radio science measurement of atmospheric winds to be simultaneous with science data downlink, then the restriction does not apply. If, however, the simultaneous collection of radio science data and science data downlink is a matter of convenience, then the restriction remains.

C-18 If a mission can meet all its science goals with its X-band system, and the bandwidth required for science return is less than the bandwidth required by the X-band TT&C system (for telemetry and tracking), which conforms to SFCG Recommendation 23-1, is that sufficient justification for not including a Ka-band downlink system?

Yes, if all science data transmission conforms to the SFCG Recommendation 23-1 for the use of X-band communications, then a Ka-band downlink system does not need to be included on the mission.

C-19 Requirement 64, page 30 states that "Adequate unencumbered cost reserves are defined to be a minimum of 25%. Adequate unencumbered cost reserves must be demonstrated at each of the following milestones: KDP-A (demonstrated in the proposal), KDP-B (demonstrated in the Phase A Concept Study Report), KDP-C (the independent cost estimate for Confirmation), KDP-D (at the end of Phase C), and KDP-E (at the start of Phase E, generally 30 to 90 days after launch)." Is it NASA's intent for the proposer to carry 25% cost reserve on estimated DSN aperture fees?

Proposals are required to carry 25% unencumbered cost reserves on their "cost to complete." This base cost should include all items whose costs may be controlled by the project. Since the scale of DSN usage is clearly under control of the project, DSN aperture fees need to be included in the calculation of unencumbered cost reserve. The detailed allocation of that reserve among WBS elements, however, is up to the proposer.

Other

O-1 Since it does not seem likely that the draft AO will be released in June as announced, will the release date of the final AO also slip?

The Draft AO was released on 7 December 2009. The current target for the release of the Final AO is June 2010.

O-2 Must both the primary and backup launch dates for a proposed investigation occur before December 31, 2016?

~~Only the primary launch date must be before December 31, 2016. Proposed investigations will be evaluated based on their proposed primary launch date.~~ In the final AO it is made clear that the launch readiness date (LRD) must occur before ~~the specified date~~ December 31, 2017.

O-3 In the Draft AO's description of potential Mars relay assets, the MAVEN mission was not listed. Was this an oversight?

Yes, this was an oversight and has been corrected in the final AO. Details of the Mars UHF relay network are found in Mars Relay Description for Discovery 2010 Proposals in the Program Library.

O-4 Please define what you mean by "essential insight" on page 5 of the Draft AO.

NASA will require that all missions conform to the reporting and review requirements of NPR 7120.5, *etc.*

O-5 Please define "passivation" as used in the discussion of spacecraft disposal.

In this context, "passivation" means the complete removal of any stored energy on board a spacecraft including residual propellants (by venting or burning), residual pressurants (by venting), electrical energy (by discharge or disconnection of batteries), kinetic energy (by unloading or de-spinning momentum wheels or gyros), and the disabling of range safety explosives.

O-6 The 2003 Decadal Survey document is not mentioned anywhere in the draft AO. Shall we conclude that its science priorities have been superseded by the* SMD Strategic Plan of 2006 and The Science Plan for NASA's Science Mission Directorate (2007-2016)*?

The priorities of the Decadal Study are reflected in the SMD Strategic Plan and the Science Plan. Proposers, however, are free to reference the Decadal Study if they feel that its priorities are part of the merit argument for their proposal.

O-7 ***Comparison of this AO to past Discovery AOs indicates that the duration between final AO release and selection of mission to proceed into Phase-B has increased from 19 months to 25 months due to a combination of longer review cycles and a longer Phase A. Could NASA remove some of the extra review cycle time (Step-1 and Step-2) to enable earlier launch dates?***

NASA will endeavor to provide the most expeditious review possible. However, the fairness and thoroughness of the review is the highest priority. . The review and selection schedule for both Step 1 and Step 2 in the final AO should be used to prepare your proposed project plan.

O-8 ***In §4.1.1, Page 5 of the Draft AO the end of Phase D is defined as "Launch (extending through in-orbit checkout)." Is Phase D still defined as ending at "Launch + 30 days"?***

The end of the "in-orbit" checkout for planetary missions generally occurs 30 to 90 days after launch. Phase D formally ends with the Post Launch Assessment Review (PLAR).

O-9 ***Not many universities have a government validated EVM system. If a university lead mission team includes a subcontractor with a validated EVM system, can the university use that system to report cost and schedule metrics for the entire project?***

It is the PI's institution's responsibility to produce the project's EVM reports, incorporating all subcontractor inputs and utilizing a formally validated system. Using a subcontractor's system for primary reporting would require the approval of the Office of Chief Engineer for a deviation from NASA's program and project management requirements (NM 7120-81). After selection, a mission may request such a deviation. A proposal containing this type of management structure will not be deemed non-compliant; the Technical-Management-and Cost review will, however, evaluate the feasibility of the proposed management structure.

O-10 ***If a Mars mission were proposed and selected, would the Mars Exploration Program Office (at JPL) be the primary overseer?***

No, any mission selected from the Discovery 2010 AO will be under the oversight of the Discovery and New Frontiers Program Office at Marshall Space Fight Center.

O-11 How does the PI-cost commitment in the Phase A Concept Study Report related to the 70% confidence cost commitment that NASA makes at Confirmation (KDP-C)?

SMD has established a policy document that answers this question. Please see SPD-19, *Meeting the 70% JCL Requirement in PI-led Missions* (available in the Program Library).

O-12 Which document takes precedence if there are differences in information - the draft AO or the community announcements or notices on the web or FAQs? Is there a hierarchy or is it simply whatever is most recent?

The text of the (as amended) final AO is the ultimate source of information. This Q&A document is intended to clarify, not to amend, the final AO.

O-13 Of the Decadal Survey (DS) mission study reports being released by the NRC, some missions — not surprisingly — are similar to Discovery proposals that may be submitted under the current AO. We are concerned that they could create some misperceptions. The assumptions that went into the DS studies are generally quite different from those of a potential Discovery proposal, such as the cost cap and readiness of key technologies in the 2015+ timeframe. Of greater concern is the fact that the Decadal Survey studies have not (as explicitly stated) invested the time or resources to address some issues that may be critical to proposed Discovery missions. We are concerned that the DS studies may be assumed to be authoritative, and with strict page restrictions on Discovery proposals there is limited space to address the issues in cases where our more detailed analysis has reached different conclusions. To what degree should Discovery proposals address the technical conclusions of Decadal Survey mission studies, particularly if there is apparent disagreement?

Proposals should address the AO requirements as best they can. NASA will evaluate each proposal on its own merits according to the criteria described in the AO (Section 7.2). NASA's evaluation will not include a comparison to other mission concepts, whether they are other Discovery mission studies or some other published mission concept. Proposal evaluators will be briefed on this concept and held to it.