

## Discovery 2014 Announcement of Opportunity Q&A Updated February 6, 2015

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<http://discovery.larc.nasa.gov/discovery>

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Other questions may be addressed to Michael New, Discovery Program Scientist,  
[michael.h.new@nasa.gov](mailto: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

- Science (S)
- Technology (T)
- Management (M)
- Proposals (P)
- Launch Vehicles and Secondary Payloads (L)
- International Participation (I)
- Radioactive materials (R)
- Telecommunications (C)
- Other (O)

### Log of Questions

2014

May 13: T-1, I-1, I-2, I-3, I-4, I-5, I-6, I-7, I-8, O-1

May 14: L-1

July 14: L-2, T-2

July 17: T-3, T-4

July 29: T-5, T-6, P-1, P-2, P-3, P-4, P-5, P-6, P-7, P-8, P-9, P-10, L-3, I-9, C-1, C-2

July 31: T-7, T-8, T-9

Aug 26: T-10, T-11, T-12, T-13, T-14, T-15, T-16, T-17, T-18, T-19, T-20 T-21, T-22, T-23, T-24, P-11, P-12, P-13, P-14, P-15, P-16, P-17, P-18, P-19, P-20, P-21, P-22, P-23, P-24, P-25, ***L-3***, L-4, L-5, L-6, ***I-7***, I-10, C-3, O-2, O-3, O-4

Sept 30: ***T-22, P-11, P-22***, P-26, P-27, P-28, P-29, P-30, P-31, P-32, P-33, C-4, C-5, C-6, O-5, O-6

Dec 03: T-25, T-26, T-27, T-28, T-29, T-30, T-31, T-32, T-33, T-34, P-34, P-35, P-36, P-37, P-38, P-39, L-7, L-8

Dec 04: **T-8, T-10**, T-35, T-36, T-37, T-38, T-39, T-40, T-41, **P-6, P-11, P-12, P-15, P-21, L-2, C-5, C-6**

2015

Jan 16: **P-1**, P-40, P-41, P-42, P-43, P-44, P-45, P-46, P-47, P-48, T-42, T-43, T-44, T-45, T-46, L-9, L-10, I-11, R-1, C-7, C-8, O-7, O-8, O-9

Feb 06: P-49, P-50, P-51

## Science

*No questions at this time.*

## Technology

**T-1** *Will the various cost incentives being offered be treated as increases to the PIMMC cost cap using the same cost-accounting methodology as in Discovery 2010?*

Yes. Incentives offered for the use of NASA-developed technologies will be treated as increases to the cap on the PIMMC.

**T-2** *What is the status of the analysis of the NEXT thruster after its long-duration life test? What analyses have been performed? Have there been any significant findings that could affect life-modeling efforts?*

Post-test analyses have not yet been completed. An interim report, though, is anticipated to be available in mid-September and will be posted on the Discovery Program Acquisition Website when it is released.

**T-3** *Can the Engineering Science Investigation (ESI) include components like a parachute up-look camera to take strategic photographs during parachute inflation.*

A parachute camera would absolutely count towards the ESI. In the ESI Goals and Objectives document in the Discovery Program Library, data from the aerodynamic decelerator is in the list of desired measurements, and frame rate suggestions are given.

**T-4** *Can a project make use of data coming from instruments necessary for the mission (e.g., an IMU) to achieve some of the goals of the ESI?*

Use of hardware already planned for your scientific mission, that can also benefit or meet objectives of the ESI, is definitely encouraged. However, as stated in the Goals and Objectives document, an IMU alone is not sufficient for meeting the intent of the ESI.

**T-5** *Will the NEXT-C PPU provider meet the command and data handling (C&DH) requirements of the spacecraft provider or must the spacecraft provider meet those of the SEP PPU?*

The command and data-handling interface to the PPU will be defined by the NEXT-C project. The existing baseline, from the technology project, is defined in the draft NEXT System ICD, which can be accessed per instructions in the AO Library NEXT-C Guidebook. This interface will be re-evaluated at the beginning of the NEXT-C Project contract.

**T-6** *Will an engineering development unit (EDU) of NEXT-C be provided or otherwise made available for interface testing? Will a front-end against which one could test electrical/data interfaces in a Flatsat-like environment be provided (or could one be formally requested)?*

Per the AO Library NEXT-C Guidebook, a prototype model PPU and the PPU testbed, and the prototype thruster and engineering model thrusters, will be available for mission use. There are no plans to provide PPU or thruster hardware simulators or electrical/data simulators in the NEXT-C project. Requests for NEXT-C scope or requirements changes are not being considered at this time but may be considered after Step 1 selection.

**T-7** *What are the specifics of the “relevant environment” in which NASA will demonstrate the Advanced Solar Arrays (ASA) prior to the end of FY17?*

The ATK MegaFlex and DSS ROSA solar arrays have met the following requirements through a combination of test and analysis, bringing them to TRL 5+ and NASA considers these now ready for development for flight missions with similar requirements.

- Mission Environment:  $2 \times 10^{15}$  1MeV e/cm<sup>2</sup> met with >5-mil cover-glass
- Solar Array Power (with 2 wings):  
35-40 kW class (Beginning of Life), 25-30 kW class (End of Life)  
Assumes state-of-the-art triple junction solar cells
- Operating Voltage: 160V – 300V
- Specific Mass: 100 W/kg EOL
- Stowed Volume: 40 kW/m<sup>3</sup>

- Deployed Strength: >0.1 g in all axes
- Deployed Frequency: >0.2 Hz
- Stowed Frequency: >25 Hz
- Stowed Strength (quasi-static): > 20g

Environments *not* addressed include:

- In-space low intensity, low temperature (LILT) solar cell operations (important for missions >3 AU)
- In-space high intensity, high temperature (HIHT) operations (<0.7 AU, Venus or hotter: composites, adhesives, other materials may not stand high temperatures)
- Extended low Mars-orbit operations with a high atomic oxygen fluence
- Mars orbit aerobraking (free molecular heating, higher operating temperature, atomic oxygen)
- Dust environments of lunar surface, Mars surface, Mercury polar surface, minor body surface & proximity operations
- Lunar surface night time cold (can weaken composite structure metallic insert adhesives)
- Lunar orbit operations with lunar eclipse cold (Earth occultation of the Sun that can be >4 hours; concern for adhesive strength)
- Mars surface-deployed wing aerodynamic structural loading\*
- Mars surface Paschen arcing\*
- Deployment under fractional g-loading (0.166 g moon, 0.38 g Mars\*<sup>§</sup>, 1 g\*<sup>§</sup> for unsupported ground-testing deployments)
- Deployment at extreme hot or cold\* temperature (outside of ±65 °C)
- Stowability/redeployment (may be desired for planetary surface mission entry, descent and landing or for proximity operations for lunar, Mars, or minor body missions)\*\*

\* The lower power, lower voltage UltraFlex array was designed for this type of environment and was flown on the Mars Phoenix mission, and will be flown on the up-coming Mars InSight mission so there is some heritage for these conditions

§A lower power proof-of-concept ROSA system was developed by DSS under an SBIR with the Air Force Research Laboratory. Contact the vendor for detailed technical information.

\*\* A lower-power, proof-of-concept, retractable ROSA wing was developed for an advanced modular power system project/multi-mission space exploration vehicle demo. Contact the vendor for detailed technical information.

**T-8** *Please clarify what exactly “will be treated as commercial procurements from proven vendor(s)” means in Table 4 of the Draft AO. Specifically related to the second footnote on this table, are ASA and GPIM to be treated as TRL-6 items, or do proposing projects need to present development plans for these items? Will the development risks of ASA and GPIM not impact proposal evaluation, so that only the mission specific accommodation will be considered by TMC? As an example, will these items be treated in the same manner as taking a star tracker to a high radiation environment (where the mission specific radiation accommodation suitability will be evaluated, but the basic design and performance - technology readiness level - of the star tracker itself is not evaluated nor considered a risk)?*

MegaFlex and ROSA should be considered as ready for mission development with requirements similar to those that we stated. The star tracker example is how the arrays should be considered. Proposal teams should contract with whichever solar array vendor they prefer, and include them as a subcontractor in their proposal. This is also true for green propellant technology. The TMC Panel will not evaluate the basic design and performance of the ASAs or the green propellant system; they will evaluate the appropriateness of the use of these technologies and the plans for any mission-specific adaptations.

*Note: In the Final AO, the quoted language has been changed to “Will be treated as a commercial procurement of a mature product from a proven vendor(s) in the same manner as any spacecraft component (where the mission specific accommodation will be evaluated, but the basic design and performance, i.e., technology readiness level, of the component itself is not evaluated nor considered a risk)”*

**T-9** *Table 4 indicates that “All costs” of the Advanced Solar Arrays (ASA) and Green Propellant will be included in the PI-Managed Mission Cost. A footnote to Table 4 indicates the intention by NASA to develop and demonstrate ASA and GPIM in a relevant environment prior to the end of FY17. Does that imply that the cost and risk of readiness (achieving  $\geq$ TRL 6 by KDP-C) is borne outside of the PI-Managed Mission Cost?*

The ATK MegaFlex and DSS ROSA solar arrays were developed to TRL 5+ and NASA considers these now ready for development for flight missions with similar requirements (see the answer to question T-7).

The Green Propellant system will be demonstrated on the Green Propellant Infusion Mission (GPIM) which is expected to launch in 2015. From the Fact Sheet for the mission (available at [http://www.nasa.gov/sites/default/files/files/GreenPropellantInfusionMissionProject\\_v2.pdf](http://www.nasa.gov/sites/default/files/files/GreenPropellantInfusionMissionProject_v2.pdf)):

The GPIM payload will fly to space aboard a Ball compact small satellite or “smallsat.” During the test flight, researchers will conduct orbital maneuvers to demonstrate the performance of the propellant during attitude control shifts, changes in orbital inclination and orbit lowering. Once proven in flight, the project will present AF-M315E [the green propellant] — and compatible tanks, valves and thrusters — to NASA and the commercial spaceflight industry as a viable, effective solution for future green propellant-based mission applications.

**T-10** *Are all the technologies presented as part of the Discovery Technology Workshop considered “NASA-developed technologies” for the purpose of the AO?*

No, only the technologies listed in Table 4 of the ~~Draft~~ *Final* AO are considered “NASA-developed technologies” for the purposes of the AO.

**T-11** *What is the volume of the DSAC?*

The TDM Demonstration Unit (flight article) is 285 mm (L) x 269 mm (W) x 228.8 mm (H) - mounting feet are on the Length-Width Plane.

**T-12** *What is the cost of both the nominal and lightweight DSAC as described in the DSAC Technology Demonstration Presentation?*

A copy of DSAC, as flown on the TDM mission using the same environmental requirements (GEVS, Earth Orbit) would cost approximately \$15M.

A lightweight DSAC, as proposed for infusion, would cost approximately \$27M. This assumes alignment to a 3-year flight project development schedule and significant NRE for changed electronics due to different environmental requirements, but no changes to the core technology (per DSAC's infusion goals).

Both of these costs are "Step 1" quality and can be refined by engaging DSAC directly now or during Step 2.

**T-13** *Is there an option to get a lightweight version of the DSAC, although at the nominal power level?*

This should be possible but it has not been evaluated in detail by the DSAC team. It should be understood that some of the primary mass savings come from combining and repackaging the existing electronics which would automatically reduce the power consumption. If a particular team desires this configuration, JPL would assign someone to work it for that team (at that team's expense).

**T-14** *Two masses and powers are listed on page 4 of the DSAC Technology Day presentation. Are these numbers the current estimate (CBE), the maximum expected value (MEV), or the maximum possible capability as described in the table in Requirement B-36?*

From Slide 4 of the Tech Day presentation:

Option 1 — 17kg, 56W (w/USO) are CBE numbers of the DSAC TDM Demonstration Unit. As of July 2014, the unit's CBE is 17.2kg and 62W (worst case cold).

Option 2 — These numbers are expected capability with NRE expended to reduce size, weight, and power ("Lightweight DSAC").

**T-15** *What minimum duration should be baselined for a DSOC operations demonstration?*

Proposers should assume that DSOC would be operated once per month during the proposed mission. The duration for each demonstration period is approximately two hours, performed when the spacecraft is otherwise not taking science data.

**T-16** *Will the DSOC provider meet the command and data handling (C&DH) requirements of the spacecraft provider or must the spacecraft provider meet those of the DSOC?*

This can be negotiated after selection, however DSOC will have a simple C&DH interface, with a limited number of commands. The only significant requirement will be access to the spacecraft time and quaternion or equivalent for fine pointing knowledge.

**T-17** *What would the cost and associated schedule be if a mission concept were to be interested in the purchase a second DSOC unit?*

A cost WAG is \$35M, and it could be delivered within 60 days of the first unit.

**T-18** *What is included in “DSOC hardware and funding for integration and operations support team?”*

One Flight Unit, mechanical and electrical GSE for post shipment bench testing the DSOC prior to integration with the spacecraft, a test optical system that will provide simulated optical input and accept laser output signals. The GSE will be delivered with the instrument. The DSOC team is funded for integration and test with the spacecraft. The DSOC team is funded for uplink and downlink terminals.

**T-19** *Will additional documentation be provided on the NASA-developed technologies, such as the interfaces, ICDs, point of contact, success criteria, current status, etc?*

We are not planning to release any additional information, but we are more than willing to answer any specific questions.

**T-20** *On page 2 of the DSOC Technology Day presentation, current best estimate (CBE) mass and power are listed along with a margin. Is there contingency in these numbers? Please provide the mass and power in terms of the current estimates, the maximum expected values, or the maximum possible values as described in the table in Requirement B-36.*

Mass: CBE 22 kg, Contingency 6 kg, Margin 8.4 kg  
Power: CBE 61 W, Contingency 15 W, Margin 24 W

**T-21** *What is the projected \$/kg cost for HEEET TPS material?*

A generic cost-per-kilogram is not the ideal way to specify the cost of the HEEET TPS material. The current best-estimate cost in terms of size of the heat-shield are:

1 m diameter = \$3M  
2 m diameter = \$6M  
3 m diameter = \$11M

**T-22** *Is the cost for the full accommodation of the Engineering Science Investigation (ESI), including potential design modifications outside the cost cap? If yes, do programs need to provide a cost estimate for design accommodations? If not, does this mean that the extra costs count against EDL proposals in TMC? If yes, will HQ provide cost for larger LV if needed?*

The only part of the ESI outside of the cost cap is the cost for any extra hardware (e.g., pressure sensors, recession sensors) needed, any testing of this hardware, and integration of this hardware. The NASA EDL Team will also provide consulting services as needed. It is not expected that the ESI will drive major design changes or a change in LV. Although not part of the TMC review, the proposal must describe the approach proposed for implementing the ESI. No cost estimates need to be included. *Details of the ESI will be negotiated with selected investigations during their Phase A.*

**T-23** *For the GFE technologies, e.g. DSOC, will a detailed ICD be made available in the Discovery Program Library? The materials from the Technology Workshop typically provide mass, power, volume, and TID. However, more detailed information such as thermal constraints, fields of view restrictions, mounting constraints, data interfaces, electrical interfaces, etc. need to be specified for project infusion.*

It is expected that missions will negotiate many details of interfaces with the technology provider during Phase A and beyond. Proposals should address those interface requirements described in the Program Library.

**T-24** *What is the recommended acquisition strategy for advanced solar arrays (ASA), green propellant, and ALHAT? These have no GFE, no incentive for use, and all costs are included in the PI-Managed Mission Cost. Should customary approaches for teaming and partnering be done so that procurement can be properly planned? How should teams proceed in the case where two vendors for a specific technology infusion currently exist?*

Yes, customary approaches for teaming and partnering should be employed so that procurement can be properly planned. If there is more than one vendor for a NASA-developed technology, it is the proposer's job to select one.

**T-25** *Is a proposed science investigation allowed to rely on DSOC? Requirement B-75 ("description of how this technology would enhance or enable the proposed investigation's science return") implies reliance.*

No, a proposed science investigation is not allowed to rely on the DSOC to return its science data. The purpose of carrying the DSOC is to demonstrate its effectiveness in deep space; it is conceivable that the DSOC will not work at all or will fail at some point in the mission.

The language in Requirement B-75 is a hold-over from the 2010 Discovery AO. It has been changed in the Final AO.

**T-26** *It is know what level of mechanical vibration the DSOC can withstand?*

Page 4 of the Tech Day Presentation gives the PSD of mechanical vibration. The DSOC team can work with different PSDs, but this would need to be refined after selection. It is mission and spacecraft dependent. If the question refers to mechanical vibration during non-operation periods, DSOC would have the same requirements as any other optical instrument. The DSOC is latched and designed to survive normal launch and mission operations environments.

**T-27** *The DSOC Technology Day presentation lists the "RMS Instrument interface attitude knowledge error, roll about LOS to ground" as 150 microradians. Does this refer to the spacecraft's required knowledge error, or is this DSOC's expected knowledge error?*

This refers to the spacecraft's required knowledge error. There is a TBC ("to be confirmed") with this number, and it is mission dependent.

**T-28** *Can you verify that the DSOC electronics can be mounted separately and/or remotely from the optical head? That is, the electronics don't have to be mounted on the disturbance isolation assembly?*

The electronics box is mounted separately. The maximum expected value of the electronics box is 10 kg with contingency.

**T-29** *Based on the interface definitions, we are assuming that the DSOC is thermally isolated from the spacecraft. If this is true, the unit will likely need survival power from the spacecraft when the unit is turned off. What should we assume for required survival power?*

The DSOC team is presently assuming that DSOC is thermally isolated from the spacecraft. The amount of survival power depends on where the spacecraft is going and what the DSOC exposure is. It would probably be safe to assume a few watts (~10 W), but the design has not been taken far enough for this to be considered anything more than a current best estimate.

**T-30** *Since the data interface to the DSOC might be negotiable for reasons of implementation difficulty, is the maximum data rate also negotiable? For example, if a SpaceWire interface were negotiated, could the maximum data rate be set at the maximum capability for the SpaceWire interface?*

Yes. The DSOC package can internally buffer some data.

**T-31** *Is there any room for negotiation on the commanding interface for DSOC (e.g. serial)?*

Yes.

**T-32** *Is transmission of mission data as part of the DSOC downlink required or could a preprogrammed sequence of data be used to successfully demonstrate the downlink capability?*

The DSOC unit will contain preprogrammed test data. Transmission of mission data is not required but will be allowed.

**T-33** *What are the data format requirements for DSOC. For example our mission data will be contained in CCSDS packets. Is there a data format requirement?*

The final data format is to be negotiated, but CCSDS is within the expected formats.

**T-34** *There is a discrepancy in the discussion of costing the Engineering Science Investigation: Section 5.1.8 of the AO states that "... An estimated cost for the ESI will not be required. Details of the ESI will be negotiated with selected investigations during Phase A." However, Requirement B-77 says: "This section, which shall not exceed five pages in length, shall describe proposed approach to achieving the goals and objectives of the Entry, Descent, and Landing ESI. At a minimum, this description shall address the following topics:... Estimated mass, power, telecommunications, cost, and schedule impacts associated with the implementation of the proposed ESI."*

As stated in the Pre-Proposal Conference, no cost estimate for the ESI is required at Step 1. Requirement B-77 will be amended to reflect this.

**T-35** *Will the key parameters of the NEXT-C throttle table be made available?*

Paragraph 2.1.1.2 of the NEXT-C AO Guidebook (available through the Program Library) states: "The key parameters of TT11 [throttle table 11] are summarized in the thruster specification sheet found in Appendix A. Due to the export control sensitivity of some of this information, more detailed throttle table data is available upon request. The Point of Contact for such requests is Mr. Scott Benson, NASA Glenn Research Center, [scott.w.benson@nasa.gov](mailto:scott.w.benson@nasa.gov)."

**T-36** *From the spacecraft perspective what is the current best estimate (CBE) of the mass of DSOC, and how much contingency does the spacecraft have to carry?*

The CBE plus contingency is given as the DSOC "Not to Exceed" mass in the Program Library document. Contingency beyond this is left to the wisdom of the proposer.

**T-37** *The DSOC documentation indicates a "Sun-Probe-Earth angle > 3° for operations (survive sun-pointing)." Does this mean that the optical head must never come within 3° of the sun, or is this restriction only for operations and the optics can be pointed at the sun when not in use? Is there a shutter to protect the optics when not in use? A "front cover" was mentioned but was not shown in the images. What is the "front cover?"*

The optical head can be pointed directly at the sun. The restriction is for operations only. The need for a shutter is mission dependent and if required will be internal to DSOC to protect the focal plane. The "front cover" is a one-use deployable cover for launch debris protection.

**T-38** *Based on the DSOC FactSheet in the Discovery 2014 AO Program Library, it appears that the mass and power have been updated from those presented in April at the Discovery Technology Day. Specifically, it looks like the latter included 30% margin over the former? Can you verify that the CBE values for mass and power are 22 kg and 61 W respectively? If so, is there a recommended contingency that should be carried over these values? Is it 30% for each? Or has that contingency been reduced to 20% or 10%?*

The current best estimates (CBEs) for mass and power are 22 kg and 61 W. See Answer T-20 for contingencies.

**T-39** *Information presented at the April Discovery Technology Day listed the user data interface for DSOC as “GigE TBC.” Would a SpaceWire or a SERDES interface be acceptable? Is the data interface negotiable?*

The data interface is negotiable.

**T-40** *Is there a Matlab or other function that can be used to generate a Data Rate (Mbps) vs. Distance (AU) plot for DSOC? Alternatively, is the data used to generate that plot available in tabular form?*

The data is available in tabular form:

<b>Deep-Space Range (AU)</b>	<b>Nighttime Nominal Data-Rate (Mb/s)</b>	<b>Daytime Nominal Data-Rate (Mb/s)</b>	<b>Link Limited MRO Ka-Band (Mb/s)</b>
0.10	264	191	25
0.20	264	186	25
0.30	160	116	25
0.40	100	63	25
0.50	57	45	17.6
0.75	35	20	7.8
1.00	19	10	4.4
1.25	14.3	5.7	2.8
1.50	10.7	3.2	2.0
1.75	7.4	2.1	1.4
2.00	6.1	1.4	1.1
2.50	3.8	0.68	0.71
3.00	2.5	0.37	0.49

**T-41** *Is there a description for when the two California ground stations are available? Are there times of day that are preferred or prohibited? Presumably, the ground stations must also allocate time for astronomical observations but what, if any, agreements have been reached regarding their availability? How much, if any, control do we have over scheduling a downlink window? Weather permitting of course.*

Both ground stations will be operational at launch. The uplink station is used for optical communication and has no astronomical scheduling issues. The downlink station is the Palomar 5 meter telescope which is used for astronomical observations. The Discovery Launch Date is well beyond the Palomar detailed planning period. An agreement is in place for its use as a Ground Receiving Station. The initiation detailed planning for Palomar in the post-launch period is still several years away.

**T-42** *If a Technology Demonstration Opportunity (TDO) involves a separate flight element (e.g., an atmospheric entry probe or a sub-satellite), will the page count be increased by both the allowance for a TDO and the allowance for a separate flight element?*

Yes, if a TDO involves a separate flight element, the proposal page count will increase by 4 pages: 2 in Section E for a description of the TDO and 2 in Sections F and G to describe the Mission Implementation and Management Approach for the extra flight element carrying the TDO.

**T-43** *Where in the WBS should proposers account for the hardware and integration costs associated with the used of NASA-developed technologies?*

NASA-developed technologies should be included in WBS 6.0 Spacecraft and WBS 10.0 Systems Integration & Testing, as appropriate.

**T-44** *Please clarify what is included in the Enhanced PI-Managed Mission Cost regarding the use of NASA developed technologies. The incentives raise the AO cost cap (p. 46), but Section 4.3.3 says they should be included outside the PI-Managed Mission Cost, as part of the Enhanced PIMMC.*

The incentives for the use of NASA-developed technologies should be included in the PI-Managed Mission Cost (PIMMC) as implied by the statement on page 46 of the Final AO that they are considered to be increases to the AO Cost Cap.

*Section 4.3.3 of the Final AO will be amended to correct this mistake.*

**T-45** *If a NASA-developed technology is required for the (single) Baseline and/or Threshold Missions, can it still be a Technology Demonstration Opportunity (which appears to require separability from the Baseline and Threshold Missions)?*

No, if a mission relies on a NASA-developed technology for the achievement of the Baseline or Threshold Mission, then the use of that technology cannot be considered a Technology Demonstration Opportunity. As stated in Section 5.1.7 of the Final AO:

*If proposed, the proposer must clearly identify the development schedule of the TDO and describe how it can be developed so as to be separable from the proposed baseline science investigation and performance floor science investigation.*

**T-46** *NEXT is described as a NASA-developed system, but only two elements of it (thrusters and PPUs) are being provided as GFE. Will the other elements of the system also be excluded from the TMC evaluation?*

If a mission is proposing to use their own feed system and the gimbals on the thrusters, then no. The feed system and the gimbals on the thrusters would be developments that the mission would presumably undertake.

## **Management**

*No questions at this time.*

## Proposals

**P-1** *For the purposes of the page limits table, in a flight system architecture comprising spacecraft bus and OTA (optical telescope assembly including telescope and optical instruments), can the telescope be considered as an instrument?*

It is unclear what is meant in the question by “optical instruments.” In general, though, a telescope is not an independent instrument but a part of an instrument.

*If there is more than one optical instrument (e.g., an HST-like architecture rather than a Kepler-like architecture), then the telescope should be considered part of the instrument that places the most stringent requirements on it.*

**P-2** *Why was Table B3 from the 2010 AO split into 2 tables?*

In using Table B3 from the 2010 AO, there was the potential for uncertainty in the application of forward pricing rates, especially when multiple organizations, each with its own forward pricing rate, collaborated. By splitting Table B3 into Real Year and FY2015 denominated tables, the organizations themselves perform the needed escalation/de-escalation.

**P-3** *Should the Enhanced PI-Managed Mission Cost be included in Tables B3a and B3b?*

Yes, as shown in the templates.

**P-4** *There appear to be numerous errors in the “Requirements Cross-walk” table in Appendix G.*

For the final AO, the table will be updated and corrected. Proposers should note, however, that Appendix G is offered as a *rough guide* to the relationship between the requirements in Appendix B and those in the main body of the AO. It is not intended to be complete nor is it assumed to be by evaluators.

**P-5** *Is the required CM&O rate of \$43K/FTE applied with or without inflation adjustment from Phase A through F?*

The CM&O rate is \$43K (FY15) per FTE for the duration of any award selected from this AO. For years after FY15, this number must be inflated.

**P-6** *Are Phase F costs considered part of the PI-Managed Mission Cost?*

Yes. As defined in Section 4.3.1 of the Draft AO “[The] PI-Managed Mission Cost is defined as the funding that the Discovery Program will be expected to provide to the PI’s implementation team for the development and execution of the proposed project, Phases A through F. It includes any reserves applied to the development and operation of the mission as well. The Phase A-D portion of the PI-Managed Mission Cost is capped at the AO cost cap (see Section 5.6.1).

*As defined in Section 4.3.1 of the Final AO “[The] PI-Managed Mission Cost is defined as the cost proposed by the PI’s implementation team to be funded by the Discovery Program for the development and execution of the proposed project, Phases A through F. It includes any reserves applied to the development and operation of the mission as well. The Phase A-D portion of the PI-Managed Mission Cost is capped at the AO Cost Cap (see Section 5.6.1).*

**P-7** *Is there a maximum duration for Phase E?*

No but the duration must be tied to the science objectives and will be evaluated in this light.

**P-8** *Is the funding associated with the bridge phase included in the PI cost cap, or is it in addition to the PI cost cap?*

The bridge funding is considered part of Phase B, so it is included in the PIMMC and is under the AO Cost Cap.

**P-9** *The incentive for SC is 1% of the PI-managed cost. Can part of the 1% of Phase E cost incentive be spent in Phases C/D, or part of the Phase C/D incentive spent in Phase E?*

There isn’t a “Phase C/D” part or a “Phase E” part of the SC incentive; the incentive can be spent in any mission phase.

**P-10** *What date should proposers use for the start of Phase B?*

Proposers should assume that Phase B will start in September 2016.

***P-11 Are the NASA-developed technologies considered a Technology Demonstration Option, as defined in Section 5.1.7?***

~~No, these are different. For the purposes of this AO, only those technologies listed in Table 4 of the Draft AO are considered “NASA-developed technologies.” Demonstration of any other technologies are considered TDOs.~~

For the purposes of this AO, only those technologies listed in Table 4 of the Draft *Final* AO are considered “NASA-developed technologies.” The original intent of offering TDOs was to allow for the demonstration of other technologies. However, there is no reason to prohibit the demonstration of NASA-developed technologies as TDOs. Therefore, the demonstration of NASA-developed technologies may be proposed as a separable TDO.

***P-12 If Technology Infusion is not a Technology Demonstration Opportunity, where in the proposal should the provision of a Technology Infusion be described? Does the page count for technology infusion increase by two as with TDOs?***

As shown in the table of page limits (page B-2 of the Draft *Final* AO), the plan for infusing NASA-developed technology should be described in Appendix J-13. This appendix is limited to 5 pages in length.

***P-13 Are the NASA-developed technology incentives applied to Phases A-E? What funding profile should be assumed for the incentives?***

Proposers should propose a profile that enables them to accommodate the infused technology and any additional science content enabled by the increased cost cap (\$450M + appropriate incentive).

***P-14 Evaluation of Technology Demonstration Opportunities (TDOs) is identified as Evaluation Factor B-7 in Science Implementation. Where is Technology Infusion of NASA developed technology critically evaluated?***

This will be evaluated under Factor C-3. It will be added to that evaluation factor in the Final AO and will be evaluated under other factors (mostly but not exclusively Factors C-2 and C-4) as applicable.

**P-15** *Please provide definition of a “typical funding profile over a nominal four-year development period” (Section 4.3.4, ~~Draft~~ Final AO).*

There really is no typical or expected profile. However, for community awareness, based on the proposed RY funding profiles of previous Step-1 proposals, including reserves and excluding contributions, the average profile seems to be 1% of PIMMC for Phase A, 14% of PIMMC for Phase B, 71% of PIMMC for Phases C/D, and 14% of PIMMC for Phases E/F. This average profile is *not* used for any evaluation purposes.

As additional information, for planning purposes, NASA has assumed that after a nine-month long, \$3M Phase A, 17% of the PIMMC will be spent in the first (post-downselection) year, 32% in the next year, 28% in the year after that, and 15% in the following year. The remainder is spent over the rest of the mission.

**P-16** *Will the parametric cost input file and results also be redacted from any proposal sent to a non-US person serving as reviewer? These files often mirror the structure of the MEL and contain a similar set of technical details.*

If the parametric cost model input file and results contain ITAR-sensitive material, they will be redacted from any proposal materials sent to non-US persons serving as evaluators. Generally, non-US persons are only used as science evaluators, not Technical, Management, and Cost evaluators.

**P-17** *Are Letters of Commitment required for contributed Co-I and collaborator services?*

Section 5.6.7 of the Final AO will state that: “The requirement for institutional Letters of Commitment for contributions does not apply to contributed support for collaborators...” The Draft AO erroneously omitted this language.

Section 5.8.1.3 of the Final AO will state that: “No Personal Statements of Commitment are required in the Step-1 proposal. No Institutional Letters of Commitment are required for individuals in the Step-1 proposal, unless the individual is contributed and part of the Proposal Team. The Proposal Team is defined to include, but not be limited to, *all members of the Key Management Team and any Co-I who is not part of the Key Management Team* [emphasis added].” This is a clarification to the Draft AO.

**P-18** *Are proposers allowed one 5-page appendix for each NASA-developed technology being proposed?*

No, proposers are allowed a single five-page appendix to describe the infusion approach of any and all NASA-developed technologies. This appendix need not repeat information that may be found in the body of the proposal. However, for completeness, discussions of NASA-developed technology in the body of the proposal should be referenced from this section.

**P-19** *Are costs that are not typically considered “Mission Operations” in Phase E intended to be part of the PI-Managed Mission Cost cap of \$450M (e.g., Phase E science team costs for data analysis and archiving)?*

The Phase A through D portions of the PI-Managed Mission Cost, excluding the cost of launch vehicles is capped at \$450M FY 2015 dollars. Development of ground or flight system software and the development, fabrication, or refurbishment of test-beds, which may occur during Phase E, will be considered deferred Phase D work and will be included under the AO Cost Cap. The costs of Phases E and F will not be under the AO Cost Cap.

**P-20** *AO Section 4.4.3 states, “Proposals may include funding for up to one year after end-of-operations for the generation and archiving of derived data products. This funding will be included in the capped PI-Managed Mission Cost.” Please clarify that Phase F costs are not included in the cost cap.*

As stated in the answer to question P-19, the costs for Phases E and F are *not* under the AO Cost Cap. The language in Section 4.4.3 of the Draft AO is a hold-over from earlier AOs in which all mission phases were under the AO Cost Cap. This will be fixed in the Final AO.

**P-21** *Should incentive additions to the PI-Managed Mission Cost be included in unencumbered cost reserve percentage calculations?*

Yes. Such incentives are certainly part of “[t]he funding that the Program sponsoring the AO will be expected to provide to the PI’s implementation team for the development and execution of the proposed project, Phases A through F.” (~~Draft~~ *Final* AO, page C-4)

**P-22** *What versions (by date) of PRICE-TruePlanning and SEER will satisfy Requirement 71?*

PRICE TruePlanning 2010 SR2 or newer. *SEER for Software 8.1.16 or newer*, SEER-H 7.2.32 or newer, SEER-H Electro-Optical Sensors 2.2.15 or newer, and SEER-H Integrated Circuits 2.2 or newer.

***P-23 It is not obvious that parametric cost models using standardized databases have the fidelity to accurately capture costs as demonstrated by the historical performance of smaller and lower-cost organizations. Requiring the use of such models may place such organizations at a competitive disadvantage.***

With respect to model fidelity for low-cost organizations, proposing teams are encouraged to include rationales for any cost differences between the benchmark model-derived estimate — assumed to be used for validation — and the proposed cost.

***P-24 The cost of acquiring the models specified in the AO (PRICE-TruePlanning & SEER-H), together with associated training costs, may place a significant financial burden on smaller organizations. Can NASA arrange for proposer access to at least one of these tools?***

NASA SMD will not arrange for proposer access to PRICE-TruePlanning or SEER-H. Proposers without ready access or experience with these tools are encouraged to partner or contract with an organization that has such access and experience.

***P-25 The NASA-funded NICM model was developed to estimate costs of certain space science flight instruments. For proposed instruments within the NICM data set may proposers use NICM to benchmark these costs?***

Proposing teams are encouraged to utilize multiple methodologies to estimate and validate proposed costs and to include those estimates and validations in their proposal. However NICM —being limited solely to instrument costs — does not provide the necessary data for NASA to validate significant fractions of proposed mission costs, and so was not included in the list of benchmark models (PRICE-TruePlanning and SEER-H).

***P-26 The AO release date (NET October 2014), combined with the proposal due date (December 2014) is inconsistent with the traditional 90-day response period.***

When the Final AO is released, at least 90 days will be available between the actual release date and the proposal due date.

**P-27** *Is PRICE-H an acceptable substitute for PRICE True-Planning given the underlying component-level CERs are the same for each module, and PRICE-H is included as part of the TruePlanning tool suite? Additionally, model inputs between PRICE-H and True-planning are identical; PRICE-H simply allows for greater user control and visibility into component level estimates.*

Because PRICE TruePlanning incorporates the core functionality of PRICE-H and expands on it to facilitate addressing additional NASA WBS elements, PRICE-H inputs will not satisfy the requirement to submit benchmark model inputs.

**P-28** *What is the scope of the benchmark model needed to satisfy Requirements 71 and B-54? Specifically:*

- a) Should it cover more than NASA WBS element 06. 'Spacecraft'? If so, what other level-2 elements should be covered?*
- b) Will the model be expected to account for the costs of flight software?*
- c) If the model is expected to account for the costs WBS element 05, can the NICM instrument cost model (industry standard) be regarded as an alternative standard parametric model? If PRICE/SEER is required for all mission elements (including instruments), can NICM output be used as a direct throughput to the model with appropriate documentation?*

- a) Apart from WBS Element 06 (Spacecraft), the benchmark model should address WBS Elements 01 (Project Management), 02 (Systems Engineering), 03 (Mission Assurance), 05 (Payload(s)), and 10 (Systems Integration & Testing).
- b) Yes, the model will be expected to account for the costs of flight software.
- c) With respect to using NICM for WBS Element 05 (Payload(s)), the intent of the benchmark model is to provide NASA with insight, within an integrated parametric modeling environment, into the basis of the proposed cost. NICM may be used by proposers as part of their own cost estimation or validation efforts, but its use in the benchmark cost estimate is strongly discouraged.

**P-29** *Requirement B-49, Requirement 71, and Requirement B-6 are inconsistent with one another (B-49 mentions “results”, 71 does not mention a requirement to report the results, B-6 does not indicate where or how to include the files containing the results of the parametric analysis).*

This will be clarified in the Final AO. In short, Requirement B-49 addresses validation of proposed costs while Requirement B-54 addresses an improvement in the transparency of the cost evaluation process. Requirement B-49 *allows* for the use of parametric models in the validation of proposed costs but does not require it. Requirement B-54 *requires* the use of one of two specific parametric models to provide additional information to evaluators. If a proposer were to choose to use a parametric model to validate the proposed costs, Requirement B-54 *does not* require that SEER for Software and SEER for Hardware, Electronics & Systems Core (SEER-H) with Electro-Optical Sensors and Integrated Circuits extended capabilities or PRICE® TruePlanning™ Cost Estimating Framework be used, although either or both could be at the discretion of the proposer. Requirement B-54 will be modified to indicate that parametric model input file(s) *and* results should be included on the CD-ROMs containing the proposal.

**P-30** *Section 4.5.4 “Conjunction Assessment Risk Analysis” states that: “Selected investigations will have to spend project funds only to establish a working interface between the Flight Operations Team and the CARA team to routinely share orbital ephemerides data and maneuvering plans.” What is the recommended way to estimate this expense? If CARA is not needed for a mission, are proposing institutions able to get an exemption from this requirement?*

The requirement in NPR 8715.6A only applies to missions in certain orbits. If the requirement does not apply to a mission, then no waiver is necessary because the requirement does not apply. If the mission meets the requirements in the NPR, no waiver will be granted and the mission must comply. The CARA team can provide the predicted number of events that will require analysis for cost estimation purposes, but how much it will cost a particular mission to plan an avoidance maneuver is mission-specific. For additional information, proposers may contact the Ms. Lauri Newman (Telephone: 301-286-3155; E-mail: [lauri.k.newman@nasa.gov](mailto:lauri.k.newman@nasa.gov)). For information regarding CARA for the Moon and Mars, please contact Mr. Roby Wilson (Telephone: 818-393-5301; E-mail: [robby.s.wilson@jpl.nasa.gov](mailto:robby.s.wilson@jpl.nasa.gov)).

**P-31** *Under Project Management Policy, Section 4.5.1, “Independent Verification and Validation of Software” states, “If the software assurance classification assessment determines IV&V is mandatory, proposal teams are encouraged to contact the Office of the Director ...” This encouragement is unactionable by the Step 1 proposal teams.*

Per NPR 7150, all Category 1 and Category 2 missions with a Payload Classification A or B require IV&V. Historically, Discovery missions have been determined to be Category 2 missions (per NPR 7120.5E) with Class B or Class C payloads (per NPR 8705.4). Therefore, almost all Discovery missions will require IV&V. The costs for IV&V will be outside of the cost cap.

**P-32** *How is the SEO on “archival data analysis programs” different from the standing Discovery Data Analysis Program? What time is it supposed to cover? One year to cover gaps before the next DDAP or an independent 3-5 years research program?*

The SEO on “archival data analysis programs” was mistakenly left in the text of the Draft AO. PSD’s Data Analysis Programs (DAPs) have replaced this type of SEO. This language will be fixed in the Final AO.

**P-33** *In order to support the details needed for parametric cost modeling (Section 5.6.3, Requirement 75), may the columns shown in Table B5 be expanded to the right, rather than lumping all this information into the “Other” column? Would it be acceptable to move all this “Other” information to a second MEL sheet, as a continuation of Table B5?*

Since the model inputs themselves can and should be annotated, no change will be made to Table B5.

**P-34** *Where should GFE be shown in Tables B3?*

Each contributed GFE (e.g., flight spares) should be shown in Tables B3a and B3b as a separate contribution, below the PI-Managed Mission Cost but part of the Total Mission Cost. GFE specifically identified in the AO (e.g., launch services, UHF relay, or NASA-developed technology hardware) should not be identified in Tables B3a and B3b.

**P-35** *Where should the total of the cost-capped portion of the PIMMC be shown?*

The Final AO added a column in each of Tables B3a and B3b for the Phase A-D total.

**P-36** *Section 5.6.3 Cost Estimating Methodologies and Cost Reserve Management: What software is included in the PRICE® TruePlanning™ Cost Estimating Framework (i.e., PRICE-H)? Will submission of a PRICE Estimation Suite (PES) file with the extension “XX.hpr” (PRICE-H file) meet the requirement?*

Because PRICE® TruePlanning incorporates the core functionality of PRICE-H and expands on it to facilitate addressing additional NASA WBS elements, PRICE-H inputs will *not* satisfy the requirement to submit benchmark model inputs. If submitting PRICE model inputs, provide an unencrypted file with the extension "XX.tpprj" (PRICE TruePlanning export file).

**P-37** *Consider increasing the submitted proposal file size from the current 20 MB. For example the Europa instrument AO file size limit may have been 25MB.*

File size is set by the capabilities of NSPIRES. Currently, NRESS engineers are confident that 20MB files can be successfully uploaded by proposers and then downloaded by evaluators. Note that the Europa opportunity did not allow for submission of larger versions of electronic proposals via CD-ROMs.

**P-38** *Requirement B-72 of the AO contains the following language:*

*List each electronic board separately, identify the functionality of each board (either in the MEL or in the Mission Implementation section), and provide the speed the board will be running at.*

*This is a new requirement for the 2014 AO. Does this requirement pertain to ALL electronics boxes on the Observatory? Items such as transponders, star trackers, solar array drive electronics, inertial rate units, reaction wheels are typically build to print heritage items that have flown dozens of times and are made in relatively large quantities, with typically only one or two circuit cards in each device. Can you provide any guidance on what equipment is targeted for this requirement?*

This requirement does not apply to off-the-shelf heritage items that are made for a wide group of customers. This requirement is intended for customized electronic boxes and electronic units where significant amount of resources are spent on design and development of hardware to satisfy a specific need.

**P-39** *Requirement 102 states the proposals shall conform to the uniform proposal format outline in Appendix B. Are the numbered sections intended to be part of this outline? For example, is Section F required to flow as depicted in the table (F.1 General Requirements and Mission Traceability, F.2 Mission Concept Description, etc.) or can the information be ordered as appropriate to clarify concepts as long as all topics are addressed?*

Yes, the numbered subsections within each lettered section are intended to be part of the required outline. This is to ensure that information needed by evaluators can be quickly found in the same location in all proposals. The ease with which evaluators can find the information they are looking for in a proposal often (unconsciously) affects the review of that proposal; having all proposals conform to the same outline removes this extraneous factor from consideration.

**P-40** *Where should the costs associated with a proposed TDO be described?*

All costs should be described and discussed in Section H.

**P-41** *Do the trajectory data files count against the 100 MB limit in Requirement B-6? Would it be sufficient to just reference standard sources for these data files and not include them on the CD-ROM?*

The 100 MB limit in Requirement B-6 applies to optional higher resolution but otherwise identical, versions of electronic proposals, only. The separate trajectory data, cost, and schedule files could utilize on the order of 580 MB on the CD-ROM. Since proposals are meant to be stand-alone, complete documents, references to external, standard sources will not be sufficient.

**P-42** *Section 5.8.1.3 inserted new language “unless the individual is contributed and part of the Proposal Team” which seems to contradict §5.6.7 which states “the requirement for institutional Letters of Commitment for contributions does not apply to contributed support for collaborators; no institutional Letters of Commitment are required with the Step-1 proposal for collaborator support”. Are institutional letters of commitment required for contributed, science-only collaborators/co-investigators?*

To clarify, Institutional Letters of Commitment are not required for Collaborators, even when named as part of the Proposal Team. Institutional Letters of Commitment are required for all contributed Co-Investigators.

**P-43** *In the final release of the AO, the word “additional” was added before the term “science instrument” in Requirement B-4. This is not as clear as the draft language which omitted the word additional. Does a mission with three instruments get 4 or 6 extra pages (2 for each of three instruments, or 2 for each additional instrument over the first?)*

The only consistent way to interpret Requirement B-4 in light of the preceding table of page limits is that a bare minimum mission — one composed of a single flight element carrying a single instrument — should receive 2 extra pages (for a total of 32) for Sections D and E and 2 extra pages (for a total of 37) for Sections F and G. In the example of a mission with 3 instruments, a total of 6 pages would be added to Sections D and E. The following formula may be helpful:

$$\begin{aligned} (\# \text{ extra pages}) = \min[ & 2 * (\# \text{ instruments}) \\ & + 2 * (\# \text{ flight elements}) \\ & + \text{if}(\text{“SEO present”}, 2, 0) \\ & + \text{if}(\text{“TDO present”}, 2, 0), 15 ] \end{aligned}$$

where  $\text{if}(\text{EXPR}, \text{A}, \text{B})$  equals “A” if EXPR is true and “B” otherwise, “SEO present” means that the proposal contains at least one Science Enhancement Opportunity (SEO) and “TDO present” means that the proposal contains at least one Technology Demonstration Opportunity (TDO)

**P-44** *Requirement B-43 calls for the project schedule to be submitted in Microsoft Project format. Within the description of what should be submitted, what is meant by a “quantified data set”?*

A “quantified data set” is a set of data presented in terms of measurable units, *i.e.*, quantitatively rather than qualitatively (large or small, good or bad, *etc.*). Such a data set allows the data to be combined, averaged, and/or manipulated as necessary.

**P-45** *What is meant by “similar purchase history” in the requirement for Vendor Quotes (Requirement B-50)? (The date of the quote, expiration date, and similar purchase history should be described). Please be more specific.*

A “similar purchase history” refers to the history of purchases previously made of a given or similar item. If available, these purchases might help demonstrate the level of consistency seen on the costs for similar items in the past.

***P-46 Are proposals required to include cost and pricing data certification for Phase A?***

No. Although FAR 15.403-4 — as referenced in AO Appendix A, Section VI — now requires certified cost and pricing data, proposals do not need to include cost and pricing data certifications. If an investigation is selected for a Phase A study then the proposing institution will be required to submit such certifications during negotiations for the Phase A contract.

***P-47 Is there a preferred version of MS Project?***

Microsoft Project format project schedules may be submitted in 2003, 2007, 2010 (preferred), or 2013 compatible file formats.

***P-48 Regarding Requirement B-78, will proposers be assigned a weakness for not using AMMOS?***

No. Slide 14 of Michael New’s Overview Presentation at the Pre-Proposal Conference indicated that extensive heritage with other sets of tools is a reasonable justification for not using AMMOS.

***P-49 AO Requirement B-8 requires that “The signature of the PI and the authorizing official (unless these signatures appear on the Proposal Summary Information)” must appear on the graphic cover page. Since this AO utilizes electronic submittal, and the submitting institution and PI indicate their commitment through NSPIRES, is the signature on the graphic cover page required?***

The Proposal Summary Information contains an electronic “signature” by the Authorizing Official (AOR) — a proposal cannot be submitted to NSPIRES without it. There is no equivalent commitment, however, for the PI. Therefore, a graphical signature is still required for the PI and is optional for the AOR.

***P-50 In the recent amendment to the AO, proposers were instructed to use red text for export-controlled material or to employ a red box for figures or tables containing such material. Paragraphs containing many scattered references to export-controlled material are very difficult to read when peppered with red. Could these paragraphs be contained in red boxes, instead?***

Yes, such paragraphs may be contained in red boxes. Note, though, that in the event that export-controlled material needs to be redacted from the proposal, the entire paragraph contained in the red box will be redacted.

**P-51** *Section 5.8.3 of the AO allows for the inclusion of a classified Heritage Appendix. Proposers are instructed to send the appendix to  
Mail Custodian  
Suite 1M40, 300 E Street SW  
Washington, DC 20546  
My organization has policies in place forbidding the transfer of classified materials to unnamed persons. To whom should the classified Appendix be sent?*

Please address the package containing the classified materials to:  
Mr. Paul Raudenbush  
Chief, NASA Headquarters Security Office

## **Launch Vehicles and Secondary Payloads**

**L-1** *What does “compatibility” with a launch vehicle family mean?*

In the context of the Discovery 2014 AO, compatibility with a launch vehicle family means that

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.

**L-2     *The AO states that using the Low Performance launch vehicle with a 4m fairing will result in an increase in the AO Cost Cap; if a mission can incorporate an upper stage into the spacecraft that provides part of the total necessary performance such that a very low performance launch vehicle can be used, will the cost difference between the Medium Performance launch vehicle offered for no cost in the AO and the much lower performance launch vehicle be added to the AO cost cap (in its entirety)?***

In short, no. Table 3 in Section 5.9.2 of the ~~Draft~~ *Final* AO lists incentives and cost cap decreases for six performance classes of expendable launch vehicles offered for this AO. The only amount NASA plans to give to proposers as an increase in the cost cap is the stated \$16M for utilizing the low performance class vehicle with a 4m fairing. Launch vehicles are competitively awarded around L-30 months, so NASA cannot predict which launch vehicle in a performance class might be awarded to a mission.

***L-3 As written, Requirements 93 and 94 preclude Principal Investigators from base-lining Falcon Heavy as a launch vehicle for their proposed missions. Falcon Heavy is scheduled to launch in 2015, prior to the completion of Discovery Phase A studies, and is anticipated to be available on the NLS catalog no later than 2016, well before the 2021 anticipated launch date. Can a mission propose using launch vehicles expected to be available on the NLS catalog by the anticipated launch date?***

~~Since launch vehicles are competitively awarded around L-30 months, neither NASA nor proposers can predict which launch vehicle in a performance class might be awarded to a mission. LVs currently available on NASA Launch Services contracts include Antares, Athena, Atlas V, Falcon 9, Pegasus, and Taurus. New vehicle configurations can be awarded contracts or added to existing contracts as part of an annual on-ramp mechanism. Requirements 93 and 94 act to constrain the size of the spacecraft. SpaceX is welcome to bid a Falcon Heavy when the Request for Launch Services Proposal (RLSP) is released to the contractors on LSP's standing contracts.~~

Proposers are not expected to identify the specific launch vehicle configuration needed for their mission, but instead, should specify the mass, minimum launch energy and payload fairing volume requirements needed to perform their mission. The information in the "Discovery 2014 AO ELV Launch Services Program Information Summary 06/11/2014" document is designed to envelope the characteristics of the launch vehicles on contract with NASA at the current time. Due to the volatility of the launch services market, cost and performance for launch vehicles not yet on contract with NASA will not be included in this AO. However, new vehicle configurations can be awarded contracts or added to existing contracts as part of an annual on-ramp mechanism to the NASA Launch Services II (NLS II) contract. When the launch service is competed (acquisition process begins approximately L-36 months) all launch vehicles on contract with NASA and eligible to bid at that time will be included in the competition.

***L-4 Can the launch vehicle options in Table 3 be expanded to include the "High Performance Class" vehicles from the 2010 AO, similar to the Atlas V 431/531?***

The high performance class was established as shown and will not be expanded further during this phase of the competition.

**L-5** *Atlas V and Falcon 9 are the only ELVs in the NLS-II contract that provide this level of performance and can satisfy Requirement 96. Upon review of the “Discovery 2014 AO ELV Launch Services Program Information Summary 06/11/2014” document in the Discovery Program Library, the performance ranges presented in Attachment 2 appear to be for the Atlas-V ELV. The Falcon 9 (v1.1) performance from the referenced website (<http://elvperf.ksc.nasa.gov/elvMap/>) is in conflict with the ELV LSP Information Summary document. The Falcon 9 (v1.1) launch vehicle spans the low- and medium-class performance ranges depending on C3. It also comes with a 5-m fairing as standard equipment. Are we correct in assuming that a mission requiring an Atlas V 501 LV will be charged \$13M to use the non-standard Atlas 5-m fairing, but will also be given a \$16M credit for using a low performance LV (For a net \$3M credit)?*

Proposers are not expected to identify the specific launch vehicle configuration needed for their mission, but instead, should specify the mass, minimum launch energy and payload fairing volume requirements needed to perform their mission. The information in the “Discovery 2014 AO ELV Launch Services Program Information Summary 06/11/2014” document is designed to envelope the characteristics of the launch vehicles on contract with NASA at the current time, including various configurations of Atlas V and the Falcon 9 v1.1. A mission falling into the “low” performance range that *requires* a 5m fairing accommodation will be assessed a \$13M charge against the mission cost cap. If a mission falling into the “low” performance range does not require a 5m fairing but a Falcon 9 (v1.1) LV is selected for it, the \$13M charge for the use of the non-standard Atlas V 5m fairing will *not* be applied.

**L-6** *Are we correct that a mission using a Falcon 9 (v1.1) will be given the \$16M low performance credit and will not be charged for the 5-m fairing, because that is standard equipment? Can NASA please clarify how the ELV, specifically the Falcon 9 (v1.1), performance is categorized relative to the Table 3 in Section 5.9.2 of the Draft AO, perhaps by adding an additional performance range graph to Attachment 2 of the ELV LSP Information Summary? How do proposers address Requirement 96 and remain flexible to be accommodated on multiple launch vehicle families since the presented incentive structure is primarily based on fairing size and doesn't align with the separation of low and medium performance ranges provided?*

Proposers are not expected to identify the specific launch vehicle configuration needed for their mission, but instead, should specify the mass, minimum launch energy and payload fairing volume requirements needed to perform their mission. The credit/charge is based on the proposed mission's performance and PLF volume requirements. The information in the "Discovery 2014 AO ELV Launch Services Program Information Summary 06/11/2014" document was designed to envelope the characteristics of the launch vehicles on contract with NASA at the current time, including various configurations of Atlas V and the Falcon 9 v1.1. Proposers are encouraged to maintain compatibility with multiple launch vehicle configurations by designing to the environments shown in Attachment 2.

**L-7** *Does the baseline launch vehicle cost include the cost associated with different height launch vehicle adaptors?*

For the Atlas V family, the Launch Services Webpage, <http://elvperf.ksc.nasa.gov/Pages/Vehicles.aspx>, lists two "Optional (Non-Standard) Services" payload adaptor diameters, but no height information is given. The 2010 User's Guide lists varying heights for the three options. For Falcon 9, the Launch Services Webpage states "[t]he provider does not currently offer an alternate adapter as a non-standard service." Nothing is said regarding height, nor does the 2009 User's Guide mention anything. Proposers are encouraged to contact the Launch Services Program directly. The Point of Contact (as of the Pre-Proposal Conference) is Ms. Diana Calero, [diana.m.calero@nasa.gov](mailto:diana.m.calero@nasa.gov).

**L-8** *Are proposing organizations allowed to continue discussions with the Launch Services Program after AO release?*

Yes, the constraint limiting direct discussions between proposers and the NASA Launch Services Program to "[p]rior to AO release" has been removed from the ELV Launch Services Information Summary in the Program Library.

- L-9** *Does LSP provide orbital debris analysis and the disposal of the upper stage? Does it impact the moon? Heliocentric orbit? And does LSP decide that? Is there any precedence from other lunar missions?*

LSP provides the launch vehicle portion of the required Orbital Debris Assessment Report (ODAR) submittals. This assessment covers all orbital debris requirements, including upper stage disposal. The means of disposal is developed on a mission-specific basis, with input from the spacecraft project, launch services contractor and LSP. There are multiple disposal options and they are typically taken into account during the Launch Services Task Order (LSTO) that is the process by which LSP procures the launch service. After award of launch service, the final solution would need to be analyzed and worked out during the integration process. The Mission Integration Team would come up with the solution that best meets both Orbital Debris policy and mission requirements. For example, in the Lunar Reconnaissance Orbiter (Atlas V) mission, the Centaur was directed into the lunar surface as part of the LCROSS secondary mission. For the GRAIL (Delta II) mission, the second stage performed depletion burn after separation to achieve a positive C3, sending it on an Earth-escape trajectory.

- L-10** *Is a “short” fairing the baseline for both 4 and 5m fairings? What are the cost deltas associated with a medium and tall fairing?*

Figure 1, providing the nominal 4m static payload fairing envelope, was added to the Discovery 2014 ELV Launch Services Program Information Summary on November 14, 2014. For the nominal 5m static payload fairing envelope and details regarding larger envelopes for both 4m and 5m fairings, proposers are encouraged to contact the Launch Services Program directly. The Point of Contact is Ms. Diana Calero, [diana.m.calero@nasa.gov](mailto:diana.m.calero@nasa.gov).

## **International Participation**

- I-1** *Does NASA define “PI-Managed instrument cost” (the divisor in the given equation) to comprise all elements of WBS 5.0 (including payload management and payload systems engineering)?*

The PI-Managed Instrument Cost is composed of all elements of WBS 4.0 (Science) and WBS 5.0 (Payload(s)).

- I-2** *Does the 1/3 limit on foreign-contributed instruments apply only to Phase A-D costs?*

No, it applies to all phases, Phases A-D, E, and F.

**I-3** *Does the 1/3 limit on foreign-contributed instruments include the contributed cost of foreign science Co-Is associated with the contributions?*

Yes, it includes the contributed cost of foreign science Co-Is.

**I-4** *Does the 1/3 limit on foreign-contributed instruments include reserves?*

Neither reserves held by the foreign partner, nor any reserves held by the project (e.g., the replacement cost of a contribution which failed to appear) should be included in the 1/3 limit.

**I-5** *How should changing exchange rates be handled in estimating the value of foreign contributions?*

The exchange rate to use is the official rate on the date of AO release.

**I-6** *Should a Student Collaboration be included in PI-Managed Instrument Cost?*

No. The costs of a Student Collaboration have not, in the past, been kept in WBS 4.0 or WBS 5.0; these costs have been carried under WBS 11.0 if they exceeded the 1% Student Collaboration Incentive.

**I-7** *Will NASA perform independent parametric cost estimates of foreign instruments to validate compliance with the new rule?*

Yes, NASA will validate the proposed value of foreign-contributed instruments ~~using a parametric model.~~

**I-8** *Will scan platforms, booms, etc. needed for a science payload count towards the PI-Managed Instrument Cost?*

Yes, scan platforms, booms, etc., needed for a science payload are included in the PI-Managed Instrument Cost.

**I-9** *Requirement 3 prohibits engagements with China. Is the April 2, 2014 Agency-wide prohibition of non-ISS engagements with Russia also applicable to Discovery 2014?*

Due to the current situation in Ukraine, the U.S. government has taken a number of actions, to include suspending official government-to-government contacts and meetings with the Russian Federation on a case-by-case basis. Consistent with this, NASA will review proposed cooperative activities on a case-by-case basis, including any Discovery 2014 proposals.

**I-10** *Section 5.7.1 “Overview of non-US participation” states that: “[t]he direct purchase of supplies and/or services, which do not constitute research, from non-U.S. sources by U.S. award recipients is permitted.” Can more specifics be provided on what constitutes “research”, and what cannot be appropriately purchased in this category.*

“Research” can be defined as “the systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions.” It is an open-ended activity with unclear endpoints. NASA funds may be used to purchase COTS items from non-US sources. NASA funds may also be used to purchase services that do not involve scientific investigations. Therefore, purchasing from a foreign source an uninterpreted assay of a material is allowed, while having the foreign source interpret the results of the assay is not. An off-the-shelf instrument may be purchased from a foreign provider, but the development program leading to the instrument or the collaborative development of an instrument specification cannot be supported.

**I-11** *Does answer I-1 mean that the constraint on foreign-contributed instruments is 1/3 of the PI-Managed Instrument Cost (as for the total mission) or 1/3 of total (PI + contributed) payload costs?*

In the Community Announcement “Clarifications of NASA Discovery Program Draft Announcement of Opportunity” issued in May 2014, it was stated that:

Foreign contributions to the science instruments remain constrained to be no more than one-third of the NASA instrument cost. To clarify:

$$\frac{\text{Value of Foreign Instrument Contribution}}{\text{PI-Managed Instrument Cost}} \leq \frac{1}{3}$$

“PI-Managed Instrument Cost” is defined as the portion of the PI-Managed Mission Cost ascribed to instruments.

Furthermore, in the Final Discovery 2014 AO, Section 4.3.3 defines the “PI-Managed Mission Cost” as “the cost proposed by the PI’s implementation team to be funded by the Discovery Program for the development and execution of the proposed project, Phases A through F. It includes any reserves applied to the development and operation of the mission as well.” Since the “PI-Managed Instrument Cost” is a portion of the PI-Managed Mission Cost, the constraint is that the value of foreign-contributed instruments cannot exceed one-third of the NASA payload costs *not* one-third of the sum of the costs of the NASA-funded and foreign-contributed instruments.

## Radioactive Materials

### ***R-1 Do RHUs have export control restrictions?***

Yes.

## Telecommunications

### ***C-1 Section 5.9.4 and Requirement 98 state that for a Mars orbiter with 1 Earth-year or more of expected life in Mars orbit, an Electra UHF relay package must be carried. But Section 5.9.4 also states that “Relay operations should not significantly impact the nominal orbiter mission”. May Mars orbiter missions with less than 1 Earth-year of nominal operations in Mars orbit and whose nominal mission would be significantly impacted by relay operations be exempted from having to carry an Electra package?***

A proposed Mars orbiter mission with less than one Earth-year of expected life in Mars orbit is not subject to the requirement to carry the Electra payload (Requirement 98).

The statement that "relay operations should not significantly impact the nominal orbiter mission" reflects the Mars Exploration Program's experience to date with relay operations on science orbiters equipped with UHF telecommunication relay payloads. This is based on the very broad beam width of the UHF antenna, minimizing any spacecraft pointing requirements, and the fact that the time duration allocated to relay services is a very small fraction of the on-orbit time. A proposing Mars orbiter mission with one Earth-year or more of expected life in Mars orbit may not waive the requirement to carry an Electra payload (Requirement 98) based on their assessment of potential impact. However, such impacts may be identified in the proposal, and may be a consideration for NASA in evaluating the potential use of the relay service prior to the completion of the proposed mission's primary science phase.

**C-2** *What is the maximum orbital altitude at which Mars orbiters are required to carry an Electra package, if their mission duration exceeds one year?*

The requirement that a Mars orbiter with one Earth-year or more of expected life in Mars orbit shall include a GFE-provided UHF communications package is waived only if that orbiter operates with a periapsis altitude of >10,000 km at all times during its primary mission and, at the end of the primary mission, would not be capable of lowering the periapsis altitude below 10,000 km.

**C-3** *Requirement 98 states that proposals with greater than one year in Mars orbit shall carry an Electra UHF crosslink. Does the one-year of time include commissioning and disposal or apply to science operations only?*

The condition of “one Earth-year or more of expected life in Mars orbit” in Requirement 98 is measured from the start of on-orbit science operations (after completion of any post-Mars Orbit Insertion commissioning activities) until spacecraft disposal.

**C-4** *Page 26 states that “NASA intends to transition all deep-space missions launched after 2016 to the use of Ka-band for science data return” and Req. 41 says “If the use of Ka-band is inappropriate for the proposed investigation, then the proposal shall contain a justification for the use of an alternative communications approach.” These words (req. 41 and 42) are identical to the 2010 Discovery AO. Does that mean that the evaluation of exceptions to use of Ka will be identical to 2010 Discovery, or will the fact that 2014 Discovery must launch after 2016 change how NASA will interpret this requirement?*

The evaluation of exceptions to the use of Ka-band telecommunications will be identical to the process used in the 2010 Discovery AO.

**C-5** *If a mission can meet its science goals with X-band while conforming to SFCG Recommendation 23-1, is it acceptable to not include Ka-band?*

Requirement 41 of the ~~Draft~~ *Final* AO states: “Proposals shall baseline the use of Ka-band for science data return. If the use of Ka-band is inappropriate for the proposed investigation (based on the SFCG recommendations), then the proposal shall contain a justification for the use of an alternative communications approach.” So, if a mission meets the bandwidth limits outlined in SFCG Recommendation 23-1, it may baseline the use of X-band.

**C-6** *Can you clarify the statement in Section 5.2.5 of the Draft AO that “DSN use will be ...penalized for excessive requirements for DSN usage.” Specifically, what required level of use is considered excessive?*

Time on the DSN should be treated as a valuable, highly limited resource. Excessive use is defined as usage out-of-family with similar missions to similar destinations unless warranted by the science. Proposers should compute the DSN usage fees (see the “NASA Mission Operations and Communications Services” document in the Program Library and the aperture fee spreadsheet available at [http://deepspace.jpl.nasa.gov/advmisss/docs/DSN\\_Aperture\\_2014\\_rev1.xls](http://deepspace.jpl.nasa.gov/advmisss/docs/DSN_Aperture_2014_rev1.xls)) to estimate the costs of DSN services. As a point of reference, past missions have generally used less than \$13M (FY15) of such services.

*Note: The language quoted above from the Draft AO has been deleted from the Final AO. Proposers should consult the text of the Final AO for current policies regarding the use of the DSN.*

**C-7** *Does the AMMOS PDS Pipeline Service work only for science data that was processed at JPL SDS?*

No, it should be able to be used with other compatible science data systems as well.

**C-8** *Please confirm that Requirement B-78 applies to AMMOS Tools, and not also AMMOS Services.*

Correct, the requirement applies only to AMMOS tools, and not AMMOS-provided services.

## **Other**

**O-1** *Will there be an E/PO requirement on Phases A-D, as in Discovery 2010?*

Education and Communication (E&C) plans are not needed at this time. NASA may impose E&C requirements during or subsequent to the Phase A concept study phase.

**O-2** *Must proposed Discovery mission concept objectives be linked directly to Decadal Survey prioritized goals?*

Evaluation Factor A-1 includes an assessment of "...the clarity of the goals and objectives; how well the goals and objectives reflect program, Agency, and National priorities..." NASA's science priorities are laid out in the Agency's Strategic

([http://www.nasa.gov/sites/default/files/files/2014\\_NASA\\_Strategic\\_Plan.pdf](http://www.nasa.gov/sites/default/files/files/2014_NASA_Strategic_Plan.pdf)) and Science

([http://science.nasa.gov/media/medialibrary/2014/05/02/2014\\_Science\\_Plan-0501\\_tagged.pdf](http://science.nasa.gov/media/medialibrary/2014/05/02/2014_Science_Plan-0501_tagged.pdf)) Plans. These plans are based on a number of sources including reports prepared by the National Research Council such as

"Vision and Voyages for Planetary Science in the Decade 2013-2022"

([http://www.nap.edu/catalog.php?record\\_id=13117](http://www.nap.edu/catalog.php?record_id=13117)), colloquially known as "the Decadal Survey."

**O-3** *AO Section 4.4.3 states that proposers can use multiple archives and that "All archive submissions must go through a peer review organized by the Planetary Data System." Please clarify if this peer review applies only to submissions to PDS, or to all archive submissions.*

For an archive to be acceptable to NASA, the data curator must perform mission-independent, peer-based reviews of submitted data to ensure that the data are complete, properly annotated, and usable by the scientific community. The reference to the Planetary Data System in Section 4.4.3 is an error. The statement should be "All archive submissions must go through a peer review organized by archiving organization."

**O-4** *Are proposing institutions allowed to use the full 1% [Student Collaboration Incentive] in Phases A through D?*

There are no restrictions on when the 1% Student Collaboration incentive may be used.

**O-5** *Will the “Discovery Safety, Reliability, and Quality Assurance Requirements” document be revised from DISC-RQMT-002B, “Discovery Program Safety and Mission Assurance Guidelines and Requirements” [dated June 13, 2008] that was cited in the Discovery 2010 AO)? If yes, when will the revised document be made available?*

Current Discovery Program S&MA documents are as follows:  
DPO S&MA Guidelines and Requirements; DISC-RQMT-002 Rev C; 6/28/2013  
DPO S&MA Implementation Plan; DISC-PLAN-006 Rev B; 6/28/2013

These updated documents have been posted on the Discovery Program Acquisition Website (<http://discovery.larc.nasa.gov>).

**O-6** *Will the potential future requirement (for Education and Communications Program) come with new funding from NASA, or do proposing institutions need a placeholder for this potential expense as done in the past (1% of PI-Managed Mission Cost for E/PO)?*

Yes, the costs for any new or expanded Education and Communications requirements will be funded with new funding. Proposals should not employ a budget placeholder for this.

**O-7** *Can students building hardware be involved after extended cruise?*

There is no requirement that the SC incentive be spent at any particular phase of the mission.

**O-8** *Proposers will have “at least 24 hours” to respond to clarifications, how much warning will they have that those clarifications are coming?*

Proposers will be told well in advance when clarification requests will be made, and how long the response time will be.

**O-9** *Is there a facility for data collected by CubeSat missions?*

Regardless of the spacecraft form factor, data needs to be archived in the PDS or a PDS-equivalent archive. The archive requirement is agnostic as to size of the spacecraft.