

***Q1: In addition to proposing institutions providing appropriate cost reserves, will the SOFIA Program Office or HQ/SMD also hold reserves?***

A1: At this time we request proposers concentrate on determining what reserves are required and how this fits into your project management plan, rather than on who specifically will hold the reserves.

***Q2: Should we include the 50 hours GTO in our cost estimate? These would be the 50 hours of guaranteed observing time that the instrument PI and team would want on the SOFIA facility.***

A2: Any GTO time is outside the scope of the proposal. This ROSES NRA element goes through commissioning and acceptance only and does not include any GTO activity, which would occur after acceptance.

***Q3. Given the funding profile limit/restriction of no more than \$5M per year and the \$17M RY \$ cost cap, can the funding profile be re-phased to have carry-over in the next FY (FY17) to allow more of a typical bell-curve funding profile? Would such a funding profile be "compliant"? Does the funding limit refer to fiscal years or program years?***

A3: The \$17M total and \$5M per/year are notional numbers that are intended for guidance only. Moreover, you should construct a budget based on Program or Task Years, which are independent of Fiscal Year boundaries, and based on what is realistically required to carry out the proposed work. NASA will decide how to phase funding with respect to Fiscal Years, not the PI. More importantly, awards are based on Program or Task Years, not Fiscal Years, and the each Program Year will start on the "Period of Performance" date (i.e, the Anniversary Date), which will occur whenever it actually occurs. Finally, if you are at a NASA Center, the award mechanism will be an RTOP, which means the concept of carryover is moot and the center can only charge for those expensed incurred in each fiscal year.

Please note that the only numerical budget information available at this time is found in Section 9, "Expected program budget", and that no further numbers will be provided. As is discussed in the main ROSES elements ----- see Section IV(d), page 20 ----- these numbers are "estimated funding" that "are subject to the availability of appropriated funds". In the absence of appropriated funds from Congress, we unfortunately can not provide more concrete numbers and that the numbers provided are intended to provide guidance only to the proposers, not firm requirements. Please review Section 4.3: Cost Requirements of this ROSES element (page D.12---10) for the details of the Step 2 cost requirements.

***Q4: We see nothing in the SOFIA call that overrides the standard ROSES requirement that civil servant labor cost be redacted from the proposal uploaded to NSPIRES. Please confirm that you're expecting us to follow that rule, or let us know if we should show the cost of labor.***

A4: Yes labor cost is redacted. Please follow standard procedure and submit a supplementary budget to HQ (via the scienceworks server) showing the full cost of the proposed investigation. To clarify, in this case the "full investigation" is the one year Phase 1 proposal.

***Q5: 'You suggest that we should be prepared for the (SRR) review about 6 weeks after the beginning of our study. Given the fact that we are assembling our study team, we won't be at full strength right away, this would not be enough time to prepare for such a review for a flight mission. We are not entirely sure what the content of such a review for SOFIA should be. Do you have examples of previous reviews we should use as examples for our preparation?'***

**A5:** I very much agree that the timeline here is compressed, driven by SMD's desire to have the 3d-gen instrument delivered for commissioning in Q3 of FY18. Given that the selection won't happen before September 2016 and that there will likely be some time lost to getting funding in place, we're trying to get the SRR and most of the preparation for the PDR accomplished in the ICS phase. It may be that the time constraints are too tight, and that holding an SRR six weeks after the kickoff is too optimistic. We have some flexibility, so your feedback would be useful. If we need to slip the SRR out a few weeks to make it effective, I think we can probably do that while keeping in mind that we'd be further compressing the latter part of the ICS schedule in doing so.

Confidence in cost estimates is another significant factor in deciding to hold the SRR as early as is practical....obviously we can't ask you for a firm budget estimate without clearly establishing requirements. Beyond technical/performance issues, we've also have seen a number of SI teams grossly underestimate the cost and effort involved in demonstrating compliance with the SOFIA airworthiness and documentation regime. We'd like to avoid repeating that, and the key then is to make sure that the SI Team is thoroughly aware of all the requirements levied and the documentation that's required. Since the primary purpose of the SRR is to have the SI team demonstrate that all requirements are understood and can be met within the cost and schedule constraints, including it in the ICS phase should improve cost realism.

Regarding content, the SI Dev Handbook has quite a bit of detail on what the SRR is aimed at. I've cut/pasted a relevant section at the end of this message for reference. For a better understanding of the requirements regime, I'd encourage a deep dive into the Dev Handbook and the SI System Spec. We will spend quite a bit of time going over the guidance contained there during the kickoff.

Since this question references the time constraints, I'm including here our timeline for the overall 3d-gen effort. This may have to be adapted as events unfold, but here is what we're shooting for:

S3GSI Development Timeline:

- *ICS Funding in Place: January 19, 2016*
- *Kick off @ARC: February 2-3, 2016*
- *SRR (locations TBD): March 15-18, 2016*
- *Formal CSR Delivered: July 19, 2016*
- *SI Teams present preliminary design and responses to TMC feedback: Aug 15, 2015*
- *Announcement to PIs: September 1, 2016* *Implementation phase begins: September 1, 2016*
- *PDR: ~November 1, 2016*
- *CDR: ~July 17, 2017*
- *Instrument Integration complete: March 15, 2018*
- *Instrument Testing: May 1 – June 30, 2018*
- *Instrument Delivery: July 31, 2018*

Finally, regarding previous SRRs that might provide a template, I don't know of a relevant example. All of the SIs up to now date from ca. 1998 origins, and the process was different enough at that time that whatever reviews were completed are of limited use in the present context. Hopefully the content in the handbook and the SI System Specification will be sufficient.

#### **7.4.1 Systems Requirements Review**

The purpose of the SRR is for the Science Instrument development team to demonstrate understanding of all system, interface and instrument performance requirements. The instrument team does this by submitting a Science Instrument *Science and Technical Performance Requirements* document stating the performance requirements the instrument needs to achieve to perform the selected science investigation, and demonstrating at the SRR that these requirements have been flowed to the appropriate instrument subsystems. Additionally, knowledge of all applicable system and interface requirements and appropriate allocations to subsystems will be demonstrated. At this review, the instrument team conveys to the SOFIA Program that for the current instrument design, requirements have been derived and flowed to subsystems where necessary and that all instrument functional, performance and interface requirements will be satisfied. The instrument team should also sufficiently articulate its planning for remaining project activities in order to justify that there are reasonable expectations that the instrument team will meet its success criteria within the allocated resources. The successful completion of the SRR will result in the freezing of design requirements and signify readiness to begin preliminary design.

##### **7.4.1.1 Purpose**

The objectives of the SRR are to confirm that: (a) definition of a producible system is complete and fully satisfies all the science investigation objectives, (b) system requirements have been logically and fully allocated to each independent system element and in turn to their respective subsystem level or below, (c) all allocated requirements are verifiable and traceable to their corresponding system level requirement, (d) preliminary verification approaches and acceptance criteria are defined, and (e) the requisite level of detail and resources are available to support the acquisition and development plan within existing constraints.

The SRR should contain a complete and comprehensive description of the system design in order to establish the baseline for which the requirements are defined. It should present the design by means of block diagrams, depicting system interfaces with external supporting systems, internal interfaces between independent system elements, and

interfaces within each independent system element to the subsystem level and below. Completed modeling and analysis results that demonstrate the ability of the design to fulfill system requirements should be presented.

The requirements allocation and control process should be presented, followed by a formal delineation of all allocated requirements in a way that illustrates their completeness, traceability, and verifiability. An understanding of risk, safety, and assurance considerations should accompany a discussion of implementation. Programmatic (cost and schedule) considerations should be discussed in sufficient detail to permit assessment of relevant review objectives. A verification matrix should also be presented (see Section 5.4.3).

#### ***7.4.1.2 SRR Entrance Criteria***

A number of specific activities and items are expected to be completed before an instrument is ready to enter its System Requirements Review. The activities and items listed below constitute the SRR entrance criteria for science instruments and pertain specifically to the technical review of SOFIA science instruments at the system/project level. (The criteria for technical reviews at the general subsystem level are available to the instrument developer if needed, however the criteria and guidance presented within this handbook contains specific tailoring which is intended to be more relevant and useful to an instrument developer preparing for a technical review of the instrument system/project.)

- 1 A preliminary SRR agenda and success criteria for the technical review have been agreed to by the instrument developer and NASA SI Development Manager.
- 2 The SRR technical products identified in Appendix A.1 – Deliverable Items List and Appendix A.2 – Documentation Delivery Schedule have been delivered by the instrument developer to NASA and have been made available to cognizant participants prior to the review.

#### ***7.4.1.3 SRR Success Criteria***

The following subsections contain guidelines for the content and subject areas that should be addressed in the SRR by the instrument team.

##### ***7.4.1.3.1 Design Description:***

- a Results of design trades are documented and include rationale for selected alternatives. On-going or future trade studies are identified and potential impact of results on design is understood.
- b Block diagrams illustrate functional flow and clearly define interfaces with external systems.
- c Results of appropriate system analyses (e.g., performance, error budgets, reliability) illustrate adequacy of system design to accomplish mission objectives within constraints and with acceptable risk.
- d Mission critical failures have been identified. Redundancies and/or workarounds have been defined or a single-string design approach has been approved.
- e Technology development related items continue on track and mitigation plans remain viable.
- f Utilization of heritage elements has been determined. Preliminary assessment of

- activity needed to verify usage on the current instrument has been completed.
- g Margins for all critical resources (mass, power, data rate, etc.) meet applicable criteria.
- h Approach to verification of compatibility across all interfaces is defined.

**7.4.1.3.2 Long-lead Procurements:**

- a A list of long-lead procurements (items that need to be procured prior to CDR) is provided along with a rationale for why the item needs to be procured prior to CDR.
- b Results of design trades and peer reviews are documented.
- c Plans for continued requirements definition and completing any needed trade studies

**7.4.1.3.3 Requirements Related Processes:**

- a Instrument requirements are defined in the *Science and Technical Performance Requirements document* and are necessary and sufficient to meet the goals of the science investigation.
- b Processes for the allocation and control of requirements are documented and approved.
- c The approach for tracking and controlling allocation and reserves of key resources (such as mass, power, etc.) is documented and approved.
- d The approach to controlling and integrating all technical activities is defined and documented.
- e Plans for design, production, and verification activities are defined and documented.

**7.4.1.3.4 Requirements Definition:**

- a Interface requirements with external systems are defined.
- b Interface requirements between independent system elements are defined.
- c Interface requirements between subsystems and components of each independent system element are defined.
- d Functional requirements for subsystems and components of each independent system element are defined so as to fully achieve system requirements. Such requirements are verifiable and are traceable to their respective system and mission requirements.
- e Allocation of key resources (e.g., mass and power) to elements of the instrument subsystems is reasonable.
- f Mission operations, data acquisition, data processing, and data analysis requirements are fully defined.

**7.4.1.3.5 Requirements Verification:**

- a Preliminary approaches for the verification of all requirements have been defined.
- b Preliminary acceptance criteria have been defined at the deliverable end-item level.

**7.4.1.3.6 Risk Management:**

- a A risk management process is defined and utilized.
- b All significant risks, problems, and open items are identified and tracked (including programmatic, development and flight performance related items). Risk mitigation plans are appropriate. Credible triggers for exercising alternatives are defined.
- c Reliability considerations have been factored into design decisions.
- d Single point failures are compatible with approved project philosophy.
- e Lessons learned have been appropriately researched and adapted.

**7.4.1.3.7 Safety and Airworthiness:**

- a A preliminary system safety assessment identifies all requirements as well as any planned tailoring approaches or planned deviation requests.
- b Preliminary hazards, controls, and verification methods are identified and documented.
- c Any open safety issues are identified with plans for resolution.
- d Preliminary plans and schedules for all required safety submittals are defined.

**7.4.1.3.8 Assurance Activities:**

- a Mission Assurance requirements have been defined (materials usage, quality control, problem reporting etc.) and preliminary plans are completed.

**7.4.1.3.9 Implementation Planning:**

- a Program flow has been defined and required quantities of hardware and software items are defined.
- b A preliminary system level verification plan has been defined.
- c Plans for controlling technical activities (systems engineering, software development, verification, configuration control, etc.) are completed.

**7.4.1.3.10 Programmatic:**

- a Roles, responsibilities, and interfaces between all participating institutions are clearly defined.
- b Project organization chart clearly delineates functional responsibilities and relationships.
- c Organization and staffing plans delineate clear responsibilities and adequate assignment of current and future staff.
- d Appropriate processes and metrics are in place to track and control cost, schedule, and technical activities throughout the remaining life-cycle.
- e Appropriately detailed schedules show realistic event times as well as appropriate funded slack and are compatible with approved commissioning dates.
- f Cost to complete shows adequate spending profiles and financial reserves, and is compatible with allocations.

**7.4.1.3.11 Project and Independent Review Activity:**

- a) An appropriate set of engineering peer reviews has been conducted and documented as needed. Resultant actions have been effectively dispositioned and executed. Appropriate additional reviews are planned.

- b) Recommendations from other project or external review activity (such as an instrument development lessons learned database) that are applicable to the subject matter of the SRR have been adequately implemented.

#### **7.4.2 Results of the Review**

Action items and liens will be collected during the review. Reviewers may submit requests for action or information, referred to as RFAs and RFIs. At the end of the review the action items will be assigned with a response due date. Any action items that must be closed prior to proceeding with the preliminary design will be assigned as liens.

Actions and liens are closed by the submission to the SI Development Manager of an action closure statement including the signature of the originator of action and the review chair indicating concurrence of the successful closure of that action or lien.

Successful completion of the SRR with closure of all liens constitutes readiness to proceed with the preliminary design of the instrument and with the plans for the long-lead procurements.

**Q6:** *Are the ICDs governing the aircraft interfaces available?*

**A6:** Yes, all of the ICDs are contained in the SOFIA Program Library, available at <http://soma.larc.nasa.gov/sofia/>

**Q7:** *'Once we decouple from our compressor after the cooldown in the lab, how quickly can we attach to and run from the compressor onboard SOFIA after installation on the aircraft?'*

**A7:** This is discussed in some detail within the PM17-2076 Cryocooler System Concept of Operations (ConOps) document, in Sections 2.4.2 and 2.4.3, though exact times are difficult to predict. The SI (on its installation cart) is weighed en route from the SI lab to the aircraft. The scale is right on the hangar floor adjacent to the lift truck, and this step doesn't take very long. Then the SI and cart are rolled into the lift truck and safely restrained for the lift operation, raised up to the level of Door 1L, and rolled over a ramp onto the SOFIA main deck for installation onto the TA.

SI (mechanical) installation procedures are completed by a combination of SI team, USRA support and AFRC-OM techs, before the AFRC-OA Avionics techs execute the associated SI cable install procedure in preparation for power-up and functional checkout. In such cases, the time before power is applied is of course highly dependent on the specifics of the SI and both the SI and cable installation procedures, but typically this would result in the SI being without power for several hours after leaving the SI lab.

However, it is understood and anticipated that unpowered dwell times of this duration will likely be problematic for CCC-cooled SIs that are transported cold from the lab to the aircraft. Depending on the cryostat design, thermal mass and heat load, it is possible that the resulting warm-up can lead to a loss of cryopumping and the cryostat vacuum going "soft" requiring use of an onboard turbo pump and resulting in a significantly longer cool-down timeline.

PM17-2076 Section 2.4.3 outlines a few changes to the typical SI installation flow that

would mitigate this warm-up, and will need to be coordinated with AFRC-OE Ops. Engineering and USRA Mission Ops. Modest gains can perhaps be made by arranging to weight the SI and cart before the cooldown, though this would only expedite the load by perhaps 20 minutes or so. Careful timelining of the entire load operation with all participating teams will ensure that unnecessary and untimely delays are avoided (e.g., due to shift changes, unavailable technicians or inspectors, etc.).

But the biggest improvements in this regard will be achieved by carefully defining and coordinating an SI load sequence in which the SI may be interfaced to the CCC compressed He QD interfaces at the U404 patch panel, and the CCC He compressor started to resume cooling operations, well before the SI is fully installed, potentially even before the SI is fully mounted to the TA. Again, much of this depends on the specifics of the SI design, and considerations such as whether the SI cold head may be operated before rest of the SI is cabled up and ready for powered operations.

There will of course also be Safety-driven considerations that will need to be addressed to convince the S&MA and Ops. Engineering / SIAT teams that connecting the SI cold head to the CCC interface via compressed He flex lines and operating the cold head prior to a full SI installation will not expose personnel or the facility to any elevated / unacceptable risks. It seems likely, for instance, that the SI will need to be at least installed on the TA IMF dowel pins, with a few of the mounting bolts in place (even if not fully torqued) before the He lines can be connected and the compressor started, just to rule out any relative motion that could yank a He line and potentially breach the integrity of the pressurized He loop.

Without knowing more about the specific SI design or the corresponding SI load procedures, it isn't possible to really "put a finer point" on this, but it does seem plausible that through careful design and coordination of these load, install, initial CCC He and cold head power interface and start-up operations, the downtime without active CCC cooling of the SI can be managed and optimized to perhaps as low as 60 ( $\pm 15$ ) minutes.

**Q8:** *'Is it possible to modify the pressure in the onboard compressor if it is not set to the optimal pressure for the cryocooler cold head? If not, can we find out the fixed pressure kept in the compressor?'*

**A8:** The He compressor does not have any pressure control functionality that would allow the operating pressure to be operationally manipulated. The running compressor will develop a pressure differential between the Supply (HIGH) and Return (LOW) QDs that is related to the static He charge in the closed loop.

That said, these pressures can be adjusted by adjusting this static He charge (within constraints specified by the compressor manufacturer). Please refer to the table below, which is excerpted from the CD32ZZ-067R Technical Instruction for the SHI CSA-71A compressor unit. Note that it specifies a static He charge pressure range between 1.45 to 1.65 MPa\*, with corresponding Supply (HIGH) side pressures ranging from 2.00 to 2.20 MPa. (\* The CSA-71A compressor is really designed to operate a G-M cold head vs. a Pulse Tube, and different static pressure ranges are specified for different SHI G-M cold heads.)

I just checked some housekeeping data that reflects the static and operating pressures that have been used with the upGREAT LFA channel Pulse Tube for their most recent flight series in Dec. 2015. The static He charge (compressor off) was between 215 to 216 psi



(1.48 to 1.49 MPa). The corresponding Supply (HIGH side) operating pressure soon after start-up was 350 to 352 psi (2.41 to 2.43 MPa), and Return (LOW side) operating pressure at this time was 119 psi (0.82 MPa).

The upGREAT team has of course experimented with different static and operating pressures in the lab, and as I recall they flew with a static pressure that was quite close to the high end of the specified range of 1.65 MPa (~240 psi) during their LFA commissioning flight series last May, resulting in Supply (HIGH side) pressures closer to 326 psi (2.25 MPa), with the Return (LOW side) pressures remaining close to 120 psi (0.83 MPa). Note that direct correlations between the static and operating pressure cases reported above are challenging, as there is some time dependency involved – after a cool-down period (dependent on thermal mass and heat load), these operating pressures (and compressor power consumption) do shift somewhat.

The main points here are that the only way to vary the operating pressures of the compressor (with a given cold head) is to vary the static pressure, but that this can be done (within the specified limits of the compressor, of course). Generally speaking, the static pressure is established on the ground via the He loop charge procedure, vs. inflight. It isn't out of the question that the SI design could include a feature that would allow some He to be vented inflight to reduce the He static pressure, however this would need to be done very carefully as there is no means to perform a He charge inflight.

Table 1.1 CSA-71A COMPRESSOR UNIT SPECIFICATION

	for RDK-408D2, 415D	for RDK-408S2, 408S, 408D
Dimension		
Width	550 mm	
Length	550 mm*	
Height	305 mm	
Helium Gas Pressure		
Static	1.60 - 1.85 MPa at 20 deg.C	1.45 - 1.50 MPa at 20 deg.C
Operating (High Side)** (for Reference)	2.00 - 2.20 MPa — approx.	2.00 - 2.20 MPa — approx.
Ambient Temperature Range	5 to 35 deg.C (20 to 35 deg.C with 5% Capacity Loss)	
Humidity Range	25 to 85 %RH (without dew)	
Mass	140 kg — approx.	
Electrical Requirement		
Power Line Voltage (+/-10%)	AC 200V / 50, 60 Hz, 3 phase (3W+PE) (Δ ground, Commercial Power Source) <b>WARNING:</b> Do not use it as a power source for the main power source.	
Operating Current	Max. 25 A	
Min. Circuit Ampacity	35 A	
Max. Fuse or Circuit Breaker Size	60 A	
Power Requirement	Minimum 9 kVA Recommended 12 kVA	
Power Consumption	Max. 8.3 kW / Steady State 7.5kW at 60Hz Max. 7.2 kW / Steady State 6.5kW at 50Hz See ELECTRICAL SCHEMATIC of "APPENDIX" for detail.	
Heat Radiation to the Environment	Max. 8.3 kW at 60Hz Max. 7.2 kW at 50Hz	
Pressure Relief Valve Setting	2.61 - 2.75 MPa	
Gas Supply Connector	1/2-inch Coupling	
Gas Return Connector	1/2-inch Coupling	

\* Input Power Cable Terminal Cover is 90.0 mm. See the Figure 1.1.

\*\* The operating pressure varies according to the heat load of cold head and temperature around the equipment.

**Q9:** *'Can we get CAD model of counterweight rack?'*

**A9:** Yes. A CAD model of the Counterweight Rack will be uploaded to the LaRC SOMA SOFIA website shortly. A CAD model of the PI Rack will also be provided.

**Q10:** *'Can we get CAD models of the dynamic/static envelope?'*

**A10:** Yes. CAD models of the SI dynamic, static, and installation envelopes defined in ICD GLOBAL\_09 (SE03-002) will be uploaded to the LaRC SOMA SOFIA website shortly.

**Q11:** *'Can we get CAD model of the 747 doorway, also any corner restrictions and floor discontinuities, for installation confirmation?'*

**A11:** Yes. A CAD model of the 747 Door 1L doorway, equipment loading ramp, and stairwell inside the cabin will be uploaded to the LaRC SOMA SOFIA website shortly. The model of the Door1L doorway is considered to be a conservative (i.e., slightly more constrained) representation of the doorway since it does not reflect the actual curvature of the aircraft door/doorway. Also, because of this, the distance between the Door1L doorway and the stairwell are conservative. The model of the equipment loading ramp is considered a high-fidelity model. (If the instrument and cart model/design predicts small clearances that could result in difficulty or interferences when operating the cart, before the design is finalized the Instrument Developer should contact the SOFIA Program for assessment of the design and possibly collecting additional information about the actual Door1L geometry, as well as a possible visit to view the actual Door1L doorway of SOFIA.)

**Q12:** *'What is the floor loading psi-limit?'*

**A12:** The floor contact pressure of a SI Cart caster is not permitted to exceed 500 psi, as defined in ICD SIC\_AS\_01 (SE03-205). The same ICD also defines that the loading at any caster location is not permitted to exceed 600 lbs, and the minimum distance between casters is required to be at least 24 inches.

**Q13:** *'Are the high-voltage cables standard NEMA safety connectors, or are they custom and with handling restriction?'*

**A13:** The cables/lines provided by SOFIA for high-voltage applications are J124-J127 on the PI Patch Panel (U400) and TA Patch Panel (U402), defined by ICD M CCS\_SI\_05 (SE03-2029) and ICD TA\_SI\_01 (SE03-036). The SOFIA connectors for J124-J127 are Reynolds Industries (Teledyne Reynolds) Part Number 167-9096. The required (mating) part number for the SI is Teledyne Reynolds Part Number 167-4535, or equivalent. A discrepancy was found in documentation for the part number of the high-voltage J124-J127 cable lines on SOFIA (Reynolds 167-2669 vs. 178-6053), clarification will be provided once the cable part number has been verified by the SOFIA Program.

**Q14:** *'You mentioned that laboratory hazardous report templates can be provided for hangar and labs, can these be provided and also are there flight hazard report examples available (there are four recurring flight hazard reports, according to our kick-off briefing)?'*

**A14:** Samples of the four generic SI hazards are included in Appendix G.1-G.4 of Rev. B of the SOFIA Science Instrument Developers' Handbook, (SCI-AR-HBK-OP03-2000). The four generic SI hazards are: *Generic SI and SI-provided GSE Structural Hazards, Generic SI Cryostat Overpressure and Habitable Atmosphere, Generic SI - Aircraft Platform Pressure Boundary Hazards, Generic SI and SI-provided EGSE Electrical Hazards*. A Rev. B draft of the handbook was distributed prior to the kick-off meeting, and was later uploaded to the LaRC SOMA SOFIA website. The official Rev. B release of the handbook will be uploaded to replace the version currently on the website shortly (the official release has approval signatures and the "draft" designation removed; content of the handbook is identical). The four generic SI hazard reports cover both lab and flight hazards. Additional hazard reports may be required, for hazards that are unique to the specific instrument which are not covered by the four generic SI hazards.

**Q15:** *'What is the caged telescope clocking position during instrument mate procedures?'*

**A15:** The telescope is oriented to 40 degrees Elevation angle for installation of the instrument assembly (i.e., the assembly that bolts to the TA Instrument Mounting Flange). For installation of the Counterweight Rack, The telescope is oriented to the 17 degrees Elevation angle for installation of the Counterweight Rack.

**Q16** *'Can we get a Project Management Plan example?'*

**A16:** I don't think we can provide an example that is well-aligned, given the significant differences in the development environment that have occurred since the first- and second-generation instruments were awarded. These early instruments were not required to deliver Project Management Plans. The best guidance I can give is to refer to Rev. B of the IDHB Appendix A-1 *'Deliverable Items list'* which lists expectations for the PMP in item 12.

**Q17:** *'From which organizations do you pull for the Review Board Members?'*

**A17:** The members that constitute a particular review board will depend on the review.

Pertaining to the ICS, the S3GSI Kick-off Technical, Management, and Cost (TMC) Evaluation Process presentation states, *'TMC Panels consist of evaluators who are experts in the factors that they evaluate.'* The TMC Panel is set up outside of SOFIA Program organization, and SOFIA doesn't select its members.

Pertaining to instrument development and technical reviews (e.g., System Requirements Review, Preliminary Design Review, Critical Design Review, Pre-Shipment Review, Pre-Installation Review, Acceptance Review), the SOFIA Program Authorities listed in the S3GSI Kick-off Program Manager's Briefing comprise the minimum typical set of review

panel members for these meetings and include: Science Instrument Development Manager, Chief Engineer, Systems Engineering & Integration Lead, Operations Center Safety Lead, Safety & Mission Assurance Lead, Facility Scientist, Project Scientist, Science & Mission Operations (SMO) Director.

**Q18:** *'Please provide a representative load path diagram.'*

**A18:** Section 8.3.1.2 of the SOFIA Science Instrument Developers' Handbook (OP03-2000) provides an example of a load path diagram.

**Q19:** *'Please provide an excel version of Verification Matrix Template (SOF-NASA-REP-SV05-2057)'*

**A19:** An Excel version of SV05-2057 will be uploaded to the LaRC SOMA SOFIA website shortly.

**Q20:** *'Is AWS D1.2 adequate for SOFIA certification of dewar structural components?'*

**A20.** The questioner specifically inquired about American Welding Society (AWS) D1.2, *Structural Welding Code – Aluminum*, so this response addresses only weld certification for cryostat components. Other aspects of cryostat certification, including Design, Qualification and Acceptance certification of Pressure Vessels and Pressurized Systems (PVS) in SE01-2028 were developed leveraging FAA / DOT requirements from CFR Title 14, Vol. 1, §25.1438 and ANSI / AIAA S-080.

SE01-2028 ParID 3.5.3.3.1 describes certain aspects of welds and associated Non-Destructive Examination (NDE) techniques, including a reference to ASME Div. 2, Part 8, Section 8.2, and Part 7, but does not prescribe specific National Consensus Codes & Standards (NCS) as being applicable. AWS does appear in a list of examples of weld certification organizations in OP03-2000, *SI Developers' Handbook*, Section 8.3.4 (see excerpt below):

*'All structural welds should be completed by a certified welder who adheres to a Program recognized standard. Science Instrument Teams should be prepared to show the standard to which all welds conform and documentation proving that the weld has been inspected and is acceptable according to that standard. Examples of certifying organizations include the American Welding Society (AWS), American Society for Testing & Materials (ASTM), National Aerospace Standards (NAS), American National Standards Institute (ANSI), and the Society of Automotive Engineers (SAE). Where inspection is required per Science Instrument System Specification (SOF-AR-SPE-SE01-2028), the Structural Analysis Report should include proof of weld integrity (e.g., the results of a dye penetrant test, ultrasonic inspection, x-ray or gamma radiographic inspection, magnetic particle inspection, borescope inspection, infrared imaging, or hardness testing). If necessary, consult with the Science Instrument Airworthiness Team (SIAT) for clarification of which inspection type is most appropriate for your instrument.'*

NASA-STDs cite various AWS, ANSI and ASME welding specifications, depending on the application. For example, NASA-STD-5005D, *Standard for the Design and Fabrication of Ground Support Equipment* (a standard for spaceflight program GSE) levies the requirements in AWS D17.1 **with the exception of pressure systems**, for which ASME BPVC and ASME B31.3 are cited. NASA-STD-5006, *General Welding Requirements for*

*Aerospace Materials*, doesn't specifically levy AWS D17.1, but does reference it in Appendix A, *Guidance*, Section A.2.2.

AWS D17.1, in turn, references AWS D1.2, *Structural Welding Code – Aluminum*, in Table 9.1, *Industrial Codes and Specifications Suggested for Welding Aerospace Nonflight Hardware*. It isn't immediately obvious which welding codes are suggested for flight hardware.

The specifics of the weld process and the standards by which these welds will be inspected and certified are typically dependent on the specific application, even within a single SI cryostat. For example, a weld that is part of the emergency crash load path for a critical structure, or for a pressurized component or vessel, will almost certainly demand additional scrutiny, more stringent NDE, certification documentation, etc., relative to a non-critical structure internal to the cryostat.

Typically, even within a “family” of specifications and codes (e.g., AWS), distinct codes are invoked for the welding processes, the certification / qualification of the welder, the type of inspections / QC that are indicated, and the certification / qualification of the inspector.

For SIs, there is some discretionary latitude with respect to the standards and certifying organizations that are declared applicable based on sound engineering judgement. As stated in OP03-2000, the SI developer should be prepared to brief the brief the SOFIA Program re: the NCS to which the welds are to be conformed. This should be declared to the SOFIA SIAT / S&MA organizations as early as is practical within the development flow, perhaps at the SRR or PDR, or even as late as CDR, but in any case before hardware fabrication commences.

**Q21:** *'We assume that if we use the same cryocooler head make and model already certified for use on SOFIA (TransMIT), that no additional qualification/safety work needs to be done. Is this a valid assumption?'*

**A21.** If the exact same transMIT PTD-406C Pulse Tube cold head were to be used, this would obviate the need to Qualify the design from a Pressure Vessels & Pressurized Systems (PVS) standpoint, to the extent that transMIT provided a CoC stating that the delivered Pulse Tube shared the same design, materials and processes as the PTD-406C. Each individual unit will in any case need to traverse Acceptance level testing to show adequate workmanship.

It should be noted that the transMIT PTD-406C Pulse Tube is a Modified COTS product, similar to a stock model but somewhat customized per proprietary specification of the upGREAT developer, MPIfR in Bonn, Germany.

Per coordination w/ SOFIA S&MA and the AFRC Pressure Systems Manager, the materials, design and construction of the transMIT Pulse Tube cold head (including the rotary valve) were shown by analysis to be capable of withstanding 4 x MOP, and a Qualification Model (mechanically identical to the Flight Model, but lacking certain internal regenerator components) was Qualified via pressure testing to 1.5 x MOP.

While these tests Qualified the design, each individual Flight Model Pulse Tube and rotary valve were still required to be Accepted via pressure testing to the pressure that activated

the integral Pressure Relief Valve (but no higher than the pressure at which the burst disc is certified to open).

Note that these Qualification and Acceptance criteria were negotiated with SOFIA SIAT and S&MA organizations, as there were technical constraints that precluded the use of the standard criteria defined within SE01-2028.

**Q22:** *'We assume that the Boiler and Pressure Vessel code requirements are not applicable to a cryostat using a cryocooler as the source of heat removal – is this a correct assumption?'*

**A22.** Per SE01-2028 ParID 3.5.3.1, cryostat outer shells (including the optical window and associated frame structure, and pressure coupler, where applicable, all of which comprise part of the pressure boundary of the aircraft) shall be designed to withstand worst-case pressure and inertial loads, where the pressure loading includes the effects of external (cabin) pressure due to the vacuum annulus.

Also, any portions of a cryostat that are or may become pressurized (i.e., during nominal operations or failure modes), including the cryocooler cold head and associated components, will need to be certified as PVS per SE01-2028 ParID 3.5.3.3.2. This requirement, along with the cited Table 3.5-3, is intended to represent the Qualification and Acceptance criteria of the applicable National Consensus Codes & Standards (NCS), not limited to just ASME BPVC.

As with the weld certifications, the detailed certification approach will likely be dependent on the specifics of the application and design, and should be briefed to the SIAT / Structures & Loads SME and S&MA as early as possible to solicit their concurrence and/or inputs.

**Q23:** *'If we need to use a built-in but ground-operated small-diameter independent piping liquid nitrogen cooldown loop to expedite the cooldown of the instrument in the lab, or on SOFIA prior to pressure sealing the fuselage & leaving the hangar, are the Boiler and Pressure Vessel code requirements not applicable?'*

**A23.** SE01-2028 ParID 3.5.3.5 levies NASA-STD-8719.17, *NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems*, on pressurized systems within SI GSE. The AFRC Pressure Systems Manager points out that all new GSE PVS shall be designed, fabricated, assembled, installed, examined and tested in accordance with an appropriate NCS, and suggests that ASME B31.3, *Process Piping*, is likely a sound choice.

It is also worth noting that the portions of such a LN2 pre-cooling system will remain embedded within the SI flight cryostat, and as such these portions of the system will of course need to be certified airworthy.

Any integral LN2 pre-cooling loop, whether used solely on the ground (in the SI labs and/or aboard SOFIA) or in-flight, will need to be vetted by the S&MA organization and deemed safe through the Hazard Report (HR) and System Safety Working Group (SSWG), with considerations including (but not limited to) PVS certification (including adiabatic expansion and safe venting of gases in isolated volumes, and the potential for icing of pressure relief valves), possible liquefaction of oxygen (LOX) from air, personnel contact with cryogenically cooled surfaces, venting of N2 in the confined volume of the SOFIA

cabin and associated asphyxiation hazard, etc.

**Q24:** *‘There are a large number of deliverables. Since HAWC+ is the most recent instrument to be commissioned, will all the HAWC+ deliverable documents and procedures be made available to us as templates to make the paperwork generation process more efficient to reduce costs?’*

**A24:** We can make example documents available. Since HAWC+ is not scheduled for acceptance until FY17, much of their documentation is yet unavailable but other examples can be provided.

**Q25:** *‘We need to work on detailed cost estimate from Phase B to delivery. What is the cost cap from Phase B to delivery? Is this still \$17M? Or \$16.6M?’*

**A25:** This element has not been specifically addressed by SMD. It is a small fraction of the total, so please consider the ICS phase funding to be outside the development budget. I’ll note that the end of the ICS phased doesn’t exactly coincide with the start of Phase B, so please consider the cost cap to be \$17M exclusive of the ICS phase.

**Q26:** *How many people (approximately) will be coming to the SRR?*

**A26:** Please plan for four representatives from the SOFIA SI Dev Office.....I suspect the total will be 25 - 30 people when we account for the TMC, HQ, and SOFIA Program interest.

**Q27:** *Will any of these people need badges? Will any of these people need an escort from the front gate?*

**A27:** Attendance isn’t set yet. We will contact the teams to arrange for any necessary badging/escort help at least a week ahead of the meeting.

**Q28:** *Should we plan on providing lunch?*

**A28:** No thanks. A lunch break at your cafeteria will work fine.

**Q29:** *Should we set up a telecon # and Webex?*

**A29:** That would be appreciated, and it’s probably most efficient to have you set it up at your institution since you will have experience with your interfaces there. If for any reason this is inconvenient, we can set it up on our end as well, just let us know. We will plan on your setting the virtual telecon up unless we hear otherwise from you.

**Q30:** *Is this review a gate? That is, what happens if we don’t pass? Are there any expectations that we would have a Delta SRR during the ICS period?*

**A30:** An established series of gates is described in the OP03-2000 SI Developer’s Handbook, and SRR

is one of these. Though the Handbook does not specifically anticipate and address the scenario of holding the SRR in the midst of a competitive down-select and ICS phase, and we recognize that the timeline is compressed, SRR is an important milestone in the conceptual design process. A demonstration of requirements maturity is among the specific evaluation criteria for the ICS, even if successfully exiting the SRR process is not. Should time constraints prevent an adequate demonstration of the credibility of the proposed SI, or the team's understanding of SOFIA requirements, it is possible that a delta-SRR might be considered necessary, but this would need to be scheduled **after** and not during the ICS phase. Since preparing for and supporting a delta-SRR would put the timeline to PDR in significant jeopardy, this should be avoided, and to the extent possible it would be best if any outstanding items can be resolved via an offline RFI / RFA closure process.

**Q31:** *Are you planning or hoping to see hardware or take a tour while you are here (keeping in mind that it will difficult or impossible to do this and complete the SRR in a single day).*

**A31:** Since this is the only opportunity for our team to see your facilities during the ICS phase, I think a lab tour might be beneficial in making the case that your team is equipped to carry out the proposed work, but we leave it up to you to set the agenda for the SRR. If you need more than one day we can likely accommodate that with sufficient advance notice.

**Q32:** (per the solicitation) *The primary ICS deliverable is: "A Preliminary Design-level description of the instrument, including both its flight software and the necessary ground data processing software, a preliminary instrument calibration and commissioning plan, the development management plan, a more detailed cost estimate, and a more detailed development schedule. A detailed management plan for the development of the selected instrument shall be developed during the ICS". Is this a description of the CSR contents? Are the plans listed actual draft documents, and where do they belong in the report?*

**A32:** Yes, per the solicitation this is the description of what the CSR contents are to encompass. At the kickoff meeting additional detail was provided, and that detail is captured in the kickoff presentation available at the S3GSI website. The specific organization and placement of this content within their CSR is at the discretion of the ICS team, within the guidance provided by SMD / TMC.

**Q33:** *At the kickoff the SI Dev Office stated that "To reach the desired timetable, we need the CSR to be as PDR-ready as is practical." How to interpret this? For instance, there are 19 documents required for PDR (most in draft form). How many, if any, of them need to be complete by CSR, and are they supposed to be delivered with the CSR?*

**A33:** As was stated at the kickoff, we recognize that a full PDR isn't possible within the timeframe and the competitive constraints of the ICS phase. We are also under significant schedule pressure to deliver an instrument for commissioning by the end of calendar year 2018, so the closer we are to being ready for the PDR at the close of the ICS phase the better our chances of holding to the timeline prescribed by SMD. OP03-2000 Appendix A.2 provides guidance re: the level of maturity that is expected for various document deliverables as entrance and exit criteria for SRR and PDR. There are several documents that are supposed to be in a final, released state by SRR (e.g., PMP, S/W SRD, ConOps, Science & Technical Performance Requirements). While not specifically required within the CSR, having drafts of deliverable documents that are due at PDR by the close of the ICS phase will go a long way to establishing that the team is on track to their PDR milestone, and demonstrably mitigate schedule risk going forward.

**Q34:** *Re: 'Deliverables' bullet on slide 46 of the kickoff slide deck, in the 'CSR Content' section: Is this a deliverables list from the Instrument Developer to SOFIA? Why is this needed given that the complete list is in the IDHB? Is this a schedule for deliverables?*



**A34:** “Deliverables’ in this context refers only to the deliverables for the CSR, which are described on the preceding slides in the kickoff slide deck. Please note that slides 46-49 in the kickoff deck are intended to collect generic ‘nuts and bolts’ guidance to allow the teams to see what is expected to be covered in the CSR. They are not a one-to-one mapping of the deliverables, but are intended to provide clarity on what areas will be of interest to the evaluation team.

**Q35:** *Re: ‘Key metrics’ bullet on slide 46 of the kickoff slide deck, in the ‘CSR Content’ section: Given that technical performance and margins are described later, what is this? Cost and schedule margin? Or is it just listed twice?*

**A35:** The bullets in this list are meant to guide the teams toward areas that should be addressed in the CSR. It is only intended to alert the teams to the fact that the CSR should capture and describe how metrics will be collected and monitored.

**Q36:** *Re: ‘Configuration management’ bullet on slide 46 of the kickoff slide deck, in the ‘CSR Content’ section: Is this a draft document or just a description of the planned approach?*

**A36:** Configuration management is within the scope of the Quality Plan, a draft of which is expected at SRR. It need not be fully mature at that stage, but should show that the project is on track to address all aspects of QA as the development progresses.

**Q37:** *Re: ‘Level 2 Requirements flowdown’ bullet on slide 47 of the kickoff slide deck, in the ‘CSR Content’ section: This phrasing is confusing. Are both Level 2 and Level 3 requirements required?*

**A37:** In the context of the SOFIA Program specification and product tree, Level 1 requirements are very high-level Program Plans and SOFIA System-level specifications and ConOps. SE01-2028 is a Level 2 (System-level) specification, and each of the SOFIA SIs is a Level 3 (System / Subsystem-level) Product. However, the definition of requirement levels within the SI development context is somewhat at the discretion of the ICS team. Looking beyond the definition of requirement and specification levels, this requirements flowdown bullet addresses the need for the CSR to provide a good view at the ICS teams’ Systems Engineering approach to capturing all applicable requirements (both SOFIA Program-imposed via SE01-2028 and sub-tier ICDs, as well as internally-imposed Science and Technical Performance requirements from the teams’ proposals). Furthermore, the TMC would like visibility into the schema by which the ICS team will establish traceability of requirements and flow down from the top-level SI System down to all applicable subsystems (e.g., a canonical SE “System of Systems” approach).

**Q38:** *Re: ‘Verification of Level 1 requirements’ bullet on slide 47 of the kickoff slide deck, in the ‘CSR Content’ section: Is this a science traceability matrix? A verification matrix?*

**A38:** Again, these items are intended to guide teams on what should be addressed in the CSR. As long as verification of top-level SI requirements is addressed, the team is free to use whatever method they deem appropriate. The hierarchical requirements flow-down and traceability discussed above supports the “roll-up” of verifications of the low-level subsystem(s) requirements, ultimately up to and including the SI System level. Requirements traceability and verification matrices are generally well-suited for this, but the ICS team is free to select and present other methods or tools.

**Q39:** *Re: ‘Project document tree’ and ‘Drawing tree’ bullets on slide 47 of the kickoff slide deck, in the ‘CSR Content’ section: This is early in the program to provide this .....won’t exist even in draft form at CSR submittal.*

**A39:** Addressing planning for document delivery and drawing tree delivery in the draft Quality Plan will suffice here.

**Q40:** *Re: 'Calibration plan' bullet on slide 48 of the kickoff slide deck, in the 'CSR Content' section: How can we put this in the Science section when 1) it wasn't there before, 2) this section shouldn't be changed, and 3) won't be re-reviewed? Should it be in Section E instead?*

**A40:** No need to put it in the Science section. Section E will be fine.

**Q41:** *Re: 'Requirements verification plan' bullet on slide 48 of the kickoff slide deck, in the 'CSR Content' section: Is this a draft document, or just the verification matrix mentioned on the previous slide?*

**A41:** As long as planning for requirements verification is addressed in the CSR, that will be sufficient. No separate document is necessary at that stage. Drafts of the verification matrices are expected at SRR, though obviously these will not be fully mature.

**Q42:** *Re: 'Plan for development and delivery of functioning algorithms for a pipeline' bullet on slide 49 of the kickoff slide deck, in the 'CSR Content' section: Is this the PLAN for the supporting documentation, or the actual "associated supporting documentation"?*

**A42:** A description of how this requirement will ultimately be met is sufficient. The algorithms and supporting documentation will be due later in the development process.

**Q43:** *Re: 'Safety and QA, NASA, Institutional and Project requirements' bullet on slide 49 of the kickoff slide deck, in the 'CSR Content' section: Are these just the safety and QA requirements as opposed to the Level 0-3 requirements already mentioned?*

**A43:** These are just the safety and QA requirements, as covered in the draft of the Quality Plan as described in the IDHB. The 'Level 0-3 requirements' are separate.

**Q44:** *Re: 'Environmental requirements' bullet on slide 49 of the kickoff slide deck, in the 'CSR Content' section: How detailed is this?*

**A44:** The level of detail is at the discretion of the ICS team, but if your instrument concept requires any particular environmental properties it will be important to address them in the CSR.

**Q45:** *Re: 'Path to completion' bullet on slide 50 of the kickoff slide deck, in the 'CSR Content' section: What is this?*

**A45:** The CSR should show how instrument development will proceed beyond the downselect. This will largely be covered by the detailed schedule, but any details not captured there should be addressed.

**Q46:** *Re: 'Draft End-to-end I&T + verification plan' and 'Preliminary commissioning plan' bullets on slide 50 of the kickoff slide deck, in the 'CSR Content' section: In the body of the CSR? Or just a basic description?*

**A46:** A simple description of the planned approach is sufficient at this stage, but the description should be sufficient to allow reviewers to understand how these issues will be addressed in development..

**Q47:** *'Are there format requirements (other than page limits) for the CSR?'*

**A47:** No specific format requirements have been levied.

**Q48:** *'Are there requirements for cover page contents?'*

**A48:** No specific requirements have been levied.

**Q49:** *'What is a "Fact sheet / Executive summary"? Is this an either/or option? What needs to be included in a fact sheet?'*

**A49:** This is intended to orient higher-level management to the major strengths and intents of the proposed instrument development, especially for cases where the management may not be able to devote the necessary time to deep study of the proposed instrument. ICS teams may choose to create this as a fact sheet or a narrative summary at their discretion.

**Q50:** *'What key team members are required to be named?'*

**A50:** Identification of key team members is at the discretion of the ICS team.

**Q51:** *'The shape of the dynamic envelope for the instrument is tapered towards the SI mounting ring on the telescope. I believe HAWC+ had a small interference waiver that was approved. Do I remember correctly? If so, Could we get a copy of this waiver?'*

**A51:** There is no waiver for HAWC+ against the ICD Dynamic Envelope. HAWC+ has been verified to comply with the ICD Dynamic Envelope. There have been discussions in the past about HAWC/HAWC+ needing a waiver but ultimately the teams did not need/pursue one.

**Q52:** *'If we have a small interference of about 2 inches directly below the telescope mounting ring, is it reasonable to expect this waiver would be approved?'*

**A52:** We cannot predict whether the SOFIA Program would accept such a deviation request; deviation requests are individually reviewed, and approval will depend on factors such as the specific instrument design and justification for the deviation being sought. Technical justification including an impact assessment (e.g., quantified clearance from aircraft structures, ground facility interfaces/ramps) will typically be included in a deviation or waiver request submitted by an instrument team for consideration by the SOFIA Program.

**Q53:** *'The IDHB lists under SRR Success Criteria: 7.4.1.3.10 f) Cost to complete shows adequate spending profiles and financial reserves, and is compatible with allocations. Given that we do not yet have an agreed upon budget or funding profile for Phase B-D, what are you expecting us to present and how do we satisfy this requirement?'*

**A53:** As explained in the answer to Question 3 elsewhere in the website FAQ: "The \$17M total and \$5M per/year are notional numbers that are intended for guidance only. That answer also includes more detail on financial guidelines and assumptions for the ICS phase. The eventual schedule and budget in your proposal must be based on what is realistically required to carry out the proposed work. Cost realism is a

specific evaluation criterion, and you should treat the \$17M total cost cap a relatively firm constraint.

**Q54:** *What, if any, cost information should we present at SRR?*

**A54:** Per the SI Dev Handbook section 7.4.1, *'The instrument team should also sufficiently articulate its planning for remaining project activities in order to justify that there are reasonable expectations that the instrument team will meet its success criteria within the allocated resources.'* The estimated cost to complete instrument development should show adequate spending profiles and financial reserves, and compatibility with program schedule and cost caps, consistent with this stage of development. It's understood that the fidelity of estimates improves as development progresses, and that one of the primary functions of financial and schedule reserves is to accommodate early-stage uncertainties. Apart from that guidance, it's up to the ICS team to decide what cost information best establishes their confidence in their budget and schedule posture. As noted elsewhere in the FAQ, confidence in cost estimates is a significant factor in deciding to hold the SRR as early as is practical.... obviously we can't ask for a firm budget estimate without clearly establishing requirements. Please note that the cost review will be done during the TMC review process, when the final budget is submitted as a part of the report at the end of the ICS phase

**Q55:** *'The schedules that have been shown so far have shown a PDR date of NLT 11/1/16, but you have indicated that there might be some room for discussion on this date. Would it be acceptable for us to hold the PDR by mid-November with the assurance that this will not affect the instrument delivery date of December 2018?'*

**A55:** The specified timeline is a target and an important guideline, but the actual development schedule and budget will be determined by the selected SI team. Cost and schedule realism is an evaluation criterion, but the development details of the selected instrument (based on *all* evaluation criteria) may dictate some adjustments to the timeline. We can't comment on specific adjustments without an understanding of the bases for that adjustment.

**Q56:** *'What is the page limit for the Science Section of the proposal? The kick-off package says 5 pages, but the team was told at the kick-off meeting that they could have more than that. We need at least 12 page in order to repeat the Step 2 science section and address the weaknesses from that debrief (one or two pages more would be even better).'*

**A56:** Slide 45 of the kickoff package does limit the length of the Science section to 5 pages. As you note, there is a conflict in that slide 17 states that *'...the peer review panel's findings with regard to science merit of the ICS report will not be revisited.'* and thus the Step 2 science section stand unless *'any issues that may have emerged in the course of the ICS have effected significant changes to the science objectives'*. To resolve this conflict, please use the Step 2 science section as-is unless you find that it no longer properly captures your science objectives. Any weaknesses identified during the debrief will be relayed to your team after the CSR is submitted, so your response to those weaknesses would have to be separate from the CSR itself.

**Q57:** *Why does SOF-DA-ICD-SE03-037 have blank figures in it?*

**A57:** It has been confirmed that ICD TA\_SI\_02 Rev. 1.1 has figures that are either missing or display improperly. Because of this Rev. 1 is being provided. The only difference between Rev. 1 and Rev. 1.1 was an administrative change made to the document number, which was changed from SOF-DF-ICD-

SE03-037 to SOF-DA-ICD-SE03-037. The content of both versions of the ICD are the same. Rev. 1 will be uploaded and provided via the SOFIA Document Library on the LaRC SOMA S3GSI website.

**Q58:** *In Sec 1.3 of the handbook, it talks about a library at [sofiacm.arc.nasa.gov](http://sofiacm.arc.nasa.gov). Why can't I see this in my browser?*

**A58:** SOFIA Windchill ([sofiacm.arc.nasa.gov](http://sofiacm.arc.nasa.gov)) is not accessible to teams during the competitive S3GSI solicitation phase. SOFIA documents that will be needed during the 3rd Generation SI solicitation will be provided via the LaRC SOMA S3GSI website here: <http://soma.larc.nasa.gov/sofia/sofiplib.html>. Additional SOFIA documents will be uploaded to the website, as requested and needed. After instrument selection occurs, access to Windchill will be provided—instructions on how to request access will be provided at that time.

**Q59:** *We are looking for a missing referenced document, SOF-AR-ICD-SOF-1030 (Handbook section 10.1.1). Where is it?*

**A59:** SOF-1030 Rev. D will be provided via the SOFIA Document Library on the LaRC SOMA S3GSI website. This is a very old document and maybe be of limited use to your teams. The SOFIA Program is currently compiling temperature data and information relevant to SI to provide to your teams, to supplement the information in SOF-1030.

**Q60:** *The CSR Content slide in the kick-off package (page 45) does not show a place for Letters of Commitment. Can you confirm that Letters of Commitment are not required in the CSR?*

**A60:** Please include letters of Commitment in an Appendix, and do not count it against any page limits.

**Q61:** *Can you be more specific about what you expect Appendix 2 "SoW for remaining work" to contain?*

**A61:** Not sure what clarification would be helpful here. I think the usual elements of a statement of work (e.g., purpose, scope, location/facilities, period of performance, deliverables schedule, applicable standards, acceptance criteria, any special requirements, type of contract/payment, etc) plus any additional items as you see fit.

**Q62:** *Typical Step 2 proposals allow enhancements to the science section to address Step 1 debrief weaknesses and to present additional supporting material, as long as the baseline science is not changed. Can we have a few pages for this purpose, in addition to the pages required to repeat the science section as is, or should we plan to address the weaknesses we have already received in Section E?*

**A62:** At the S3GSI Kickoff the SOFIA Program Scientist stated (kickoff presentation slide 17):

*-The SOFIA Program Scientist and Deputy Program Scientist will determine whether any issues that may have emerged in the course of the ICS have effected significant changes to the science objectives that were the basis of the peer review panel's rating of the scientific merit of the Step 2 proposal.*

*-If there are no significant changes to the proposed investigation that undermine the basis of this rating, the peer review panel's findings with regard to science merit of the ICS report will not be revisited.*

*-If there are significant changes, the Program Scientist will conduct a peer review to reevaluate the scientific merit of the objectives in light of these changes. The factors for reevaluating this criterion will be the same as those used for the Step 2 proposal review.*

Based on this I do not anticipate that the review committee will be evaluating the science case, but please address any concerns as you see fit in Appendix E.

**Q63:** Please provide the maximum operational vibrational specification.

**A63:** We don't have a vibration spec, but some studies attempting to characterize the in-flight vibration environment are available and will be posted to the S3GSI website in the next day or two. One is formatted for eventual inclusion in the SI Developer's handbook (though it didn't make it in time for Rev. B) and is titled '*OP03-2000B Section 10.3 Vibration UPDATES 20160421.pdf*', and the other is concerned with the measured vibration environment for instruments mounted in the cargo hold of SOFIA on the purpose-built SI shipping fixture (*SI Shipping Assembly Structure Dynamic Analysis, SOF-NASA-REP-SE07-2165*). These will both be posted to the 'Support Documents' section of the webpage.

**Q64:** Is an optical description of the telescope available?

**A64:** Yes. Two documents are being added to the document library section of the S3GSI website: SOF-SPE-KT-1000.0.01, *Optical Assembly Design Definition* and SOF-TAN-KT-1000.0.02, *As-Built Ray Tracing Analysis*.

**Q65:** 'In order to properly budget, we need to have some additional details regarding the site visit very soon. Can you tell us who is expected to attend, the location, the date, and duration?'

**A65:** The planning for the 'site visit' has evolved slightly since the S3GSI Kickoff meeting. Dates are the same, but the meetings will now be held virtually for both teams. No travel is required. Final details will be provided, but the present schedule includes a half-day presentation by each team to describe their instrument design on August 22. The TMC may provide formal questions in writing to the teams following their presentations. The teams will have an opportunity to answer these questions the following day.

**Q66:** 'Is the same embargo on asking questions going to be present there as it was for SRR?'

**A66:** No. The 'embargo' was put in place to preserve the integrity of the competitive process prior to submission of the CSRs. These will have been submitted by the time of the 'site visit', so no need for the embargo to continue.

**Q67:** 'Is an optical model of the telescope assembly available?'

**A67:** Yes. We will shortly add a Zemax file to the Document Library, *OS01-697.zmx*, based on the *SOF-SPE-KT-1000.0.01* description of the telescope design.

**Q68:** 'Given that the SRR RFI responses were not considered in the original structure of the Concept Study Report, can we add an appendix to address the RFI responses either directly, or to include an index listing the RFIs and giving the location within the CSR where each RFI is addressed?'

**A68:** Delivery of RFI lists under by Headquarters direction offers the ICS teams the opportunity to improve their proposals, at the team's discretion. This does not change effective page limits or other formatting instructions provided previously. We believe that it would be unfair to change the rules on proposal structure at this stage, and thus the basic CSR guidelines will not be changed. However, should a team desire to provide responses to RFIs in an appendix, it may do so provided they limit the appendix to 5 pages. The review panel may use that information during its deliberations at its discretion.

