

NASA Response to the  
2019 Independent Reviews of the  
Stratospheric Observatory for Infrared Astronomy  
(SOFIA) Program

August 12, 2019

## **Background**

The Stratospheric Observatory for Infrared Astronomy (SOFIA) is a joint NASA/DLR program and consists of a German-built 2.7-meter (2.5-meter useable aperture) telescope with a suite of imaging, polarimetry and spectroscopy instruments, mounted in a Boeing 747-SP aircraft supplied and modified by NASA. Operations costs and observing time are shared by the United States (80%) and Germany (20%). Flying at altitudes up to 45,000 feet, SOFIA observes from above more than 99 percent of Earth's atmospheric water vapor, thereby opening up wavelengths for astrophysical observations not available from the ground.

SOFIA reached full operational capability (FOC) in February 2014 and began its five-year prime mission in May 2014. Although SOFIA is designed to have a twenty year operational capability, like all other NASA missions, regular reviews are expected to ensure that any NASA project is operated with the highest efficiency to ensure the maximum scientific return for the Federal taxpayer dollars used to operate the mission, as well as to evaluate and assess its continuing scientific relevance.

The SOFIA project has learned many lessons over its five years of prime mission operations and 2019 is an appropriate time for an external review to further improve its scientific return on the dollar and plan for its future.

SMD AA Thomas Zurbuchen directed that two aspects of the SOFIA project merit a review:

1. A review of SOFIA's operational paradigm, to assure that SOFIA is operationally efficient and effective. This review was called the SOFIA Operations and Maintenance Efficiency Review.
2. A review of SOFIA's science progress and science prospects, to assure that SOFIA is scientifically productive. This review was called the SOFIA Five Year Flagship Mission Review (S5YFMR or FMR).

Like all other SMD missions in extended missions phase, NASA anticipates reviewing SOFIA triennially to determine whether it continues to be scientifically productive and to improve its science productivity and value to the community.

### **SOFIA Operations and Maintenance Efficiency Review (SOMER)**

The SOFIA Aircraft & Operations Maintenance Reviews (SOMER) primarily looked at aircraft operations and maintenance. The SOMER was chaired by Shane Dover (Chief of Aircraft Operations, NASA LaRC).

The SOMER schedule was

Sep 26, 2018:	Terms of Reference issued
Oct 4, 2018:	Introductory telecon of panel
Oct 11-12, 2018:	Site visit by SOMER panel to AFRC
Dec 18, 2018:	SOMER panel meets at HQ

Dec 22-Jan 25: Government Shutdown (5 weeks)  
Apr 22, 2019: Final report of SOMER delivered to HQ  
May 10-13, 2019: AFRC, ARC, SOFIA responses to HQ

The SOMER membership was:

Shane Dover (Chair), Chief of Flight Operations, NASA Langley  
Carol Carroll, Program Operations, NASA ARC Deputy Director  
Thomas Decher\*, Operations, Special Mission Aircraft Services, Lufthansa  
Matt Elder, Research Pilot / Aircraft Operations, NASA Langley  
Christy Hansen\*, Program Management, Airborne Science Ops, NASA GSFC  
Andy Roberts, Government & Commercial Management of Aircraft Operations & Maintenance,  
BAERI  
Mihailo Rutovic, Aircraft Ops, Program Management, Engineering, NASA JSC  
Rick Shetter, Aircraft Operations for Science, BAERI  
Bruce Tagg, Agency Strategic Management of Airborne Science, NASA HQ  
Mike Thompson, Airborne Program, NASA AFRC  
Burkard Wigger, Fleet-management, Flight-operations, Airworthiness & Maintenance  
Management, DLR  
Elbert (Lucien) Cox, Executive Secretary, SOFIA PE, NASA HQ  
\* served only through site visit

Throughout the review period, the SOMER Executive Secretary, Mr. Elbert “Lucien” Cox, collected and forwarded 76 specific Requests for Information (RFIs) to the SOFIA team. SOMER recommendations were generated through: the auditing of programmatic data, budgetary analysis, operational modeling, as well as personnel interviews with SOFIA maintenance personnel, operations personnel, and the program’s management team. The SOMER panel used private-sector and other governmental aircraft operators for benchmarking and comparative analysis.

### SOMER Executive Summary

- The SOMER team has concluded that fundamental changes in the management model, operational paradigm, and workforce construct are necessary to significantly improve flight-hour production and/or reduce program Operations and Maintenance (O&M) costs.
- SOFIA conducts safe flight operations. The O&M staff are dedicated professionals and the aircraft is well-maintained.
- Despite abundant funding, the program suffers from sub-optimal flight-hour production, historically low dispatch rates and is laden with unnecessary, and/or underutilized workforce.
- These inefficiencies encumber the program and originate from SOFIA senior management's failure to effectively transition its workforce and processes from a developmental program to an FOC model.

### SOMER Specific Recommendations for Improvement

Based upon a detailed analysis of identified issues, the SOMER has made specific recommendations for improvement in three major areas:

#### Management

1. Transition SOFIA aircraft operations away from an integrated astrophysics program into an existing independent aircraft management model - such as SMD's Airborne Science Program (ASP) - in order to leverage aircraft operations expertise.
2. Consider issuing a Request for Information (RFI) to consider the feasibility of a Government-Owned Contractor-Operated (GOCO) mode of operations, should operations continue long-term.
3. Re-establish firm operational metrics and regularly measure SOFIA performance against them.

#### Operations

4. Reduce flight profiles to 8 hour flights, improving safety posture, dispatch rate, scheduling flexibility and increasing the percentage of aircraft time at high-value altitudes.
5. Schedule 6 flights per week, which would directly correlate to an increased number of total flights per year.
6. Adjust aircrew mission briefing, pre-flight, and post-flight duty periods to shorten the overall crew duty day, improving crew turn-around times and maximizing maintenance touch-time.
7. Manage the number of instrument changes to allow for more aggressive aircraft scheduling.
8. Dedicate assigned aircrew to a primary SOFIA role (limit to two total aircraft qualifications of similar category on a not-to-interfere basis) which would decrease scheduling complexity and reduce the overall pilot training requirements, both in time and cost.
9. Incorporate exchange aircrew support from DLR to improve operational diversity and add unique experience/thought processes.

#### Workforce

10. Reduce/reassign full-time O&M workforce in specified areas (such as engineering, inspection, technicians, flight safety and aircrew) decreasing extraneous program costs.

#### **SOFIA Five Year Flagship Mission Review (S5YFMR or FMR)**

The SOFIA Five Year Flagship Mission Review (S5YFMR or FMR) primarily looked at science and mission operations. The FMR was chaired by Dr. Kenneth Sembach (Director, Space Telescope Science Institute, Baltimore MD).

The FMR schedule was

Nov 19, 2018:	Terms of Reference issued
Dec 19, 2018:	Panel appointed (some changes in Jan/Feb)
Feb, 2019:	Two members of FMR fly on SOFIA (all offered option to fly; some already familiar with SOFIA ops)

Mar 4, 2019:	Introductory telecon of FMR panel
Mar-May, 2019:	RFIs requested (four separate requests)
Apr 17, 2019:	FMR reviews SOFIA Instrumentation
Apr 22, 2019:	FMR hears the SOMER Exec Summary & Recommendations
Apr 24-25, 2019:	Site visit by FMR panel to ARC
May 31, 2019:	Debrief to SOFIA from FMR panel
Jun 7, 2019:	Final FMR report shared w/ all stakeholders

The FMR membership was

Kenneth Sembach, Chair (Space Telescope Science Institute)  
Laura Ferrarese (National Research Council of Canada / Herzberg Astrophysics)  
Phil Jewell (National Radio Astronomy Observatory)  
Oliver Krause (Max-Planck-Institut für Astronomie, DLR-appointed)  
Sangeeta Malhotra (Goddard Space Flight Center)  
Rick Shetter (BAERI, SOMER panel member)  
Matthias Steinmetz (Leibniz Institute for Astrophysics Potsdam, DLR-appointed)  
Lisa Storrie-Lombardi (Caltech / Jet Propulsion Laboratory)  
Lou Strolger (Space Telescope Science Institute)  
Burkard Wigger (DLR, SOMER panel member)  
Belinda Wilkes (Smithsonian Astrophysical Observatory)  
Kartik Sheth (NASA HQ), SOFIA PS, Executive Secretary

### FMR Executive Summary

SOFIA is an international mid-far infrared airborne observatory with astronomical observing capabilities complementary to those available with ground-based facilities or space-based observatories. SOFIA entered full operational capability in 2014 and has performed observations that provide new views of astronomical phenomena ranging from planets in the Solar System to the nuclear engines of distant galaxies. SOFIA observations to date have resulted in 144 science publications in the peer reviewed astronomical literature. These publications have been cited 1836 times, with an observatory h-index value of 22. The working relationship between NASA and DLR appears to be both productive and collegial. Both partners have a vested interest in the future of SOFIA.

Science productivity has increased over the past few years, but falls short of that expected by the science community for a flagship mission with an annual operating cost to NASA of approximately \$86M per year. In light of this, NASA convened the SOFIA 5-Year Flagship Mission Review panel to assess the current state of SOFIA's science operations, science productivity, and observatory plans for the next five years. In addition, the panel was also tasked with identifying metrics that could be used to assess SOFIA's performance in the future. Bold vision and transformative change are needed to take SOFIA to the next level and strengthen its role as a general-purpose flagship-class observatory that takes full advantage of its observational capabilities. The mission would benefit greatly from a paradigm shift in aircraft operations, a substantial increase in flight hours at stratospheric altitudes, implementation of ambitious observing programs that have lasting archival legacy value, and aggressive pursuit of science

synergies with ground-based observatories and other missions in NASA's astrophysics portfolio. More science would result by focusing efforts on extracting the latent science potential of existing instruments and developing data archive tools than from development of new instruments beyond those already underway (e.g., HIRMES). There is also need for a clearer, more focused role for SOFIA Science Mission Operations and a relentless commitment to moving the mission forward with science at the forefront of decision making in the next few years. A stronger sense of urgency within SOFIA leadership is essential to set the course for the future.

We offer ten recommendations aimed at improving SOFIA's science return, with the expectation that NASA and the SOFIA project will find ways to implement these recommendations in a cost neutral fashion, without additional funding needed beyond the in-guide profile for FY20-22. The recommendations are:

- (1) Nurture a science-driven culture within the mission,
- (2) Embrace change in operational approaches,
- (3) Emphasize completion of high priority science programs,
- (4) Emphasize the collection of high quality data,
- (5) Maximize observing time at stratospheric altitudes,
- (6) Fly more southern hemisphere flights,
- (7) Transfer data products into the archive quickly,
- (8) Split aircraft operations from telescope/science operations,
- (9) Invoke HIRMES cost and schedule control, and
- (10) Focus on current science operations rather than future instrument development.

For each recommendation there is an accompanying set of actions that we believe would promote mission success. We also recommend that SOFIA use a robust set of metrics appropriate for a flagship mission in its prime mission at full operational capability to judge scientific productivity, mission progress, and future viability. A core set of metrics is provided in this report to use as the starting point for discussions of the complete set to be developed.

## **NASA Response to the SOFIA Independent Reviews**

The Director of the SMD Astrophysics Division has directed the following changes in the SOFIA project, in response to the recommendations of the SOMER and the FMR.

1. NASA Ames will manage SOFIA with the focus on science and mission operations, as recommended by FMR. To facilitate implementing the FMR recommendations, NASA is converting SOFIA from a single-project-program to a project within the Astrophysics Strategic Missions Program. The SOFIA project manager will develop a new project plan that includes metrics based on the FMR report. A basic set of science metrics proposed by the FMR are:
  - a) # of science papers per year
  - b) Completion rate of approved high-priority programs
  - c) % of complete high-priority programs resulting in at least one science pub
  - d) H-index
  - e) % of level 3 data to archive in 15 days

f) % of level 2 data to archive in 30 days

The FMR noted that "... [these metrics] should form the basis for a more extensive set that include standard metrics such as oversubscription rate, number of investigators, number of new investigators, number of citations to refereed papers, amount of data downloaded from the archive, number of scientific press releases, etc."

2. Aircraft operations and maintenance anticipated to be the responsibility of the Airborne Science Program (ASP) at Armstrong. The intent is to assign aircraft operations and maintenance to an aircraft center of excellence. ASP will identify operational efficiencies and estimate the costs for the staffing, operations and maintenance for an increased cadence (~5-6 days a week x ~8 hr flights for ~40 weeks). Based on analysis, HQ will determine the model for aircraft operations and maintenance.

NASA expects that SOFIA will be operating at a higher cadence and higher science productivity no later than the end of CY 2019.

For further information contact:

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