National Aeronautics and
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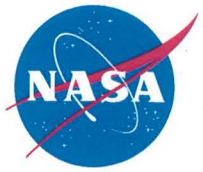

Reply to Attn of: Science Mission Directorate/Planetary Science Division

NASA Response to the Psyche Independent Review Board Implementation Assessment

On May 30, 2023, the Psyche IRB provided their final briefing to NASA on their assessment of NASA and JPL's implementation of the recommendations from their report dated November 4, 2022. Their assessment responses were reported in terms of appropriate, appropriate with additional work, or inadequate. In evaluating progress on these recommendations, which were split in two categories – those pertaining to the project, and those pertaining to the JPL institution – the IRB considered both the work accomplished to date and future plans, acknowledging the incredibly hard work and achievements to date in many areas. They noted the importance of maintaining the diligence in certain areas to both keep Psyche on track for launch in 2023 and achieve widespread success going forward.

The IRB assessment celebrated the Psyche team's exceptional efforts to develop a credible plan and implement corrective actions to achieve the later October 2023 launch. We are thrilled that the IRB has concluded that the overall probability of mission success is high. We concur with the IRB's assessment that a significant amount of work remains in operations planning, and that continued emphasis is needed in areas such as the line management's technical oversight, and improvements to programmatic plans, assessment approaches, and metrics.

We partially concur with the IRB's assessment that the responses to the SRB Review Process improvement recommendations were inadequate. NASA agrees that significant work is needed to meet the spirit of the recommendations in this area. We acknowledge, however, that this is an area of Agency responsibility, requiring active engagement across multiple Headquarters organizations, and efforts that go well beyond the Psyche Project, JPL, or even SMD jurisdiction. The work being led by the NASA Chief Project Management Officer in collaboration with the Mission Directorates is underway and is intended to address deficiencies in the current SRB and independent assessment processes and practices. We note the IRB's positive acknowledgement of the active efforts specific to the Psyche SRB, and we remain committed to delivering impactful improvements to benefit all relevant NASA projects and programs in the future.

The IRB described the response to all JPL institution findings and recommendations as appropriate and shared that the responses exceeded the board's high expectations. This reflects the seriousness with which JPL and Caltech leadership undertook these efforts. We appreciate and fully concur that continued engagement, commitment, and leadership will be needed to maintain this tenor and institutionalize the significant changes underway.

We want to thank the entire board for their comprehensive and rigorous two-phased review, and extend our heartfelt appreciation to the IRB Chair, Mr. A. Thomas Young, for his leadership and for again assuming this momentous responsibility. We are proud of the hard work the teams have undertaken thus far and remain confident that the impact of the significant efforts reflected in this report will set the stage for continued success.

Nicola J. Fox, Ph.D.
Associate Administrator,
Science Mission Directorate

Laurie A. Leshin, Ph.D.
Director,
Jet Propulsion Laboratory

Psyche

Independent Review Board
Assessment Report

May 30, 2023

Psyche IRB Charter

- Assess the Psyche Project's and JPL institution's progress and implementation of the Independent Review Board (IRB) recommendations.
  - Recommendations cited in this report are per the Psyche IRB's original report.
  - Observations and work-to-go described in this report reflect the status at the time of IRB's progress reviews of Psyche (March 2023) and JPL (April 2023).

Review Methodology

- IRB meetings on-site at JPL, to review progress of the Psyche Project and JPL institution on IRB recommendations
- Structured reviews
- Informal sessions
- Personnel interviews
- IRB deliberations and discussion

Assessment Definitions

- Appropriate – The response, including future activities, fully addresses or exceeds the IRB recommendations.
- Appropriate with additional work needed – The response largely addresses the IRB recommendations, missing a few key elements.
- Inadequate – The IRB recommendation has not been adequately addressed.

Psyche IRB Membership

- Allen Bacskay, Ex-Officio, NASA Retired, Psyche SRB Chair
- Steven Battel, Battel Engineering, President
- Doug Bernard, JPL, Deputy Chief Engineer
- Antonio Elias, Orbital ATK, Retired
- Orlando Figueroa, NASA, Retired
- Robyn Haleski, JPL, MSR SRL Avionics and Flight Software Product Delivery Manager
- Fiona Harrison, Caltech, Chair, Division of Physics, Mathematics and Astronomy
- Tom Jedrey, JPL, Europa Clipper Deputy Flight System Manager
- Gentry Lee, JPL, Chief Engineer for Planetary Science Directorate
- Fuk Li, JPL, Retired
- David Mitchell, NASA HQ, Chief Program Management Officer
- Ellen Ochoa, NASA, Retired
- James O'Donnell, NASA GSFC, NESC GNC Technical Discipline Team
- Jessica Samuels, JPL, MSR CCRS JPL Flight Segment Manager
- Janet Vertesi, Princeton University, Associate Professor of Sociology
- A. Thomas Young (Chair), former NASA, Lockheed Martin Corp., Retired

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Karen Gelmis, NASA HQ, Review Manager

Sam Thurman, JPL, Associate Review Manager

Joan Salute, NASA HQ, Observer

William Knopf, NASA HQ, Observer

Psyche
Summary and Conclusions

Psyche Project Summary and Conclusions

- The judgement of the IRB is that the response to the IRB recommendations and work-to-go is outstanding and exceeded the board's high expectations.
- The Principal Investigator, Psyche Project, JPL senior leadership, and JPL Line organization are to be commended for their exceptional contributions.
- A credible plan has been developed for the remaining work to be accomplished to support an October 2023 launch. Initial operations planning is viewed by the IRB to be positive; however, this area has a significant amount of work yet to be accomplished.
- The IRB believes the October 2023 LRD is credible and the overall probability of mission success is high.
- It is the judgement of the IRB that the positive actions observed validate NASA's decision to continue the Psyche Project.

JPL Institution
Summary and Conclusions

JPL Institution Summary and Conclusions

- The IRB recognizes that the board's findings and recommendations were challenging, necessary, and would ultimately require considerable time to complete the corrective actions.
- The IRB's assessment includes the work accomplished to date and the plans to complete the remaining actions.
- The IRB assesses that the response to all the findings and recommendations are appropriate. The IRB is extraordinarily impressed by the accomplishments of the total JPL organization and Caltech.
- Engagement in and leadership of the overall response process by the JPL Director and senior leadership is deemed "world class."
- The amount of work-to-go is extensive and will require continued engagement, commitment, and leadership. The IRB is confident this will occur.

Psyche
Assessment of Recommendations

General

Recommendations

- Develop plan forward that prioritizes and completes development activities.
- Establish a new launch date with sufficient margin to have high confidence in success.
- Review work performed in last several months before the launch delay to assure it is at the required level of excellence with no embedded problems.
- Conduct a detailed review and assessment of “use-as-is” problem dispositions and “unverified failures.”

Assessment

- Appropriate

General

Observations

- The project has performed a commendable replanning process with a resulting plan that is thorough, detailed, and executable with credible schedule margin remaining.
- The refinement of the verification and validation (V&V) plan is especially important and impressive, and it should give the project proper insight into its progress. This gives the IRB increasing confidence that the new launch date selected in October 2023 is viable.
- The project has innovated organizationally as well to assess the level of technical quality achieved and uncover embedded problems, including forming independent Technical Advisory Groups (TAGs), “step-back” reviews, thorough rereview of “use-as-is” items, off-site meetings, and engaging with its Standing Review Board (SRB).
- There remains some activity as described in the “work-to-go” section, and the project has prioritized these activities appropriately.
- Overall, the project is on a strong footing for a successful launch.

Management and Communications

Recommendations

- Establish and implement processes to assure open, credible, and responsive communications both vertically and horizontally throughout the Psyche Project.
- The JPL Director, senior management, and Line management must establish and implement processes that assure significant insight into flight-project execution and participation in resolution of problems and risks.
- The role of the Line management function in elevating concerns needs to be emphasized and strengthened.
- The workforce should be trained that the Independent Technical Authority should be used for elevating unresolved issues of any nature, including programmatic.

Assessment

- The assessment of the Psyche Project and senior management response to these recommendations is appropriate.
- The assessment of the Line management response is appropriate with additional work needed.

Management and Communications

Observations

- The Psyche Project has properly and adequately engaged several of the critical Line organizations to review their ongoing work.
- TAGs have been created by the Line organizations to provide valuable technical oversight.

Work Still Needed

- In some technical areas, mission operations in particular, there does not yet exist sufficient Line-management oversight of the work being done on Psyche.
- Line managers whose personnel are working on Psyche must be actively engaged with the quality of the technical work.

Staffing

Recommendations

- Provide additional 10–12 full-time, experienced leaders at all levels of the project.
- Adequately supplement and maintain project staffing to support the replan.
- Special attention should be given to assigning/maintaining a Project Chief Engineer; Guidance, Navigation, and Control (GNC) Cognizant Engineer; and Fault Protection Lead Engineer.

Assessment

- Appropriate

Staffing

Observations

- JPL's response to the Psyche staffing recommendations exceeded the IRB's expectations.
- They identified, provided, and maintained excellent leaders who had the experience to implement the necessary changes to the project, including appropriately staffing the Integrated Psyche Systems Organization (IPSO) and the key project positions identified by the IRB.
- Additionally, these leaders have performed a very valuable mentoring function that not only benefits Psyche but will serve JPL well into the future.
- The institution has clearly put a priority on keeping Psyche staffing stable, which has enabled trust and healthy communications paths to be rebuilt and resulted in impressive progress on project milestones.

COVID-19 Related

Recommendations

- Reestablish informal communications, such as “walking the floor” and “drop-in discussions.”
- Remote and hybrid work must be minimized on Psyche to give the team the best opportunity to coalesce in a short time.

Assessment

- Appropriate

COVID-19 Related

Observations

- The return to majority in-person work has made a tremendous difference in restoring visibility and informal communications across the project.
- Drop-in meetings, social coffee hours, off-site intensives, and individuals “walking the floor” have improved team interaction, problem-solving, efficiency, and trust.
- The team is also making judicious use of remote and hybrid access options as appropriate to ensure flexibility while not compromising their collaboration.

Project Metrics

Recommendations

- Develop a detailed, integrated, resource-loaded, and adequately margined and verified schedule for all remaining work.
    - This must include sufficient task completion milestones in key areas like V&V, system integration and test (I&T), and mission ops preparations, such that progress in these areas can be readily tracked.
- Establish and implement a management information and reporting system that produces a credible and timely assessment of status, risks, and issues against this integrated baseline.

Assessment

- Appropriate with additional work needed

Project Metrics

Observations

- The Psyche Project presented a comprehensive and logical resource-loaded plan reflecting the work-to-go with reasonable durations for the activities defined.
- Progress against the plan is monitored through multiple metrics (e.g., staffing and closure of Engineering Change Requests, Problem/Failure Report [PFRs], waivers, risks) and successful achievement of major milestones in the plan, such as progress against the V&V plans.
- Progress against the plan is getting weekly attention from IPSO and the personnel accountable for doing the work (e.g., Phase and domain leads) for technical and system concerns.
- Progress against the plan is being reconciled at a regular cadence (typically monthly) for higher-level programmatic assessment at the project level and for reports to JPL management.
- Performance to date shows that the project has consumed about a third of its three-month schedule margin against the October 2023 Launch Readiness Date (LRD), reflecting very good performance to date and giving credence to their ability to meet the LRD.

Project Metrics

Observations, cont'd

- Operations Readiness is an area that requires focused attention for development and configuration control of flight rules, procedures, training of personnel, etc., to make sure they are sufficient to meet the requirements of the Certificate of Flight Readiness.
- The project is planning for deferment of some development and V&V activities associated with orbit operations to post-LRD with a robust staffing plan, which is warranted given the priority tasks that need to be completed ahead of the LRD and requirements for early commissioning.

Work Still Needed

- The Psyche metrics and processes are a big step in the right direction for comprehensive and effective programmatic plans, assessment approaches, and metrics. Critical assessment post-LRD for broader applicability to JPL projects throughout the life cycle is warranted and highly recommended.

SRB Review Process

Recommendations

- The SRB process must be strengthened such that there is discrimination between “normal” activities and serious issues that will highlight critical factors impacting a project’s success.
- Guidelines given to projects for status reporting should be clear and unambiguous (e.g., for “green,” “yellow,” and “red” color-coding).
- The response to the SRB-reported issues and concerns must be thoroughly reviewed by the SRB, Management Center, and NASA authorities on a regular basis until satisfactory resolution is achieved.

Assessment

- Inadequate

SRB Review Process

Observations

- The SRB process includes an independent board, interaction with the project being reviewed, and NASA oversight of the board and project activities to ensure board actions are properly implemented.
- The timing of the Psyche SRB reviews did not allow identification of the problems that caused the launch delay such that corrective action could be implemented. The board did identify schedule issues that were not communicated with sufficient level of severity and were not acted upon appropriately by the project or properly dispositioned by NASA.
- The IRB believes the SRB process can be an important project-management asset to identify critical problems requiring corrective action.

Work Still Needed

- The IRB believes NASA and Management Centers should take the necessary action to clarify the responsibilities of the board, the appropriate schedule for board meetings, and board membership composition.
- NASA's actions should specifically define the responsibilities of the project in answering board recommendations and NASA accountability for governance of the total process to ensure that board recommendations are properly understood and dispositioned.

Psyche-Specific SRB Forward Plans

- NASA Headquarters is aware of deficiencies in the current SRB processes and practices, and have multiple organizations working on improvements.
- In order to address the SRB-process deficiencies on Psyche, moving forward between now and launch in October 2023, the Psyche SRB Chair is working with the Psyche Project, the Planetary Mission Program Office, JPL, and NASA Headquarters to enhance the SRB activity specifically for Psyche.

JPL/Maxar Relationship

Recommendations

- The Psyche experience provides an excellent opportunity to document best practices for future collaborations between NASA and commercial spacecraft providers in areas such as:
  - Early and sustained in-depth interactions to develop mutual understandings of cultural and process differences
  - Ensuring interfaces between the two organizations are correct, complete, and adequately documented and reviewed by subject-matter experts
  - Contract structure

Assessment

- Appropriate with additional work needed

JPL/Maxar Relationship

Observations

- Lessons from the JPL and Maxar experience are still a work in progress and evolving in areas such as testbeds as the work continues for the team to be ready for the LRD in October 2023.
- Interactions with project personnel (JPL and Maxar) provided evidence of a close working relationship and commitment to mission success, with documented lessons in all three areas of the recommendation.
- The project indicated that many of the lessons to date have been shared in informal settings with other NASA Centers.

Work Still Needed

- The formal documentation of lessons from the JPL/Maxar experience provides an invaluable opportunity to inform future missions in similar and often unique and important contractual relationships; they should be documented formally and shared, as is planned.

Work-to-Go for Launch

Recommendations

- The Psyche IRB reported several areas of work-to-go for launch in its report, including:
  - PFR closures
  - Completion of GNC; flight software (FSW); flight system V&V; and assembly, test, and launch operations activities
  - Mission system completion and operational readiness
  - Prelaunch review completion

Assessment

- Appropriate with additional work needed

Work-to-Go for Launch

Observations

- The Psyche Project has incorporated each of the items the IRB included in its Psyche work-to-go list and has made excellent progress in most areas.
- The project is aware of additional work-to-go in FSW and operations, and is properly focusing on the additional work.

Work Still Needed

- FSW:
  - At this juncture, Psyche is in the process of releasing and testing a FSW version with substantial updates.
  - There is an opportunity for one more major release, but that release will receive only limited regression testing prior to launch.
  - The challenge for the project is to determine which changes will reduce the risk of loss of mission, and then implement and test the changes deemed necessary.

Work-to-Go for Launch

Work Still Needed, cont'd

- Operations Readiness:
  - In multiple dimensions, there is substantial work required to finalize how to operate the spacecraft during initial checkout and early cruise – and to train the team to be able to execute that operations plan. The project will benefit from working intentionally and constructively across IPSO and Mission Systems.

JPL Institution
Assessment of Recommendations

Flight Project Workload

Recommendations

- Flight projects must be fully staffed with appropriately experienced personnel from the beginning, particularly in Systems Engineering, GNC, FSW, and Avionics.
- Balance must be achieved between the workforce needs of flight projects and the available JPL workforce.
  - Timing of achieving this balance is critical.
  - Psyche is an example of the major problems this imbalance is causing today.
- IRB believes that by the end of March 2023, significant corrective actions must be implemented to achieve balance.
- For any corrective actions requiring more time, a detailed plan of action must be developed and approved by JPL, Caltech, and NASA.

Assessment

- Appropriate

Flight Project Workload

Observations

- Significant progress has been made in achieving balance between staffing and flight project workload. Psyche and Europa Clipper are currently fully staffed.
- Senior management is evaluating workforce needs and issues on a timely basis, and this provides a positive mechanism to address the Lab's needs.
- A Future Work Board has been established to address JPL workforce balance and to strategically assess and decide on the pursuit of future flight project activities.
- JPL has expanded arrangements with institutions and companies to provide a more diverse range of surge-capacity options.

Line Organization Issues

Recommendations

- Repopulate the Line organization with experienced leaders and engineers to reestablish the Line organization as an equal partner with flight projects during implementation.
- Add experienced people and include them in the effort to achieve balance.
- Address the Division 31/34 staffing, accountability, and coordination issues.
- Continually examine the issues between and within Divisions 31 and 34 because of the importance of these Divisions to the execution of flight projects.

Assessment

- Appropriate

Line Organization Issues

Observations

- The response to Line organization issues is critical to the effective operation of the Lab.
- The path forward by JPL establishes a sustained commitment to improving this essential element of the institution at all levels of the technical organization.
- The formation and deployment of TAGs across multiple disciplines is a positive step to provide timely advice to the Line and project teams, and forms part of the critical technical safety net.
- The IRB is encouraged by the proactive collaboration between the management of Divisions 31 and 34 to address the interactions and relationships between the two organizations.
- The plans to create opportunities for cross-organizational development of technical talent are strongly supported.

Senior Management Engagement

Recommendations

- JPL senior management must establish regularly scheduled meetings, formal and informal communications, and “drop-in” visits to facilitate necessary engagement on major flight projects, communicate priority, and maintain cognizance of status.
- Prioritize the large number of activities competing for senior management’s attention to focus on those in greatest need and importance such that commitments to NASA and the various stakeholders are met.
- Senior management should develop and codify in JPL’s Flight Project Practices the metrics that will be employed for tracking progress, especially during system I&T and V&V.

Assessment

- Appropriate

Senior Management Engagement

Observations

- Senior management engagement has increased dramatically as a result of new forums, metrics, and stakeholder interactions in understanding and addressing project risks.
- The JPL Director is chairing a revamped monthly review of major flight projects where the project and institutional leadership discuss project status. Afterwards, key JPL leaders perform an integrated programmatic assessment across all flight projects.
- New and updated engineering and business metrics, currently being used by Psyche and Europa Clipper, provide valuable insight. Particularly noteworthy are the metrics for V&V. The IRB expects these new metrics to be codified in JPL's command media.
- In addition, the JPL Director and Associate Director are engaging in informal lab visits and meetings at the working level to strengthen communication and insight.

Hiring and Retention

Recommendations

- JPL must develop the capability to successfully hire and retain mid-level people in this new environment.
- JPL must develop approaches for the career growth and retention of critical and high-potential personnel.
- JPL must characterize problems with retention and develop incisive and decisive actions to address the identified problems.

Assessment

- Appropriate

Hiring and Retention

Observations

- JPL leadership has recognized the importance of this issue and has implemented corrective actions, including an increase in HR staffing and engagement.
- JPL has made an exceptional recovery from a looming shortfall in the quality and quantity of its technical staff. In both hiring and retention, results have improved markedly in the last six months.
- An overhaul of the recruiting process and policies, plus close coordination between Human Resources and the technical divisions, has led to the successful acquisition of many critical mid-career engineers, including the rehiring of many recently departed staff members.
- In addition, an aggressive and proactive retention thrust has significantly reduced the attrition rate.

Hybrid Work Environment

Recommendations

- JPL should immediately revisit its policy for hybrid work to make it more effective and better reflect the evolving needs of flight projects in different mission phases.
- Carefully consider which tasks, project phases, and circumstances permit hybrid and remote work arrangements.
- Any hybrid work arrangements should recognize the need for in-person interactions. In addition, it is critically important that early-career employees work alongside seasoned employees for their long-term development.
- Inefficiencies in productivity and communications associated with hybrid work must be included in the workforce, cost, and schedule plans for flight projects.

Assessment

- Appropriate

Hybrid Work Environment

Observations

- JPL moved rapidly to establish an effective on-Lab hybrid work policy.
- The majority of staff are on-Lab a minimum of three days per week in person.
- Remote work arrangements are in place for individuals, depending on task and role.
- The IRB observes that Psyche and Europa Clipper have successfully implemented the new policy.

Caltech Governance

Recommendations

- Caltech should have a better understanding of the JPL institutional issues and play a supporting role in addressing them.
- JPL should strengthen the quality of flight projects status presentations to Caltech.
- Caltech should develop a more rigorous annual review and evaluation approach for the performance of the Laboratory Director.

Assessment

- Appropriate

Caltech Governance

Observations

- Caltech has restructured the Board of Trustees' JPL Oversight Committee, which has enhanced the level of insight into JPL flight projects and institution.
- Briefings to the committee have been revised to contain substantive reports on mission status and strategic institutional issues.
- Caltech has responded to JPL's unique staffing challenges by updating policies that increase flexibility and competitiveness.
- The Caltech President and Laboratory Director communicate frequently and effectively to ensure timely resolution of issues and strategic challenges.
- Caltech has established an annual 360 review of the Laboratory Director.

Backup

Acronyms

ATK	Alliant Techsystems
Caltech	California Institute of Technology
CCRS	Capture, Containment, and Return System
FSW	Flight Software
GNC	Guidance, Navigation, and Control
GSFC	Goddard Space Flight Center
HQ	Headquarters
I&T	Integration and Test
IPSO	Integrated Psyche Systems Organization
IRB	Independent Review Board
JPL	Jet Propulsion Laboratory
LRD	Launch Readiness Date
MSR	Mars Sample Return
NESC	NASA Engineering and Safety Center
PFR	Problem/Failure Report
SRB	Standing Review Board
SRL	Sample Retrieval Lander
TAG	Technical Advisory Group
V&V	Verification and Validation