NASA Implementation of
Executive Order 14303, Restoring Gold Standard Science

Introduction

On May 23, 2025, President Trump issued Executive Order (EO) 14303, Restoring Gold Standard Science. The goal of EO 14303 is to rebuild Americans' trust in science, especially the science underpinning regulations and other government decisions, through defining best practices for the conduct, communication, and use of research —termed in the EO as "Gold Standard Science."

Gold Standard Science is characterized by "Reproducibility, rigor, and unbiased peer review…" and "…practice[s] data transparency, acknowledge[s] relevant scientific uncertainties, [is] transparent about the assumptions and likelihood of scenarios used, approach[es] scientific findings objectively, and communicate[s] scientific data accurately." These are widely accepted characteristics of prime research practices.

NASA's research and communication practices are contained in multiple NASA Policy Documents (NPDs), NASA Procedural Requirements (NPRs), Mission Directorate-level policies, and handbooks. Implementing EO 14303 requires multiple documents be reviewed and updated as necessary. This report, prepared by the NASA Science Mission Directorate (SMD), summarizes the Agency's efforts to implement EO 14303. The SMD anticipates being formally assigned to lead policy and external interfaces for matters of scientific research integrity (RI) and research security (RS) on behalf of all Mission Directorates and other research or related programs and activities.

Tenets of Gold Standard Science

In detail, the EO defines the following nine tenets of Gold Standard Science:

i. Gold Standard Science is *reproducible.*
ii. Gold Standard Science is *transparent.*
iii. Gold Standard Science is *communicative of error and uncertainty.*
iv. Gold Standard Science is *collaborative and interdisciplinary.*
v. Gold Standard Science is *skeptical of its findings and assumptions.*
vi. Gold Standard Science is *structured for falsifiability of its hypotheses.*
vii. Gold Standard Science is *subject to unbiased peer review.*
viii. Gold Standard Science is *accepting of negative results as positive outcomes.*
ix. Gold Standard Science is *without conflicts of interest.*

These tenets resonate with NASA's values and NASA-funded researchers.

Reproducibility

Reproducibility in science is the ability of independent researchers to test a hypothesis through multiple methods and consistently achieve results that confirm or refute it, ensuring findings are generalizable and robust across different approaches. Replicability is the ability to perform the same experiment or study using the same methods and conditions to achieve the same result. The Office of Science and Technology Policy (OSTP)'s June 23, 2025, memorandum on "Agency Guidance for Implementing Gold Standard Science in the Conduct and Management of Scientific Activities" develops four requirements, as shown in Table 1, for the reproducibility of Federal Government-performed or -supported research.

Table 1: Requirements and actions related to the tenet of *reproducibility.*

Requirement	Current State	Planned/Future Action
Agencies shall prioritize disciplined, scientific methods, and experimental design. This includes requiring clear, standardized, and justifiable protocols; comprehensive documentation; robust statistical methods; adequate sample sizes; validated methodologies; and appropriate controls.	These are all best practices that are regularly conducted as part of research and held as a standard for the Earth and Space Sciences research community. Additionally, these are considered during peer review of proposals when considering intrinsic merit, see the NASA Grants and Cooperative Agreements Handbook.	NASA will perform continuous review of, and modify, as necessary, the instructions in ROSES and in the guidance provided to proposal reviewers to ensure standardized and adequate review of these principles as a part of the intrinsic merit review criterion. Continue to utilize this review criterion to inform selection decisions.
Agencies should encourage researchers to deposit raw data and code that contributes to research outcomes in publicly accessible repositories, where appropriate, to facilitate exact replication and support reproducibility through diverse methodological approaches.	Within SMD, archiving of raw data and code from research projects is already required (see, for example, SMD Policy Document (SPD) #41A).	NASA will continue to support efforts specifically focused on research data repositories and tools to manipulate those data. NASA SMD will continue to utilize the expertise of the Office of the Chief Science Data Officer to integrate best practices across the directorate.
Agencies should address barriers—such as incomplete reporting or resource constraints—by fostering training, shared infrastructure, and incentives for open science practices.	NASA has provided to members of the scientific community a series of free training modules in the concepts and practices of Open Science. Both self-paced and in-person training was offered and the training	NASA will continue to support access to the Open Science 101 training modules.

Requirement	Current State	Planned/Future Action
	modules are available for download at https://science.nasa.gov/open-science/training/	
Agencies should establish incentives, such as grant programs, awards, or recognition, to encourage researchers and institutions to prioritize both reproducibility and replicability, reinforcing their complementary roles in open science.	As a fundamental principle for conducting scientific research, NASA continues to encourage and support reproducibility and replication studies in proposals.	NASA will continue to provide support for Open Science and actively work with the Office of the Chief Science Data Officer and all NASA stakeholders to assess the current programs and awards and modify or create new ones to reinforce the complementary roles of replicability and reproducibility in open science.

Transparency

Transparency in science entails the open, accessible, and comprehensive sharing of all components of the research process—methodologies, data, analytical tools, and findings—to enable stringent scrutiny, validation, and reuse by the scientific community and the public. Transparency builds trust, fosters accountability, and promotes collaboration while reducing errors and bias.

The OSTP memorandum on implementing EO 14303 contains five requirements related to scientific transparency:

Table 2: Requirements and actions related to the tenet of *transparency*

Requirement	Current State	Planned/Future Action
[Transparency] requires detailed disclosure of experimental protocols, raw data, software tools, and potential conflicts of interest, facilitated through platforms such as open-access journals, public data repositories, and standardized reporting frameworks.	NASA and SMD policies already include these requirements.	Consider updating policies to require publication as open access and deprecate the option of providing an "as accepted" version of a closed access publication to NASA's PubSpace archive.

Requirement	Current State	Planned/Future Action
Transparency includes prioritizing clear, detailed reporting of methodologies, making raw data and analytical tools publicly available when feasible and lawful, and disclosing funding sources or conflicts of interest.	NASA and SMD policies already include these requirements.	No further action identified.
Data sharing plans should be required in grant applications, to include timelines and platforms for public release.	NASA policy already requires that proposals contain data management plans (see §10.11, NASA Grant and Cooperative Agreements Manual)	NASA will coordinate across MDs on data management plan requirements and best practices.
[A]gencies shall adopt and support standardized metadata formats and data-sharing platforms to ensure accessibility and interoperability.	NASA recognizes the importance of using of standardized metadata data sharing platforms. More work, though, is still required to define standards and to support data-sharing platforms.	NASA will support research efforts that focus on adopting and standardizing metadata formats and data-sharing platforms for the various research communities to enable accessibility and interoperability.
Transparency also extends to peer and merit review processes, where agencies shall, as appropriate and feasible, disclose review criteria publicly, and share anonymized reviewer comments with applicants.	NASA policies require that research solicitations explicitly describe the review criteria to be applied. SMD policy requires that applicants be provided with anonymized versions of the review comments which are the basis for selection decisions. To further reduce bias in reviewing applications, SMD has adopted Dual-Anonymous Peer Review as the default review method. Other parts of NASA are piloting this approach too.	No further action identified.

Communication of Error and Uncertainty

Communicating error and uncertainty in science entails the clear, precise, and accurate

disclosure of limitations, variability, and potential sources of error or limitations in measurements or research findings, enabling other scientists to critically assess, replicate, and extend the work.

The OSTP memorandum on implementing EO 14303 contains five requirements related to the communication of error and uncertainty:

Table 3: Requirements and actions related to the tenet of *error and uncertainty.*

Requirement	Current State	Planned/Future Action
Agencies shall prioritize the communication of error and uncertainty in scientific research to drive robust generation of new science.	As defined in NASA's guidelines for Promoting Scientific and Research Integrity, a key agency goal is to convey to the public scientific and technological information derived from NASA research and development activities. In the context of conveying this information, NASA encourages a clear explanation of underlying assumptions, accurate contextualization of uncertainties, and the probabilities associated with both optimistic and pessimistic projections, including best-case and worst-case scenarios when appropriate.	NASA will continue to hold scientific researchers to the highest standards and continue to work towards the agency's goal of conveying to the public scientific and technological information derived from NASA research and development activities, inclusive of error and uncertainty. NASA will consider reinforcing the research standard that research proposals include a section on potential errors and uncertainties.
Research reporting should include quantitative measures of uncertainties—such as confidence intervals, error margins, or sensitivity analyses—alongside clear explanations of methodological constraints and assumptions and the intended scope of the research, including what the scientific findings do and do not establish.	NASA facilitates the free flow of scientific and technological information among scientists and engineers, between NASA staff and the scientific and technical community, and between NASA employees and the public, as consistent with the National Aeronautics and Space Act as amended, which stipulates that NASA shall "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."	Update relevant policies to strongly encourage the use of quantitative measures of uncertainties in publications citing NASA funding.

Requirement	Current State	Planned/Future Action
Agencies should encourage standardized formats for reporting uncertainty, such as graphical visualizations or concise, accessible summaries, to enhance clarity and utility for the scientific community.	NASA does not currently promote this practice, however it is common in the fields of Earth and Space Science.	NASA will encourage the submission of proposals that aim to standardize formats for reporting uncertainty, such as graphical visualizations or concise, accessible summaries, to enhance clarity and utility for the scientific community and the American people.
To prevent overstatement of results, agencies should promote cautious, evidence-based language in reports, publications, and public communications.	It is vital for the NASA mission to maximize openness with the media and the American people, as supported by the National Aeronautics and Space Act as amended. Policies governing NASA media relations can primarily be found in 14 CFR 1213.105, Release of Information to News and Information Media. NASA is dedicated to cultivating articulate and knowledgeable spokespersons, as specified in 14 CFR 1213.105(b). Additionally, peer reviews of proposals and scientific publications in Earth and Space Sciences routinely screen for overstatement of results and will penalize proposals and publications that do.	NASA will provide continuous review of policies governing NASA media relations on a regular cadence and ensure they promote cautious, evidence-based language in reports, publications, and public communications
Agencies should discourage speculative claims or extrapolations that extend well beyond the data's scope, especially when science is used in an operational or regulatory context.	NASA believes that the scientific and technical information that employees (and extramural researchers) share about NASA programs and projects should be timely, accurate and unfiltered (14 CFR 1213.102(a)).	NASA will ensure distribution of NASA's policy on the Release of Information to News and Information Media" to employees, which requires that all public affairs officers "Be honest and accurate in all communications".

Collaborative and Interdisciplinary Research

Collaborative and interdisciplinary science refers to the strategic integration of a wide range of expertise, methodologies, and perspectives across disciplines and sectors to address complex scientific challenges and catalyze transformative discoveries.

The OSTP memorandum on implementing EO 14303 contains three requirements related to collaborative and interdisciplinary research:

Table 4: Requirements and actions related to the tenet of *collaborative and interdisciplinary research.*

Requirement	Current State	Planned/Future Action
Agencies shall prioritize collaborative and interdisciplinary approaches in scientific research to accelerate discovery and innovation.	NASA has encouraged interdisciplinary approaches, notably in astrobiology and the study of extra-solar planets.	Working with other Mission Directorates and the National Academies, develop a plan to assess collaborative and interdisciplinary research opportunities.
Further, agencies shall foster partnerships across agencies, disciplines, institutions, and sectors by supporting joint funding opportunities, interdisciplinary research centers, user facilities, and accessible data-sharing platforms.	NASA has successful examples of these types of efforts such as the Astrobiology Institute, the SEEC program at the Goddard Space Flight Center, and the current five-agency partnership on long-lived tissue chips. Inefficiencies in the current process for making Inter-Agency Agreements have introduced further barriers to meeting this requirement.	NASA will seek efficiencies in establishing Inter-Agency Agreements through pre-negotiated, partner-specific General Terms and Conditions to foster partnerships across agencies, disciplines, institutions, and sectors. An initial pilot of this approach, focused on Inter-Agency Agreements between NASA and Los Alamos National Lab is underway
Agencies should promote team science by encouraging clear protocols for collaboration, such as shared digital workspaces, interoperable software, and the use of tools for effective communication and data integration.	NASA has supported this through the Open Science 101 curriculum, and by supporting open-source tools, and interdisciplinary platforms. The Scientific Artificial Intelligence, Data, and Analytics portfolio does aim to provide shared digital workplaces through coordinated high performance and cloud computing	NASA will continue to promote team science via programs explicitly focusing on consortium studies. NASA will review the language of solicitations to ensure they encourage clear protocols for collaboration.

Requirement	Current State	Planned/Future Action
		NASA will also identify collaboration science tools currently being used by the community and will determine if NASA policies create barriers for their use and consider policy modifications to remove any barriers found.

Skepticism of Findings and Assumptions

Gold Standard Science requires that researchers remain critical and open-minded in their evaluation of research findings, methodologies, and underlying assumptions to ensure their validity, robustness, and reliability.

The OSTP memorandum on implementing EO 14303 contains four requirements related to maintaining a skeptical approach to findings and assumptions:

Table 5: Requirements and actions related to the tenet of *skepticism of findings and assumptions*

Requirement	Current State	Planned/Future Action
Agencies shall foster a culture of constructive skepticism in scientific research through policies and programs that emphasize critical evaluation, transparency, and objectivity.	Critical evaluation, transparency, and objectivity are principles that underlie regular SMD and pre-publication peer review practices.	NASA will review relevant policies and re-emphasize the important role that critical evaluation, transparency, and objectivity play in the performance of research.
Agencies shall support innovative methods to promote constructive skepticism, such as support for adversarial collaborations where teams with differing hypotheses design studies to rigorously test results, minimizing confirmation bias.	NASA has funded *ad hoc* adversarial collaborations in the past in SMD, for example teams have been awarded Archive research Grants in Astrophysics to re-examine previous data sets, although there is not a continuously solicited program specifically dedicated to this activity	NASA will review the *ad hoc* adversarial collaborations that have been funded by SMD in the past to determine their impact and to discern best practices. NASA will utilize this information to inform future opportunities and share the information widely across Mission Directorates.

Requirement	Current State	Planned/Future Action
		NASA will also consider sponsoring special sessions at conferences or workshops to discuss markedly differing viewpoints on scientific topics.
They shall fund replication studies and statistical validation methods, such as sensitivity or uncertainty analyses, to critically assess the reliability of research results.	NASA recognizes that replication studies and statistical validation methods are critical to assess the reliability of research results. NASA's Human Research Program has historically had a robust effort in statistical validation studies, including sensitivity and uncertainty analysis, particularly for small sample sizes. NASA's Safety and Mission Assurance also performs this function using probabilistic risk analysis.	Update key solicitations to explicitly encourage the submission of proposals focused on replication and statistical validation studies. NASA peer reviewers will be instructed to not discount a proposed effort solely because it focuses on replication and statistical validation of methods.
Agencies shall also cultivate environments that incentivize critical inquiry by supporting fora where research premises and results are thoroughly evaluated, potential overinterpretations are challenged, and alternative explanations explored.	NASA's commitment to scientific and research integrity is reflected in many NASA and Government-wide policies, beginning with NPD 1000.0A, NASA Governance and Strategic Management Handbook, which stipulates that integrity is a NASA core value and that the Agency "is committed to maintaining an environment of trust, built upon honesty, ethical behavior, respect, and candor."	NASA will continue to cultivate an environment where everyone is encouraged to challenge the accepted. NASA's role in challenging accepted scientific theories is a natural outcome of our mission to explore the unknown in air and space, innovate for the benefit of humanity, and inspire the world through discovery. New instructions to peer review panels will be written to encourage the objective consideration of proposals exploring minority viewpoints on science issues.

Requirement	Current State	Planned/Future Action
	NASA does have programs to support topical workshops, Technical Interchange Meetings, symposia, and science conferences in general.	

Structured for Falsifiability of Hypotheses

Structuring science for falsifiability of hypotheses entails designing research studies and experiments to enable hypotheses to be carefully tested and potentially disproven through empirical evidence.

The OSTP memorandum on implementing EO 14303 contains four requirements related to structuring research for falsifiability of hypotheses:

Table 6: Requirements and actions related to the tenet of *structured for falsifiability of hypotheses.*

Requirement	Current State	Planned/Future Action
Agencies shall prioritize scientific research that is structured for falsifiability of hypotheses.	Organizing research around falsifiable hypotheses is a core tenet of most modern research and the peer review process pays close attention the capacity of a program of proposed research to "close"—to definitively falsify its hypotheses.	NASA will encourage the submission of hypothesis-driven research proposals (when appropriate to the discipline).
Research programs should be designed to allow for the rejection of hypotheses based on empirical evidence, prioritizing studies that advance knowledge through thorough testing.	The peer review process pays close attention the capacity of a program of proposed research to "close" —to definitively falsify its hypotheses.	NASA will amend key solicitations to emphasize structuring research around falsifiability of hypotheses when appropriate.
Agencies should promote research proposals that articulate clear, testable hypotheses with explicitly defined, measurable criteria for falsification, supported by solid experimental designs and statistical methods.	NASA does not have a specific policy or requirement for structuring research for falsifiability of hypothesis. However, the peer review process pays close attention the capacity of a program of proposed research to "close"	NASA will amend key solicitations to emphasize structuring research around falsifiability of hypotheses when appropriate.

Requirement	Current State	Planned/Future Action
	—to definitively falsify its hypotheses.	
Agencies should promote practices that enhance falsifiability, such as pre-registration of study protocols, use of appropriate control groups, and transparent reporting of null or negative results in publications and data repositories.	NASA has recently offered to members of the scientific community a series of free training modules in the concepts and practices of Open Science which included these practices.	NASA will consider adding material to the Open Science training modules.

Unbiased Peer Review

Subjecting science to unbiased peer review (sometimes referred to as merit review) refers to the impartial and independent evaluation, by qualified experts, of both research proposals and manuscripts that report results of federally supported research, to ensure validity, quality, and credibility prior to funding, publication, or dissemination.

The OSTP memorandum on implementing EO 14303 contains four requirements related to the used of unbiased peer review:

Table 7: Requirements and actions related to the tenet of *unbiased peer review:*

Requirement	Current State	Planned/Future Action
Agencies shall prioritize unbiased peer review to advance sound science in the review, selection, and awarding of Federal grants and contracts, including competitive and discretionary awards.	NASA has a thorough and thoroughly documented process to ensure high-quality, unbiased peer review. Most recently, SMD has made Dual-Anonymous Peer Review its default review method to further reduce any bias in evaluating applications.	No further action identified.
Research proposals should undergo independent, impartial peer review, guided by clear, transparent evaluation criteria and standardized, streamlined processes to ensure objectivity and consistency.	NASA has a thorough and thoroughly documented process to ensure high-quality, unbiased peer review.	NASA will consider developing a more complete evaluation rubric with greater detail than that currently published in solicitations.

Requirement	Current State	Planned/Future Action
	Evaluation criteria are standardized and published in calls for proposals. Certain requirements (e.g., Fieldwork Plans in Planetary Science) have published review rubrics for researchers.	
Agencies should ensure appropriate reviewer selection, prioritizing expertise, independence, and viewpoint diversity, and adopt double-blind review where appropriate, with clear disclosure of potential conflicts of interest. The review, selection, and awarding of Federal grants and contracts must be consistent with relevant provisions of the Federal Acquisition Regulations or 2 CFR Part 200 (Uniform Guidance), its supplements, and other relevant regulations.	NASA currently follows these practices. The characteristics of chosen reviewers are outlined in a required Selection Requirements Package which is reviewed by various Selecting Officials. SMD has made Dual-Anonymous Peer Review the default peer review process used for research solicitations and Space Technology Mission Directorate (STMD) has also begun adopting the approach where appropriate. The NASA Office of Procurement's Grants Policy and Compliance group reviews all solicitations for compliance with the FAR and the Uniform Guidance. NASA has developed the Science Management System (SMS) to automate and aid in the creation of review panels.	NASA will expand the adoption of Dual-Anonymous Peer Review agency-wide to pertinent solicitations where appropriate. Identify opportunities to add automation to review processes to ease the recruitment of qualified and unconflicted reviewers, including the expansion of the Science Management System (SMS).
Awards must be granted based on merit, without bias in the selection of awardees, in accordance with the Constitution, the Civil Rights Act of 1964, the Americans with Disabilities Act of 1990, and other relevant laws.	NASA selection processes are currently based on the merit of the applications. Information regarding the applicant's sex, race, ethnicity, *etc.* are never part of selection decisions.	No further action identified.

Accepting Negative Results as Positive Outcomes

Accepting negative results as positive outcomes in science refers to recognizing and valuing—as meaningful contributions to knowledge generation—null or unexpected findings that fail to support a hypothesis.

The OSTP memorandum on implementing EO 14303 contains two requirements related to the acceptance of negative results as positive outcomes:

Table 8: Requirements and actions related to the tenet of *accepting negative results as positive outcomes:*

Requirement	Current State	Planned/Future Action
Agencies shall recognize negative or null results as valuable contributions to scientific knowledge, fostering integrity and innovation. This recognition includes expectations that funded research projects transparently report all outcomes, including null or negative results, in publications and publicly accessible data repositories, accompanied by clear, detailed documentation of methods, analyses, and limitations.	NASA makes publicly available the scientific and technical information, peer-reviewed publications, and unclassified, digital, scientific and technical, development data sets arising from NASA-funded research, development, and technology programs, as outlined in NPR 2200.2, Requirements for Documentation, Approval, and Dissemination of NASA Scientific and Technical Information, and NPD 2230.1, Research Data and Publication Access. NASA makes publications and technical information publicly available through the STI homepage.	NASA will continue to facilitate the free flow of scientific and technological information among scientists and engineers, between NASA staff and the scientific and technical community, and between NASA employees and the public, as consistent with the National Aeronautics and Space Act as amended, which stipulates that NASA shall "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof", including the inclusion of negative or null results..
Agencies should promote standards that encourage the submission and dissemination of negative findings, such as establishing dedicated journal sections or specialized repositories for null results, integrating these outcomes into broader research narratives.	NASA makes publicly available the scientific and technical information, peer-reviewed publications, and unclassified, digital, scientific and technical, development data sets arising from NASA-funded research, development, and technology programs, as outlined in NPR 2200.2, Requirements for Documentation, Approval, and Dissemination of NASA Scientific and Technical	NASA will continue to facilitate the free flow of scientific and technological information among scientists and engineers, between NASA staff and the scientific and technical community, and between NASA employees and the public, as consistent with the National Aeronautics and Space Act as amended, which stipulates that NASA shall "provide for the widest practicable and appropriate

Requirement	Current State	Planned/Future Action
	Information, and NPD 2230.1, Research Data and Publication Access. NASA makes publications and technical information publicly available through the STI homepage. All mission data —and soon all research data —is made publicly available immediately, without a proprietary period. Naturally, these data will fail to falsify some hypotheses.	dissemination of information concerning its activities and the results thereof", including the inclusion of negative or null results.

Avoidance of Conflicts of Interest

Conducting science without conflicts of interest refers to ensuring that research is designed, executed, reviewed, and reported free from financial, personal, or institutional influences that could bias outcomes or undermine objectivity.

The OSTP memorandum on implementing EO 14303 contains three requirements related to the avoidance of conflicts of interest:

Table 9: Requirements and actions related to the tenet of *avoidance of conflicts of interest:*

Requirement	Current State	Planned/Future Action
Agencies shall prioritize conducting and managing scientific research free from conflicts of interest to advance unbiased science.	NASA has detailed and well-documented and applied policies on avoiding conflicts of interest. Civil servants are trained annually on their responsibilities regarding their own conflicts.	No further action necessary.
Agencies shall require disclosure of all relevant conflicts of interest by researchers, reviewers, and agency officials involved in the funding or performance of Federal research. These efforts include requiring comprehensive,	NASA mandates the disclosure of conflicts of interest for reviewers of proposals and Civil Servants and Intergovernmental Personnel Act (IPA) individuals. Civil Servant and IPA disclosures are reviewed by the Office of the General Counsel and clear recusal	NASA will continue to require the disclosure of conflicts of interest and potential biases by researchers, reviewers, and agency officials involved in the funding or performance of Federal research.

Requirement	Current State	Planned/Future Action
standardized disclosure of all financial, personal, or institutional interests in research proposals, publications, peer and merit reviews, and data repositories, with clear and standardized protocols to identify, mitigate, and manage potential biases.	guidance is provided to Civil Servants and IPAs. Scientists participating in NASA peer reviews of research proposals and conducting NASA research, whether NASA civil servants or members of the external scientific community, must follow documented standards for conflicts of interest to eliminate or mitigate conflict and perception of conflict in peer review processes, as outlined in SPD-01, Handling Conflicts-of-Interest for Peer Reviews; HRP-47053, Science Management Plan; and the Grants and Cooperative Agreements Manual.	
Agencies should mandate the use of independent oversight approaches and enforce strict conflict-of-interest policies.	While NASA has, and enforces, strict conflict of interest policies on its employees, contractors, and IPAs, it does not utilize independent oversight.	NASA will consider what "independent oversight approaches" means in this context and, if appropriate, promulgate new policies to realize this approach.

Policy and Procedure Updates

To accomplish the changes described above, and pursuant to EO 14303's direction to replace policies and procedures approved between January 20, 2020, and January 20, 2025, several NPDs and NPRs need to be modified. Drafts of updated NPRs and NPDs have been prepared and will be approved through the processes described in NPR 1400.11, NASA Directives Procedural Requirements. The following updates have been drafted:

1. NPD 1920.1, Scientific and Research Integrity, was updated to:
    a. Remove material referencing or derived from EOs and other memoranda issued between January 20, 2020, and January 20, 2025;
    b. Align document with current EOs and memoranda as of August 5, 2025;
    c. Add requirements for discussions of uncertainties and possible sources of error in research communications; and,
    d. Reflect the elimination of the NASA Office of the Chief Scientist and the requirement of EO 14303 that the Agency Research Integrity Officer (Agency

RIO) be a senior appointee selected by the Administrator. Created role of Senior Technical Advisor on Research Integrity and assigned this role to the SMD Associate Administrator (AA).

2. NASA Advisory Implementing Instruction 1920.1, Research Integrity Handbook, was updated to:
    a. Remove material referencing or derived from EOs and other memoranda issued between January 20, 2020, and January 20, 2025;
    b. Align document with current EOs and memoranda as of August 5, 2025;
    c. Reflect the elimination of the NASA Office of the Chief Scientist and the requirement of EO 14303 that the Agency Research Integrity Officer (Agency RIO) be a senior appointee selected by the Administrator. Created role of Senior Technical Advisor on Research Integrity and assigned this role to the SMD AA; and,
    d. Clarify that allegations of sexual harassment or bullying should be reported as violations of *both* the research integrity and anti-harassment policies.
3. NPD 1090.2, Citizen Science, was updated to:
    a. Change responsible office to SMD;
    b. Explicitly require compliance of Citizen Science projects with the requirements of EO14303; and
    c. Add an emphasis on replicable and reproducible hypothesis-driven research which includes assessments of possible sources of error and uncertainty.
4. SPD #33, Citizen Science, was updated to:
    a. Align responsibilities with current structure of SMD; and,
    b. Explicitly require compliance of Citizen Science projects with the requirements of EO14303.
5. NPD 2230.1, Research Data and Publication Access, was updated to:
    a. Change responsible office to SMD;
    b. Delete references to the Office of the Chief Scientist; and,
    c. Change the name of the primary document required from “Data Management Plan” to SMD’s “Open Science and Data Management Plan”.

NPR 7100.5, Curation of Astromaterials, also needs to be updated to reflect the dissolution of the Office of the Chief Scientist as it contains explicit reference to the responsibilities of the NASA Chief Scientist —a position which no longer exists. The contents of this NPR do not directly touch on issues of research integrity, so it has not been updated at this time.

There are other fundamental policies and procedures which need modification but are owned by other entities outside of SMD:

1. NPR 2200.2E, Management of NASA Scientific and Technical Information, needs to be checked for alignment with EO 14303 and other current EOs. OCIO is the Responsible Authority for this NPR. A request has been made to OCIO.
2. NPD 1000.3F, The NASA Organization, needs to be updated to reflect that:
    a. SMD will lead policy and external interfaces for matters of scientific research integrity (RI) and research security (RS) on behalf of all Mission Directorates and other grant-making programs or related activities.

b. The SMD AA will serve as the Administrator's science representative to the international community, as appropriate. The SMD AA will also serve as the Senior Technical Advisor on RI to the senior appointee designated by the NASA Administrator to administer the Agency's internal research integrity processes (the Agency Research Integrity Officer).

This NPD 1000.3F is owned by the Associate Administrator of the Agency and cannot be updated without the involvement of the Associate Administrator's Office.

3. NPD 2230.1, Research Data and Publication Access, needs to be updated to align with EO 14303 and, if necessary, the future structure of the Agency. The operative version of this policy does not have a "Responsible Authority" assigned, though NASA anticipates assigning this responsibility to SMD.

Metrics and Evaluation Mechanisms

When managing a process or procedure change, measuring relevant outcomes is an important part of knowing how effective the changes are in driving the change desired. SMD has a standard practice of evaluating research policy and process changes after three years of activity. Research awards are three-years in duration, on average so evaluating changes after one set of awards has been completed, and while two sets of awards are in execution, has proven to be an appropriate timeframe. Based on the actions outlined above, and subject to the constraints of funding, workforce, and the assignment of responsibility for measuring and reporting these metrics, NASA will use the following measures to gauge the effectiveness of its implementation of Gold Standard Science:

Action	Gold Standard Science Tenet	Measure
Completion of research data repositories and tools to manipulate those data	Reproducibility	Fraction of awards placing data into NASA research data repositories or other appropriate public data repositories. Number of users of new NASA tools
Amend solicitations to encourage proposals to reproduce or replicate previously published results.	Reproducibility, Skepticism of Findings and Assumptions	Fraction of submitted proposals containing reproduction or replication tasks. Fraction of selected proposals containing reproduction or replication tasks.
Require NASA-funded research publications be published as Open Access	Transparency	Fraction of peer-reviewed, published research papers

Action	Gold Standard Science Tenet	Measure
		citing NASA funding published as Open Access.
Require proposals to include a section on potential errors and uncertainties.	Error and Uncertainty	Fraction of submitted proposals containing discussions of quantitative estimates of potential errors and uncertainties. Fraction of selected proposals containing discussions of quantitative estimates of potential errors and uncertainties.
Encourage publications citing NASA funding to report quantitative measures of uncertainties.	Error and Uncertainty	Fraction of peer-reviewed, published research papers citing NASA funding that contain quantitative estimates of uncertainties.
Encourage the submission of proposals that support constructive skepticism	Skepticism of Findings and Assumptions	Fraction of submitted proposals containing tasks supportive of constructive skepticism. Fraction of selected proposals containing tasks supportive of constructive skepticism.
Encourage submission of proposals focused on creating forums for the critical scrutiny of research premises and results	Skepticism of Findings and Assumptions	Fraction of submitted proposals containing tasks that create forums for critical scrutiny of premises and results. Fraction of selected proposals containing tasks that create forums for critical scrutiny of premises and results.
Encourage submission of proposals exploring hypotheses considered to be the “minority view.”	Skepticism of Findings and Assumptions	Fraction of submitted proposals containing tasks exploring hypotheses considered to be the minority view.

Action	Gold Standard Science Tenet	Measure
		Fraction of selected proposals containing tasks exploring hypotheses considered to be the minority view.
Encourage proposals, when appropriate, that are structured around falsification of hypotheses.	Structured for Falsifiability of Hypotheses	Fraction of submitted proposals structured around the falsification of hypotheses. Fraction of selected proposals structured around the falsification of hypotheses.

Plans and Resources for Training

NASA currently offers two relevant training resources, one for NASA Civil Servants and one for any member of the community. For NASA Civil Servants, NASA offers course AG-RCR-21, "Responsible Conduct of Research" through the SATERN system. This course is designed for NASA researchers to review the core elements of the responsible conduct of research, including current legal definitions, NASA and Federal policies, and best practices. The course covers research misconduct, authorship and publication, key responsibilities of the NASA workforce, data management and record retention, the avoidance of bias in conducting research and peer review, the avoidance of conflicts of interest, and when and how to report potential violations of research integrity.

Once the updates to NPD 1920.1, Scientific and Research Integrity, and to NAII 1920.1, Research Integrity Handbook, have been approved through the NASA standard processes outlined in NPR 1400.11, NASA Directives Procedural Requirements, the material in these trainings will be updated to reflect any changes in Agency structure and to align with the updated NPD 1920.1 and NAII 1920.1.

For all members of the community, aspects of research integrity are a part of the five-module, free training "Open Science 101." This training may take place in-person at major science conferences or anytime through a self-paced online delivery channel. These modules provide researchers, students, and the general public with a solid foundation on the principles of open science; how to plan, conduct, and participate in open science research projects; legal and ethical considerations when planning open science projects; and open science best practices.

Open Science 101 modules have been updated to remove references to EOs from 2020-2024. NASA will plan future updates to Open Science 101 with content from EO 14303 as appropriate.

In addition to updating and improving NASA's existing training tools, several new training tools will need to be developed, and new funding identified for that development. As NASA works to define new metadata standards to enhance interoperability, members of the scientific community both inside and outside of NASA will require training on them. Stand-alone training tools focusing specifically on applying quantitative measures of uncertainties to NASA-funded research and on standardized formats for reporting uncertainties may also be required. Training and protocols for collaborations will also be developed.

Leveraging of Technology

Underlying the widespread adoption of the tenets of Gold Standard Science is a change in the culture of science and science management. Although technology can ease the transition, new technology, alone, does not drive the adoption of new practices. The ease of the technology, the culture and communities using the technology, incentives or enforcement of the use of the technology, and the benefits of the new technology all factor into the adoption of new technologies.

The Earth and Space Science communities have often been at the forefront of using new technologies to advance scientific discovery. This includes NASA's decades long history of open scientific mission data repositories, which have resulted in significant return for the American taxpayer. Other examples have included the adoption of preprint services in astrophysics, communities of practices for analysis working groups in space biologic sciences, and development of open-source software that has driven the data science revolution. Scientists working for NASA have led the use of Artificial Intelligence (AI) throughout the scientific process.

The use of Large Language Models (LLMs) provides an opportunity to accelerate scientific discovery though with some existing challenges. AI can be used to improve the processes needed to implement Gold Standard Science and support the production of training material. However, the lack of transparency along with the probabilistic nature of LLMs can result in work that is unreliable and does not meet the expectations for reproducibility or scientific rigor.

While many of the services and technology exist to support the goals of Gold Standard Science, the ease of adoption, funding models, and lack of training limit their use. The accessibility of compute (cloud and high performance) and data necessary for groundbreaking science is complicated by access issues and funding models. NASA is actively working to provide better access through the Scientific Artificial Intelligence, Data & Analytics (SAIDA) portfolio. Many of these open science services and open-source software projects, along with their integration of the latest technologies, are being advanced as funding permits.

Challenges

There are several challenges to implement all aspects of EO 14303. Specifically,

1. Development of new or expanded training programs and resources, as well as expanding NASA's open science platforms and repositories and their integration into existing workflows are not supported in the President's FY2026 Budget Request and the

Technical Supplement to the Budget Request. Some efficiencies may be gained by partnering with other science agencies such as the National Science Foundation (NSF).

2. Practices like open access publications, preprints, pre-registration, metadata preparation, and reproducibility studies may require additional incentives or funding to be adopted by the scientific community due to existing structural barriers or a lack of incentives.
3. Civil Servant scientists lack access to the latest AI models due to security requirements, bureaucracy, and procurement limitations.
4. The limited size of current research awards inhibits the funding of many interdisciplinary teams. Large teams require budgets often considerably larger than the planned average award size.