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**Long-term sustainability of outer space activities**

# United States of America's reporting on national implementation of the Guidelines for the Long-term Sustainability of Outer Space Activities

The present conference room paper was prepared by the Secretariat on the basis of information received from the United States of America. The information was reproduced in the form it was received. A shorter related text is available in all the official languages of the United Nations in document A/AC.105/C.1/L.409/Add.1.

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**United States of America's Reporting on National Implementation of the Guidelines for the Long-Term Sustainability of Outer Space Activities**

## A. Policy and regulatory framework for space activities

### Guideline A.1: Adopt, revise and amend, as necessary, national regulatory frameworks for outer space activities

**Summary of Activity**
The United States Government reviews and updates, as necessary, its space policies and regulations, taking into account U.S. obligations under international law. There is a concerted effort across the government to streamline regulations and to promote safety, responsibility, and effectiveness within the full range of government and non-government space activities while enhancing the long-term sustainability of outer space activities.

**Noted Efforts of Specific Government Agencies**

**Department of Transportation: Federal Aviation Administration (FAA):** Under US law (51 USC Chapter 509, formerly the Commercial Space Launch Act of 1984, as amended), the US Department of Transportation's Federal Aviation Administration facilitates the strengthening and expansion of US commercial space transportation infrastructure, as well as regulates launch, reentry, and the operation of launch and reentry sites.

An extensive update to FAA launch and reentry regulations (14 CFR Part 450) went into effect in March 2021. The revision created a single licensing regime for all types of commercial space flight launch and reentry operations and replaced prescriptive requirements with performance-based criteria.

The FAA, through its licensing process, which provides for consultation with the Department of State and other departments and agencies, helps to ensure that regulated activities are carried out in conformity with our international obligations and protects the public health and safety, safety of property, and national security and foreign policy interests of the United States.

**Federal Communications Commission (FCC):**
*Orbital Debris in the New Space Age, Report and Order and Further Notice of Proposed Rulemaking, and Second Report and Order*

- In 2020, the FCC adopted a comprehensive update to its rules on orbital debris mitigation for commercial, amateur, and experimental satellites. The changes adopted were designed to reflect improvements in debris mitigation practices and evaluation methods used within the FCC's rules, incorporated practices developed in individual cases since the rules were first adopted in 2004, and addressed market and technology changes, particularly the increasing use of small satellites and the deployment of larger constellations of satellites.
- In the *Further Notice of Proposed Rulemaking (FNPRM)* portion of the 2020 document, the FCC also sought additional comment on possible further changes to its rules, including whether to adopt a specific probability metric for evaluating the risk of accidental explosions, whether to adopt a requirement that spacecraft be maneuverable

above a certain altitude, what criteria to apply for evaluating collision risks associated with nongeostationary satellite systems that involve a large number of satellites, and whether to adopt certain economic and legal incentives for operators to follow best practices for orbital debris mitigation.

- At its September 29, 2022 meeting, the FCC adopted a *Second Report and Order* that adds to the FCC's rules a requirement that all commercial, amateur and experimental satellites ending their mission in, or passing through, the LEO region and planning disposal through uncontrolled atmospheric re-entry must complete disposal as soon as practicable, and no later than five years after the end of the mission.

*Allocation of Spectrum for Non-Federal Space Launch Operations, Report and Order and Further Notice of Proposed Rulemaking*

- In 2021, the FCC adopted a *Report and Order (R&O) and FNPRM* as a first step in enabling the FCC to issue licenses for spectrum use during commercial space launches. The R&O added a secondary non-Federal Space Operation allocation to the 2200-2290 MHz band through use of an Allocation Table footnote. The footnote limits use of this allocation to pre-launch testing and space launch operations in four five-megahertz sub-bands and requires coordination with the National Telecommunications and Information Administration (NTIA) prior to each launch.
- In the *FNPRM*, the FCC sought comment on the potential allocation of spectrum for the commercial space launch industry, including:
    - adopting primary non-Federal allocations in the 420-430 MHz, 2025-2110 MHz, and 5650-5925 MHz bands for use during commercial space launches;
    - adding a non-Federal Mobile allocation to the 2200-2290 MHz band, removing the limitation to four sub-bands for non-Federal operations, and upgrading the non-Federal Space Operation allocation from secondary to primary; and
    - removing a restriction in an Allocation Table footnote prohibiting Federal satellites in the 399.9-400.05 MHz band, which has Federal and non-Federal Mobile Satellite Service allocations
- The *FNPRM* also proposed service rules for commercial space launch operations in these frequency bands, including licensing and technical rules, as well as coordination procedures with other services that share these bands. The *FNPRM* also sought comment on payload operations that either utilize or could potentially utilize those frequencies, such as vehicles used for transport to the International Space Station. It also sought comment on cases in which an object that might otherwise function only as a launch vehicle upper stage would continue operations after the initial launch phase in order to support operations of customer instruments or radios. The FCC received comments in the record that addressed a broader range of activities, including situations in which a spacecraft is used either to deploy or move other spacecraft that are already in orbit. Several commenters also advocated for a new licensing framework for on-orbit servicing separate from the FCC's existing satellite licensing regimes.
- The *FNPRM* also sought to refresh the record from a 2013 *Notice of Proposed Rulemaking* on potential ways to facilitate Federal use of commercial satellite services in what are currently non-Federal satellite bands and enable more robust federal use of the 399.9-400.05 MHz band.

*Facilitating Capabilities for In-space Servicing Assembly, and Manufacturing, Notice of Inquiry*

- In 2022, the FCC sought comment on the status of in-space servicing, assembly, and manufacturing (ISAM) technologies including where the industry is today, how the Commission can best support its sustainable development, and what tangible economic and societal benefits may result from the development of these capabilities. The Notice of Inquiry sought to develop a record on where these capabilities are today and the steps needed to promote their development.

**Guideline A.2: Consider a number of elements when developing, revising or amending, as necessary, national regulatory frameworks for outer space activities**

**Summary of Activity**
The United States reviews existing regulations to identify opportunities for modernization and to streamline regulatory processes to encourage space exploration and commercial investment. Previous Space Policy Directives, the 2021 United States Space Priorities Framework, and related policies provide guidance to U.S. departments and agencies on modernizing the regulatory framework of space activities while considering, as appropriate, the list of elements contained in LTS Guideline A.2.2(a)-(i).

**Noted Efforts of Specific Government Agencies**

**Department of Defense (DoD):** DoD provides input regarding national security equities when reviewing and commenting on proposed legislation and regulations.

**Department of Transportation: Federal Aviation Administration (FAA):** The FAA is directed to ensure compliance with international obligations of the United States and to protect the public health and safety, safety of property, and national security and foreign policy interests of the United States.

FAA regulations include environmental reviews for launch, reentry and launch and reentry sites. For example, for launch or reentry sites (spaceports), the FAA is responsible for complying with the procedures and policies of the National Environmental Policy Act (NEPA) and other applicable environmental laws, regulations, and Executive Orders prior to issuing a license under 14 CFR Part 420.

Additionally, when developing new FAA regulations, a regulatory impact analysis is required. FAA rulemaking includes public comment period. FAA encourages and receives input from affected entities in the form of advisory committees, specifically the Commercial Space Transportation Advisory Committee (COMSTAC) and Aerospace Rulemaking Committees (SpARCs).

**Federal Communication Commission (FCC):**
FCC rulemaking proceedings generally weigh the costs, benefits, disadvantages, and risks of a range of approaches and solutions and encourage advisory input from national entities via public comment. A few proceedings warrant particular mention and are detailed below.

*Orbital Debris in the New Space Age, Report and Order and, Further Notice of Proposed Rulemaking*

- The rules adopted in the orbital debris *R&O* and discussed in the *FNPRM* were an effort to implement space debris mitigation measures informed by both domestic and international debris mitigation measures, including the NASA Technical Standard (NASA Standard) and Orbital Debris Mitigation Standard Practices (ODMSP), as well as guidance documents from the Inter-Agency Space Debris Coordination Committee (IADC) and UN COPUOS.

- Both the *R&O* and *FNPRM* addressed human casualty risk. The FCC adopted a rule specifying that the human casualty risk assessment must include all objects that would have an impacting kinetic energy of 15 joules and that for those satellites disposed of by reentry into Earth's atmosphere, the risk of human casualty from surviving components with impact kinetic energies greater than 15 joules should be less than 0.0001 (1 in 10,000), consistent with the NASA Standard and ODMSP. The *FNPRM* sought comment on adopting additional rule provisions concerning strategies to lower casualty risk and consideration of human casualty risk on a system-wide basis.
- The *FNPRM* sought to expand the record on including an indemnification requirement into the FCC's rules, noting U.S. obligations under the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty) and the Convention on International Liability for Damage Caused by a Space Object (Liability Convention).

*Streamlining Licensing Procedures for Small Satellites, Report and Order*

- In 2019, the FCC adopted a requirement that applicants under the 47 CFR Part 25 streamlined process must certify that their satellite(s) will be disposed of through atmospheric re-entry following conclusion of the mission and certify that they have conducted a casualty risk assessment using the NASA Debris Assessment Software or another higher fidelity model, and that the assessment resulted in a human casualty risk of zero.

*Allocation of Spectrum for Non-Federal Space Launch Operations, Report and Order and Further Notice of Proposed Rulemaking*

- In the *FNPRM*, the FCC weighed its options and potential risks discussed in the proceeding by seeking further comment on various licensing frameworks to authorize a variety of telemetry, tracking, and command operations between launch vehicles and ground stations during the initial launch and reentry phases of space launch operations and whether there are additional measures that should be considered in order to facilitate radio-frequency licensing of certain other types of space launch operations that may be currently addressed through experimental licensing.

*Facilitating Capabilities for In-space Servicing Assembly, and Manufacturing, Notice of Inquiry*

- This *Notice of Inquiry* was established to develop an up-to-date record on current ISAM activities that may involve FCC licensing and rules. It sought information on the steps the FCC might take to facilitate progress and reduce barriers for ISAM missions, including clarifications, updates, or modifications of licensing processes. It also sought comment on possible spectrum needs for ISAM missions, including potentially relevant international frequency allocations, potential modifications to or adaptations of FCC rules on orbital debris mitigation that may be appropriate to address and facilitate ISAM missions, and any unique regulatory issues presented by ISAM activities beyond Earth's orbit and possible means to promote growth, innovation, and development in ISAM operations.

- The *Notice of Inquiry* considered how some ISAM mission may also raise the possibility of interactions between operators under jurisdictions of different States

and sought comment on whether and how to take this into account in the FCC's licensing process and what international coordination is needed for U.S.-licensed servicing of non-U.S. satellites, and vice versa. The FCC further asked how it could ensure that operators and/or governments share common understandings of the scope of certain activities involving non-U.S. spacecraft and whether there are circumstances in which the FCC should consult with the State Department to help ensure mutual understanding between governments and whether such a process should be formalized.

**Noted Inputs from the U.S. Private Sector**

*Note: The views expressed in this section do not necessarily reflect the views of the United States government and were gathered from inputs received through a public solicitation process. Submissions were received from representatives of non-governmental organizations, commercial actors, and academia and do not necessarily reflect a consensus view among them.*

Non-Governmental Organizations (NGOs):

- Some NGO representatives have provided their views on perceived oversights in space strategy, policy, and other related areas.

- Some NGO representatives have encouraged legislative action to authorize a civil space traffic management function in the United States government and to ensure that such a function is sufficiently resourced and structured.

Commercial Industry

- Some commercial industry representatives have engaged in appropriate government processes to provide their views on potential changes to U.S. regulatory framework to facilitate a safer outer space operating environment, including ways to minimize collision risk for LEO constellations.

- Some commercial industry representatives have also engaged in the rulemaking process through public comment, specifically regarding the mitigation of orbital debris and to promote harmonized and flexible regulatory frameworks.

**Guideline A.3: Supervise national space activities**

**Summary of Activity**
The United States performs regulatory oversight of national space activities to ensure their conformity with our obligations under the Outer Space Treaty and other applicable international law. Departments and agencies review U.S. regulatory and policy frameworks for opportunities to improve the oversight of national space activities, as well as to enhance transparency and provide guidance that not only facilitates growth within the commercial space sector but does so in a manner which promotes the long-term sustainability of outer space activities.

**Noted Efforts of Specific Government Agencies**

**Department of Transportation: Federal Aviation Administration (FAA):** Under 51 US Code Chapter 509 (formerly the Commercial Space Launch Act of 1984, as amended), the FAA licenses US commercial space launch, reentry, and the operation of non-federal launch and reentry sites. The FAA also consults with other U.S. agencies as part of its licensing process. Regulations for launch and reentry can be found in 14 CFR Part 450. Regulations addressing launch and re-entry sites and operations can be found in 14 CFR Parts 420, 431, 433, and 435.

See: https://www.faa.gov/space/legislation_regulation_guidance for additional information on US law, regulations, and national policies.

**Federal Communications Commission (FCC):** The FCC reviews satellite operator plans for mitigation of orbital debris as part of the public interest considerations within the FCC's overall satellite licensing process, as consistent with its authority to license radio frequency usage by satellites. FCC review covers U.S. satellites, other than those belonging to and operated by the Federal government. This includes amateur and experimental spacecraft, as well as commercial spacecraft. The FCC also examines the debris mitigation plans for non-U.S. satellite systems that seek to communicate with U.S. earth stations. Following recent changes to the National Oceanic and Atmospheric Administration (NOAA) remote sensing regulations, FCC review of a remote sensing satellites debris mitigation plan is considered sufficient for NOAA licensing purposes. The FCC also participates in the FAA's payload review process.

**Noted Inputs from the U.S. Private Sector**
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Commercial Industry:

- Some commercial industry representatives have encouraged the development and implementation of practical, clear, and modernized oversight of government, private, and academic activities across the space enterprise.

- Some commercial industry representatives have advocated for the modernization and enhanced clarification of the regulatory framework for government authorization and

supervision of commercial in-space activities, including In-Space Servicing, Assembly, and Manufacturing (ISAM).

- An example of this advocacy is providing public comments to the FCC's ISAM Notice of Inquiry.

**Guideline A.4: Ensure the equitable, rational and efficient use of the radio frequency spectrum and the various orbital regions used by satellites**

**Summary of Activity**
Increased accessibility to space has made spectrum allocation and management a pressing and challenging issue. The United States has made this a national space priority by highlighting spectrum management in Presidential Space Policy Directives 2 and 3. Federal agencies are taking steps to ensure increased spectrum demand are rationally, efficiently, and economically resolved in conformity with the provisions of the Radio Regulations.

**Noted Efforts of Specific Government Agencies**

**Department of Commerce: National Oceanic and Atmospheric Administration (NOAA):**
NOAA's National Environmental Satellite Data & Information Service (NESDIS) ensures NOAA's space-based radio frequency operations are conducted in a manner that appropriately addresses any harmful interference. NOAA follows U.S. law and regulations to adhere to the International Telecommunication Union (ITU) Radio Regulations and filing processes which support the equitable, rational and efficient use of the radio frequency spectrum.

**Department of Defense (DoD):**
The DoD, through agency policy and processes conforming with United States laws and regulations and the International Telecommunication Union (ITU) Radio Regulations, participates in interagency working groups and committees to review spectrum coordination actions, technical operational interference analyses, and the spectrum deconfliction and orbital allocation process to support the equitable, rational and efficient use of the radio frequency spectrum.

**Department of Transportation: Federal Aviation Administration (FAA):** Regarding Guideline A.4., see response to Guideline D.1.

**Federal Communications Commission (FCC):** The FCC is responsible for managing and licensing the electromagnetic spectrum for satellites and satellite systems, Earth stations, and launch vehicles operated by commercial and non-commercial users subject to U.S. jurisdiction, including state, county, and local government users, in accordance with the ITU Radio Regulations and the ITU Radiocommunications Sector (ITU-R) Recommendations. In licensing the spectrum, the FCC promotes efficient and reliable access to the spectrum for a variety of innovative uses as well as promotes public safety and emergency response.

**National Aeronautics and Space Administration (NASA):** NASA, through agency policy and processes conforming with United States laws and regulations and the International Telecommunication Union (ITU) Radio Regulations, works to ensure that NASA operations involving the use of the electromagnetic spectrum adhere to the rules and procedures supporting the equitable, rational and efficient use of the radio frequency spectrum. By following technical and operational parameter constraints and through coordination with the international community through the ITU filing processes and the Space Frequency Coordination Group, NASA works to ensure that NASA's space-based radiofrequency operations are conducted in a manner that appropriately addresses any potential harmful interference.

**Noted Inputs from the U.S. Private Sector**

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Non-Governmental Organizations (NGO):

- Some NGO representatives have advocated for industry-led solutions to mitigate radio frequency interference on radio astronomy.

Commercial Industry:

- Some commercial industry representatives have created processes for more efficient spectrum use that provides reliable communication globally while reducing spectrum consumption.

**Guideline A.5: Enhance the practice of registering space objects**

**Summary of Activity**
The United States meets its registration obligations under the Outer Space Treaty and the Convention on the Registration of Objects Launched into Outer Space and takes into consideration the recommendations contained in General Assembly resolutions 1721 B (XVI) and 62/101, while continuing to develop and implement effective and comprehensive registration practices. As dictated by Space Policy Directive 3 (SPD-3), the United States has implemented procedures to improve the timeliness and quality of its registration practices. The Department of Defense, Federal Aviation Administration, and NASA furnish relevant information regarding U.S. space objects to the Department of State, which then submits registration information to the United Nations Office of Outer Space Affairs. Moreover, the United States is responsive to external inquiries seeking information about U.S. launched objects or for consultation regarding such objects.

**Noted Efforts of Specific Government Agencies**

**Department of Commerce: National Oceanic and Atmospheric Administration:** NOAA provides information on its civil space missions to NASA consistent with the interagency standard operating procedure (SOP).

**Department of Defense (DoD):** DoD coordinated upon the development of a U.S. interagency standard operating procedure (SOP) to increase the timeliness and quality of registration of U.S. space objects as directed by the implementation plan for SPD-3, the National Space Traffic Management (STM) Policy. The SOPimproved the U.S. response quantitatively and with regard to timeliness. The DoD also provides space situational awareness information to the Department of State to assist in fulfilling U.S. obligations under the Registration Convention.

**Department of State (DOS):** SPD-3 tasked the Department of State with "streamlining the interagency process to ensure accurate and timely registration submissions to the UN, in accordance with our international obligations under the Registration Convention." The DOS has implemented several Department-specific and interagency efforts to accomplish this task, which are highlighted below.

- Drafted an interagency standard operating procedure (SOP), in coordination with the Department of Defense, Federal Aviation Administration, Federal Communications Commission, National Aeronautics and Space Administration, and other federal agencies to clearly delineate roles, responsibilities, and timelines for gathering and sharing space object registration data, then compiling and delivering completed filings to the United Nations Office for Outer Space Affairs (UNOOSA) in a timely manner.
- Leads an interagency working group on improving space object registration filings. This group discusses potential improvements to the SOP, new challenges arising in the space object registration process, and provides a forum to discuss complex registration cases.
- Identify individuals who perform space object registration tasks in other governments and engage with them on their own national practices. This allows DOS to identify ways to improve the U.S. process and share our own lessons learned and related information with other governments. Additionally, this has become a crucial effort due to the rising

number of space objects that have multiple launching states. Clear communication between relevant parties is essential for determining an appropriate State of registry.
- Coordinate with the private sector on space object registration, particularly concerning other nations involved in the procurement, launch, licensing, and/or operations of a private sector space object.
- Communicate with the UN Office for Outer Space Affairs on how to improve U.S. filings in regard to formatting and other areas, particularly how to facilitate efficient translation and timely posting of the filings.

**Department of Transportation: Federal Aviation Administration (FAA):** FAA meets the guideline to report objects launched into space by requiring operators to provide a registration report to the FAA within thirty days of a launch. The FAA then compiles and submits a monthly report to the Department of State for licensed launches and payloads manifested on those launches. FAA regulations for registration are in 14 CFR Part 450.217 (Registration of space objects). FAA has expanded information in inputs provided to the Department of State that are in-line with the LTS Guidelines.

**Federal Communications Commission (FCC):** The FCC coordinates with the State Department to provide information relevant to space object registration.

**National Aeronautics and Space Administration (NASA):** NASA assists in the timeliness of registering objects launched into space by providing information in advance to the FAA and DOS related to upcoming U.S. civil launches and the International Space Station (ISS)-related deployables (including Cygnus deploys pre- or post- docked operations). NASA provides the FAA and DOS with a launch forecast for U.S. civil missions at the beginning of every month. Within 5 days of the launch of an ISS resupply mission, with ISS deployables onboard, NASA provides to the FAA and DoS planned ISS payload deploy information, which may include U.S payloads and/or spacecraft not owned/controlled by a U.S. entity.

**Noted Inputs from the U.S. Private Sector**

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Non-Governmental Organizations (NGO):

- Some NGO representatives have advocated for spacecraft owners, operators, and stakeholders to engage with governments on ascertaining the appropriate State of registration.

## B. Safety of Space Operations

### Guideline B.1: Provide updated contact information and share information on space objects and orbital events

**Summary of Activity**
The United States is emphasizing a whole-of-government approach to continue improving its space situational awareness (SSA) information sharing efforts, to include making readily available national contact information, information on on-orbit spacecraft operations, conjunction assessments, and the monitoring of objects and events in outer space. The USG recognizes that timely and actionable SSA data and space traffic coordination services are essential to space activities and will continue to provide USG-derived SSA data and basic space traffic coordination services free of direct user fees.

As part of ongoing improvements in enhancing data sharing – including exchanging relevant information on space objects and events in near-Earth space with different sources as well as effectively accumulating and providing access to information on objects and events in outer space – the 2021 United States Space Priorities Framework directed a transition of SSA sharing responsibilities to a U.S. civil agency. That process is underway for civil and non-governmental entities. These efforts should improve data sharing, transparency, and consistency in the understanding and use of such information, as well as facilitate effective responses to orbital collisions, orbital break-ups, and other events that might increase the probability of accidental collisions or may pose a risk to human lives, property and/or the environment, in the case of uncontrolled re-entry of space objects.

**Noted Efforts of Specific Government Agencies**

**Department of Commerce (DOC): National Oceanic and Atmospheric Administration:** NOAA NESDIS currently works through NASA for information on space objects and orbital events.

**Department of Defense (DoD):** On behalf of the United States, DoD's United States Space Command (USSPACECOM), through the U.S. Space Force's 18th and 19th Space Defense Squadrons, provides a free, publicly-available, internet-based space catalog which provides monitoring information of objects and events in outer space, and also provides occasional notifications of space activities of interest including actual or potential situations in near-Earth space that may affect the safety of outer space operations. USSPACECOM also routinely and actively solicits space operator information to enable emergency close approach notifications and offer advanced spaceflight safety services such as conjunction assessment. To facilitate the U. S. Government's enhanced incorporation of data, services, and SSA sharing with civil and non-governmental entities, DoD-signed a Memorandum of Agreement to transition civil and commercial SSA sharing responsibilities to the DOC.

**Department of Transportation: Federal Aviation Administration (FAA):** FAA regulations require that launch providers and operators of payloads launched on US-licensed vehicles provide the U.S. Government with sufficient information for implementation of our obligations

under the Convention on Registration of Objects Launched into Outer Space.

**Federal Communications Commission (FCC):** The FCC makes documentation and decisions in licensing actions publicly available through the International Bureau Filing System (IBFS) and the FCC website. Rulemaking documents, including public comments, are also publicly available on the FCC website through the Commission Documents (EDOCS) and Electronic Comment Filing System (ECFS) databases.

- *Orbital Debris in the New Space Age, Report and Order and, Further Notice of Proposed Rulemaking*
    - The FCC adopted a requirement that applicants must disclose the extent to which a satellite operator plans to share information regarding initial deployment, ephemeris, and/or planned maneuvers with the 18th Space Defense Squadron or successor entity, or other entities that engage in space situational awareness or space traffic management functions, and/or other operators. This also includes disclosure of risk thresholds for when an operator will deem it appropriate to conduct a collision avoidance maneuver. This disclosure provides an opportunity for the FCC to assess the extent to which the operator is actively engaging with space situational awareness facilities.

    - The FCC adopted a rule requiring applicants for Non-Geostationary Orbit (NGSO) satellites to certify that, upon receipt of a conjunction warning, the operator of the satellite will take all possible steps to assess and, if necessary, to mitigate collision risk, including, but not limited to: contacting the operator of any active spacecraft involved in such warning; sharing ephemeris data and other appropriate operational information directly with any such operator; and modifying spacecraft attitude and/or operations.

**National Aeronautics and Space Administration (NASA):** Operator-to-operator communication about close approaches is critical to prevent both operators from simultaneously maneuvering into each other and causing a collision. In order to ensure flight safety and prevent maneuver-on-maneuver collisions, NASA screens planned maneuvers before they are executed. This screening ensures that a representation of the planned trajectory is available to all other space operators. NASA also provides contact information for our spacecraft on Space-Track.org.

**Noted Inputs from the U.S. Private Sector**

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Non-Governmental Organizations (NGO):

- Some NGO representatives have advocated for and engaged in the development of a space traffic coordination framework.

- Some NGO representatives endorse data sharing relevant to orbital debris mitigation and collision avoidance.
- Some NGO representatives have developed a "crowd-sourcing" data lake model to bring disparate operator and USG SSA data together to create a comprehensive SSA and flight safety tool. This crowdsourcing includes sharing of contact information between spacecraft operators.

Commercial Industry:

- Some commercial industry representatives actively engage in sharing SSA data internationally and advocate for the development and implementation of U.S. government mechanisms to share SSA data more broadly.

- Some commercial industry representatives provide accurate, up-to-date contact information to governments, NGOs, and relevant international bodies to facilitate rapid and efficient communication concerning space operations.

- Some commercial industry representatives ensure transparency of operations and share ephemeris data while also engaging with governments, industry, NGOs, and the public.

- Some commercial industry representatives have created industry associations that develop industry-led standards and best practices for outer space activities, including for in-space servicing, assembly, and manufacturing. These associations may also engage in research publications, public comments on U.S. government regulatory proceedings, drafting common guiding principles for commercial services, recommended design practices, developing a shared lexicon, and presentations to international audiences.

- Some commercial industry representatives actively engage and share information with "orbital neighbors" on maneuvers and the orbital environment.

- Some commercial industry representatives engage with the international community and domestic regulators on recommending specific criteria for trackability, identification, and end-of-life procedures for space objects.

- Some commercial industry representatives provide both emergency and non-emergency contact information to operators and stakeholders.

- Some commercial industry representatives share predictive trajectories, satellite maneuverability status, and planned maneuvers with other operators.

- Some commercial industry representatives research and apply artificial intelligence, shared vocabularies, consensus algorithms, and related methods to improve information sharing between space operators.

**Guideline B.2: Improve accuracy of orbital data on space objects and enhance the practice and utility of sharing orbital information on space objects**

**Summary of Activity:**
Space sustainability, safety of flight operations, and the development and implementation of open, transparent, and credible international standards, policies, and practices are priorities for the United States, as illustrated in the 2021 Space Priorities Framework. Department and agencies across the U.S. government are working to improve our space catalogue by improving the accuracy of orbital data for spaceflight safety and leading in the development and implementation of open, transparent, and credible international standards, policies and practices, as well as working to launch a streamlined open data platform to enable collaboration and information exchange.

**Noted Efforts of Specific Government Agencies**

**Department of Commerce (DOC): National Oceanic and Atmospheric Administration (NOAA):** NOAA's space weather prediction center and space weather observations provide data and information to support improved accuracy of orbital data.

The DOC also leads the USG's participation in the development of international standards through the International Organization for Standardization (ISO), such as detailed in ISO/CD 26900, *Space data and information transfer systems – Orbit data messages*, which specifies three standard message formats for use in transferring spacecraft orbit information between space agencies and commercial or governmental spacecraft operators; and ISO/TR 16158, *Space systems – Avoiding collisions among orbiting objects*, detailing techniques for perceiving close approaches, which can help facilitate greater shared awareness and enable timely prediction and prevention of potential collisions; and ISO/CD 9490 *Space systems — Space Traffic Coordination*, which addresses protocols and operational Space Traffic Coordination (STC) requirements critical to ensure flight safety and mitigate collision risk, from pre-launch safety assessment through maneuver plans, on-orbit collision avoidance support services, and end of mission disposal.

**Department of Defense (DoD):** DoD, through the United States Space Command (USSPACECOM), publishes an up-to-date catalog of space objects online and provides spaceflight safety services. USSPACECOM consistently seeks to improve the accuracy, fidelity, and quantity of information shared. DoD also works with space operators worldwide to promote understanding of U.S.-generated information and promotes collaboration and information exchange in order to enable timely prediction and prevention of potential collisions. The U.S. Space Force regularly researches methodologies to improve data accuracy, and the U.S. Space Force is providing increased funding for sensor improvements to the U.S. space surveillance network.

**Department of State (DOS):** The Department of State furnishes U.S. space object registration information to the UN Office of Outer Space Affairs (UNOOSA) for translation and public release. This information includes orbital elements.

**Federal Communications Commission (FCC):** *Orbital Debris in the New Space Age, Report and Order and, Further Notice of Proposed Rulemaking*

- The FCC adopted a requirement that applicants must disclose the extent to which the satellite operator plans to share information regarding initial deployment, ephemeris, and/or planned maneuvers with the 18th Space Defense Squadron or successor entity, or other entities that engage in space situational awareness or space traffic management functions, and/or other operators. This also includes disclosure of risk thresholds for when an operator will deem it appropriate to conduct a collision avoidance maneuver. This disclosure provides an opportunity for the FCC to assess the extent to which the operator is actively engaging with space situational awareness facilities.

**National Aeronautics and Space Administration (NASA):** NASA Heliophysics Division Space Weather Program, through its space weather research-to-operations and operations-to-research solicitation, funds investigations to improve the understanding of the dynamic nature of the neutral density in Earth's thermosphere that impacts orbits of space objects in this region, in order to enable better accuracy of orbital forecasting data.

NASA is also researching methods for two spacecraft performing automated maneuvers to exchange planned maneuver data in near-real-time to increase safety of flight.

**Noted Inputs from the U.S. Private Sector**

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Non-Governmental Organizations (NGO):

- Some NGO representatives advocate for continued improvements to the United States Space Situational Awareness (SSA) infrastructure, including the transfer of many SSA responsibilities to the Department of Commerce.
- Some NGO representatives promote the practice of using sensitive onboard sensors to increase the accuracy and quality of orbital positioning data and are of the view that high accuracy data should be disseminated to parties in close proximity to the satellite operator.

Commercial Industry:

- Some commercial industry representatives share detailed ephemeris information with the U.S. government and non-governmental SSA associations to facilitate a safer space environment and allow for more informed decision-making.

- Some commercial industry representatives support the development and implementation of international standards to enable collaboration and information exchange through a multi-stakeholder effort involving industry and governments.

- Some commercial industry representatives work with government and private sector SSA operators to facilitate more accurate and timely tracking of objects.

- Some commercial industry representatives develop tools to allow satellite operators to visualize and understand the orbital environment in a manner that enhances space situational awareness and collision avoidance.

- Some commercial industry representatives have developed a legal and computational framework that promotes and facilitates the exchange of orbital information.

**Guideline B.3: Promote the collection, sharing and dissemination of space debris monitoring information**

**Summary of Activity**
The United States is committed to continuing its practices of developing and sharing derived data products and methodologies in support of research and international scientific cooperation on the evolution of orbital debris. A key example is NASA's release and regular updates of orbital debris modeling and mission compliance assessment tools based on debris monitoring data, which are used by hundreds of satellite operators, academia, and research groups around the world. The USG also currently promotes the sharing and dissemination of derived data products about the characterization and location of orbital debris through the DoD's space-track.org, which will be captured in the continued development of the Department of Commerce's Open Data Platform. Additional federal agencies are also reviewing their debris monitoring procedures, as detailed below.

**Noted Efforts of Specific Government Agencies**

**Department of Commerce (DOC):** NOAA provides orbital positioning information to the Joint Space Operations Center (JSpOC) and Space Data Association which is used for conjunction assessments and collision avoidance.

The Commerce Department is charged, pursuant to Space Policy Directive-3 (SPD-3) and the United States Space Priorities Framework, with developing a civilian open data platform to share space situational awareness (SSA) information and provide basic spaceflight safety services to civil and commercial space operators. This platform will leverage data and services provided from a variety of government, commercial, academic, and international sources. DOC is working closely with colleagues in the U.S. Government and in industry to conduct pilot programs and initiate acquisitions that will enable the new SSA system to reach initial operations in 2024. SPD-3 seeks to advance SSA and STM science and technology; provide federally-supported basic SSA data and STM services to the public; and improve SSA data interoperability to enable greater SSA data sharing.

**Department of Defense (DoD):** DoD promotes the sharing and dissemination of derived data products for monitoring and characterization of space debris.

**Federal Communications Commission (FCC):** *Orbital Debris in the New Space Age, Report and Order and Further Notice of Proposed Rulemaking*

- The FCC adopted a requirement stating that applicants must disclose the extent to which the satellite operator plans to share information regarding initial deployment, ephemeris, and/or planned maneuvers with the 18th Space Defense Squadron or successor entity, or other entities that engage in space situational awareness or space traffic management functions, and/or other operators. This also includes disclosure of risk thresholds for when an operator will deem it appropriate to conduct a collision avoidance maneuver. This disclosure provides an opportunity for the FCC to assess the extent to which the operator is actively engaging with space situational awareness facilities.

**National Aeronautics and Space Administration (NASA):** NASA continues to monitor and characterize debris too small to be tracked, but large enough to threaten human spaceflight and robotic missions. Efforts include collecting radar and optical debris measurement data, processing laboratory experiment data, and developing and maturing in-situ small debris measurement technologies. NASA shares the orbital debris monitoring data from these activities with the international community via a publicly available website (orbitaldebris.jsc.nasa.gov), technical publications (NASA Orbital Debris Quarterly News, etc.), and presentations at international events (e.g., the International Orbital Debris Conference, the European Conference on Space Debris, the International Astronautical Congress). NASA also releases and regularly updates orbital debris modeling and mission compliance assessment tools based on debris monitoring data. Such modeling tools are used by hundreds of satellite operators, academia, and research groups around the world.

## Noted Inputs from the U.S. Private Sector

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Non-Governmental Organizations (NGO):

- Some NGO representatives advocate for government support for the development of both government and commercial active debris remediation technologies.

- Some NGO representatives promote the creation of bilateral or multilateral dialogues with international partners on the rationale, costs, and benefits of ADR.

- Some NGO representatives advocate for the regular review and update of the Orbital Debris Mitigation Standard Practices (ODMSP).

- Some NGO representatives develop services in direct support of SSA, enabling functions such as near-real-time sensing and command capabilities for conjunction avoidance.

- Some NGO representatives encourage the use of SSA and STM entities to share safety of flight data

Commercial Industry:

- Some commercial industry representatives provide SSA data to the U.S. government for conjunction assessment services and have created internal processes for automatic uploads of predicted maneuvers.

- Some commercial industry representatives have developed tools to track space objects smaller than what conventional sensors are able to track, including debris, and identify the non-spherical characteristics of space objects.

**Guideline B.4: Perform conjunction assessment during all orbital phases of controlled flight**

**Summary of Activity**
The United States Government performs conjunction assessments for all spacecraft, regardless of capability to maneuver, and provides conjunction assessments to non-USG space operators. The USG has made publicly available two complementary handbooks detailing USG experience and practices regarding collision avoidance information to help clarify USG approaches and methods: (1) NASA's "Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook" and (2) DoD's "Spaceflight Safety Handbook for Satellite Operations." In addition, the FCC has adopted a regulatory rule requiring applicant NGSOs to certify that they will take all possible steps to assess and, if necessary, to mitigate collision risk, upon the receipt of a conjunction warning.

**<u>Noted Efforts of Specific Government Agencies</u>**

**Department of Commerce: National Oceanic and Atmospheric Administration (NOAA):** NOAA relies on NASA to perform conjunction assessments during all orbital phases of controlled flight for the full lifetime of NOAA missions.

**Department of Defense (DoD):** DoD performs around-the-clock conjunction assessment for all active satellites on-orbit. USSPACECOM provides basic conjunction analysis without cost for all operators and disseminates emergency and routine conjunction assessments to operators worldwide. USSPACECOM also provides advanced conjunction assessment prediction (screening) information to operators with Space Situational Awareness sharing agreements. DoD, through USSPACECOM and the United States Space Force's (USSF) 18th Space Defense Squadron, has also published a "Spaceflight Safety Handbook for Satellite Operations," which provides the U.S. knowledge and experience, e.g., processes, methodologies, screening criteria, notification thresholds related to the creation and interpretation of conjunction assessment information and collision avoidance. This handbook is updated periodically.

**Federal Communications Commission (FCC):** *Orbital Debris in the New Space Age, Report and Order and Further Notice of Proposed Rulemaking*

- The FCC adopted a rule requiring applicants for NGSO satellites to certify that, upon receipt of a conjunction warning, the operator of the satellite will take all possible steps to assess and, if necessary, to mitigate collision risk, including, but not limited to: contacting the operator of any active spacecraft involved in such warning; sharing ephemeris data and other appropriate operational information directly with any such operator; and modifying spacecraft attitude and/or operations.

**National Aeronautics and Space Administration (NASA):** NASA defines a 3-step process for conjunction assessment (CA):

1. Conjunction assessment prediction (screening) — The process of comparing trajectory data from the asset to be protected against the trajectories of the objects in the space object catalogue to predict when a close approach will occur within a chosen protective volume placed about the asset.

2. Conjunction risk assessment — The process of determining the likelihood of two space objects colliding and the expected consequence if they collide in terms of lost spacecraft and expected debris production. Risk is defined as the product of likelihood and consequence. Computing the risk determines which predicted events may represent dangerous situations and therefore require a mitigation action.

3. Conjunction mitigation — An action taken to remediate conjunction risk via a propulsive maneuver, an attitude adjustment (e.g., for differential drag or to minimize frontal area), or providing ephemeris data to the secondary owner/operator to enable them to perform an avoidance maneuver.

Space exploration presents challenges that impact not only the United States, but also the international community. NASA performs conjunction assessment for all NASA operational missions during their entire mission lifetime. NASA has a long history of experience with conjunction assessment and was involved in developing the process that many entities use today.

The NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook (https://nodis3.gsfc.nasa.gov/OCE_docs/OCE_50.pdf) provides descriptions of methods, rationale for choosing one method over another, and supporting analyses drawn from NASA's long history of performing CA. NASA continuously examines and actively updates its best practices for CA as the industry undergoes rapid evolution.

**Noted Inputs from the U.S. Private Sector**

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Commercial Industry:

- Some commercial industry representatives conduct active collision avoidance throughout the space objects mission and use available sources of space situational awareness data to assess conjunction warnings.

**Guideline B.5: Develop practical approaches for pre-launch conjunction assessment**
**Summary of Activity**
U.S. law requires FAA-licensed launch service providers to conduct pre-launch conjunction assessment for space objects to be launched, per 14 CFR § 450.169 – launch and reentry collision avoidance analysis requirements. The USG will continue to build on its existing mechanisms for providing pre-launch conjunction assessments. This is a multifaceted approach that involves multiple departments and agencies to ensure safe operations and address emerging challenges of pre-launch coordination.

**Noted Efforts of Specific Government Agencies**

**Department of Commerce: National Oceanic and Atmospheric Administration (NOAA):** NOAA uses NASA's Conjunction Assessment Risk Analysis (CARA) to provide pre-launch conjunction assessments for NOAA missions.

**Department of Defense (DoD):** DoD conducts pre-launch conjunction assessment for all U.S. Government space objects to be launched, as well as for those operators that request assistance and have a written SSA sharing arrangement with DoD, and provides multiple public resources regarding conjunction assessment, including:

- The NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices handbook (https://nodis3.gsfc.nasa.gov/OCE_docs/OCE_50.pdf), which provides descriptions of methods, rationale for choosing one method over another, and supporting analyses drawn from NASA's long history of performing CA;

- The 18th Space Defense Squadron Spaceflight Safety Handbook (2020)(https://www.space-track.org/documents/Spaceflight_Safety_Handbook_for_Operators.pdf), which explains the DoD's conjunction assessment process, e.g., describes safety services available, screening schedules, screening volume, reporting criteria, ephemeris formats, etc.

- The specialized Launch Conjunction Assessment Handbook (2018)(https://www.space-track.org/documents/LCA_Handbook.pdf), which explains the launch conjunction assessment process, screening limitations, and trajectory formats.

**Department of Transportation: Federal Aviation Administration (FAA):** FAA requires all commercial launch providers to perform a conjunction assessment before launch per 14 CFR § 450.169 (Launch and reentry collision avoidance analysis requirements). FAA only regulates launch and reentry. Reentry regulations are for controlled reentry vehicles.

**National Aeronautics and Space Administration (NASA):** In November 2020, NASA expanded its documentation requirements to provide more detailed, lower-level conjunction assessment (CA) requirements for its missions, to help them adapt to the challenges of the changing space environment. The guidance expands NASA's required CA activities beyond just those performed after the spacecraft has launched, to include previously optional pre-launch activities. Required pre-launch activities include taking steps to avoid co-location of spacecraft to the extent practical, planning for robust communications and data sharing between co-located

spacecraft when co-location is unavoidable, and analyzing planned mission trajectories to determine anticipated number of potential conjunctions, both during ascent and those expected to be regularly encountered in the final mission orbit, in order to estimate fuel usage and expected personnel activity levels.

**Noted Inputs from the U.S. Private Sector**

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Commercial Industry:

- Some commercial industry representatives develop robust internal processes for ensuring comprehensive collision risk assessment and timely and effective collision avoidance operations.

- Some commercial industry representatives encourage the use of launch providers who take steps to preclude collisions between spacecraft, stages of the launch vehicle, and debris throughout the deployment phase.

**Guideline B.6: Share operational space weather data and forecasts**

**Summary of Activity**
The United States monitors space weather continuously to the extent possible, and supports and promotes the collection, archiving, sharing, intercalibration, long-term continuity and dissemination of critical space weather data and space weather model outputs and forecasts, as a means of enhancing the long-term sustainability of outer space activities. The DOC's NOAA consistently provides free and unrestricted access to operational space weather data, disseminates space weather forecasts, and engages in extensive international cooperation to coordinate approaches and meet critical needs for space weather information and/or data.

**Noted Actions of Specific Government Agencies**

**Department of Commerce: National Oceanic and Atmospheric Administration (NOAA):** NOAA operates space weather satellites and participates in and helps lead the Real Time Solar Wind Network. NOAA shares operational space weather data on a full, free and open basis. In addition, NOAA provides operational space weather predictions 24/7 for the United States and the world. NOAA also leads or participates in a number of international space weather efforts including, but not limited to:

- Co-chair the Coordination Group for Meteorological Satellites (CGMS) Space Weather Task Team which determines how to meet global baseline requirements for space weather data;
- Member of the International Space Environment Service (ISES), which facilitates the exchange of data and NOAA/NWS/SWPC acts as the "World Warning Agency", a hub for data exchange and forecasts;
- Member of the World Meteorological Organization (WMO) Expert Team on Space Weather; and
- Serves as an International Civil Aviation Organization (ICAO) space weather information center.

**Department of Defense (DoD):** The Air Force Weather Agency (AFWA) partners with NOAA to provide additional space weather information for public release, e.g., the report of solar and geophysical activity.

**Guideline B.7: Develop space weather models and tools and collect established practices on the mitigation of space weather effects**

**Summary of Activity**
Under the direction of the 2015 United States National Space Weather Strategy, the United States Government, primarily through NOAA and NASA, works with global partners to undertake a coordinated approach to identify and fill gaps in research, operational models, and forecasting tools required to meet the needs of the scientific community, as well as of providers and users of space weather information services. This includes the ongoing promotion of cooperation and close coordination regarding ground- and space-based weather observations, forecast modelling, satellite anomalies, and reporting of space weather effects in order to mitigate hazards to space activities. These efforts extend to dissemination of scientific research and associated capacity building through training and knowledge transfer on the use of space weather data.

**Noted Efforts of Specific Government Agencies**

**Department of Commerce: National Oceanic and Atmospheric Administration (NOAA):** NOAA develops and runs operational space weather models and tools and works within the U.S. Government and with industry to develop and collect best practices for the mitigation of space weather effects. NOAA has actively participated in the efforts of the UNCOPUOS Space Weather Expert Group as well as of other international bodies, including serving as an International Civil Aviation Organization (ICAO) space weather information center. NOAA works with U.S. partners and industry as well as international partners on the development of models as well as best practices. NOAA helps develop and is an important part of the United States National Space Weather Strategy and associated Action Plan. NOAA also participates in the World Meteorological Organization (WMO) Expert Team on Space Weather and other key international initiatives to support this guideline.

**Department of Transportation: Federal Aviation Administration (FAA):** The Department of Transportation continues to contribute to space weather national policy implementation.

**National Aeronautics and Space Administration (NASA):** The 2015 United States National Space Weather Strategy and accompanying Action Plan clearly articulate a path forward for the U.S. government, working closely with the private sector and our international partners, to enhance preparedness for space weather. The strategy guides, organizes, and unifies the U.S. response to this risk and identifies the mechanisms and processes to inform national and international policies on space weather. In accordance with the strategy, NASA continues to develop and improve predictive models and tools through enhanced fundamental understanding of space weather and its drivers through funding basic and targeted research opportunities through its recently established Heliophysics Space Weather Program. This includes engaging with the operational space weather community to transition mature modeling efforts to operations. The U.S. has actively participated in the space weather activities of UNCOPUOS, and NASA continues to support the International Space Weather Initiative, especially related to capacity building, small instrument deployment, and space weather science involving scientists and students from around the globe.

**Guideline B.8: Design and operation of space objects regardless of their physical and operational characteristics**

**Summary of Activity**
The U.S. government remains committed to implementing relevant legally non-binding international and national space debris mitigation standards and guidelines, including, for example, the 2007 UNCOPUOS Space Debris Mitigation Guidelines and the Inter-Agency Space Debris Coordination Committee's Space Debris Mitigation Guidelines. The U.S. Orbital Debris Mitigation Standard Practices (ODMSP), most recently updated in 2019, incorporate and build upon these international best practices. In order to extend the long-term sustainability guidelines and best practices to U.S. licensed entities, the FCC has adopted regulations which promote design approaches that increase the trackability of space objects, as well as require communication with U.S. government entities providing tracking and conjunction information. In the absence of other regulation, some U.S. industry are voluntarily designing for responsible operation and disposal of their space objects.

**Noted Efforts of Specific Government Agencies**

**Department of Defense (DoD):** DoD implements the U.S. Orbital Debris Mitigation Standard Practices, which are both more quantitative and more stringent than the UNCOPUOS Space Debris Mitigation Guidelines. DoD's launches are fully consistent with the ODMSP as of launches beginning in 2018.

**Federal Communications Commission (FCC):**

*Streamlining Licensing Procedures for Small Satellites, Report and Order*

- In this proceeding, the FCC made available a new, optional licensing process for small satellites. This enables small satellite applicants to choose a streamlined licensing procedure and thereby take advantage of an easier application process, a lower application fee. In so doing, the FCC limits the regulatory burdens borne by applicants and offers potential radiofrequency interference protection for critical communication links, while promoting orbital debris mitigation and efficient use of spectrum. This action supports and encourages the increasing innovation in the small satellite sector.

*Orbital Debris in the New Space Age, Report and Order and Further Notice of Proposed Rulemaking*

- The FCC adopted a "presumed trackable" approach for satellites in LEO larger than 10 cm in the smallest dimension, and for other cases, including where a satellite is planning to use deployable devices to increase the surface area. It concluded that operators should provide more information to support their conclusion that the satellites will be reliably trackable.

- The rules adopted require disclosures related to trackability and identification and information sharing for situational awareness – including the extent to which the satellite operator plans to share information regarding initial deployment, ephemeris, and/or planned maneuvers with the 18th Space Defense Squadron or successor entity, or other

entities that engage in space situational awareness or space traffic management functions, and/or other operators.

**National Aeronautics and Space Administration (NASA):** NASA has developed and implemented orbital debris mitigation requirements that are both more quantitative and more stringent than the UNCOPUOS Space Debris Mitigation Guidelines. The NASA requirements are applicable to the design and operation of all NASA missions, regardless of their physical and operational characteristics, to mitigate the generation of orbital debris for the long-term sustainability of outer space activities.

**Noted Inputs from the U.S. Private Sector**

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Commercial Industry:

- Some commercial industry representatives use onboard telemetry systems to improve tracking of objects.

- Some commercial industry representatives have designed their spacecraft in a manner that if a failure occurs, the space object's battery and propellant tanks are designed to leak rather than explode.

- Some commercial industry representatives minimize debris generation by designing spacecraft to not release any planned debris during normal operations and that all separation and deployment mechanisms are retained by the spacecraft.

- Some commercial industry representatives design second stages in a manner that allows purposeful de-orbiting.

**Guideline B.9: Take measures to address risks associated with the uncontrolled re-entry of space objects**

**Summary of Activity**
The United States regularly makes available to other States, as well as to the global public, information on forecasted uncontrolled re-entry of potentially hazardous space objects. The United States also cooperates with other States and organizations with relevant technical capabilities and resources to improve the reliability of results, primarily through NASA's participation in the annual Inter-Agency Space Debris Coordination Committee (IADC) reentry prediction campaigns, which encourages data sharing among the IADC members to improve their prediction capabilities. Moreover, several U.S. government departments and agencies, both regulatory and non-regulatory, have adopted respective rules or procedures, to minimize the risks associated with fragments of space objects surviving reentry.

**Noted Efforts of Specific Government Agencies**

**Department of Defense (DoD):** DoD regularly shares information on forecasted uncontrolled re-entry of potentially hazardous space objects by tracking the objects and generating information on their trajectory. In the interest of spaceflight safety, the DoD also continues to perform conjunction assessments and notifications to potentially affected entities with regard to the object as it re-enters.

**Federal Communications Commission (FCC):**

*Orbital Debris in the New Space Age, Report and Order and Further Notice of Proposed Rulemaking*

- The *R&O* updated the FCC rules to specify that the human casualty risk assessment must include all objects that would have an impacting kinetic energy of 15 joules and incorporated the 0.0001 (1 in 10,000) or less human casualty risk metric for those satellites that would be disposed of by atmospheric re-entry.

- The *FNPRM* sought comment on adopting additional rules related to strategies to lower human casualty risk, including targeted re-entry and design for demise approaches and any potential alternatives. It also sought comment on considering cumulative casualty risks on a system-wide basis.

*Streamlining Licensing Procedures for Small Satellites, Report and Order*

- The FCC adopted requirements that for applicants under the 47 CFR Part 25 streamlined process, their satellite(s) must be disposed of through atmospheric re-entry following conclusion of the mission and operators must certify that they have conducted a casualty risk assessment using the NASA Debris Assessment Software or another higher fidelity model, and that the assessment resulted in a human casualty risk of zero.

**National Aeronautics and Space Administration (NASA):** NASA has developed and implemented orbital debris mitigation requirements that are both more quantitative and more stringent than the UNCOPUOS Space Debris Mitigation Guidelines. One of the NASA requirements is to limit risks from the uncontrolled reentries of NASA objects. NASA encourages its mission developers to seek design-for-demise trade options to reduce reentry risk and has initiated efforts to characterize reentry demisability of composite materials via laboratory experiments and testing. NASA releases information to the public via press release and website updates prior to high-risk reentries of NASA objects. NASA participates in the annual Inter-Agency Space Debris Coordination Committee (IADC) reentry prediction campaigns and shares data with the IADC members to improve their prediction capabilities. NASA also develops and releases the Debris Assessment Software, including a reentry risk assessment module, to the international community to assess risks associated with uncontrolled reentries. NASA publishes technical papers on reentry risk assessments to share the knowledge base with the international community.

## Noted Inputs from the U.S. Private Sector

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Commercial Industry:

- Some commercial industry representatives emphasized their purposeful design of satellites to deorbit with minimal risk to human life and creation of debris.

- Some commercial industry representatives develop and share information on improved end-of-life disposal technologies and practices.

- Some commercial industry representatives advocate for design-for-demise and practical casualty risks per spacecraft.

**Guideline B.10: Observe measures of precaution when using sources of laser beams passing through outer space**

**Summary of Activity**
Prior to the use of lasers that generate beams passing through near-Earth outer space, relevant U.S. government departments and agencies follow safety analyses and deconfliction procedures to reduce the risks of accidental illumination and of malfunctioning, damage, and break-up due to illumination; and as necessary, observe appropriate measures of precaution. Regulators such as the FCC disclose licensees' laser-related information to appropriate intergovernmental entities such as the ITU on behalf of those licensees, if provided.

**Noted Efforts of Specific Government Agencies**

**Department of Defense (DoD):** DoD follows an internal instruction "Management of Laser Illumination of Objects in Space," DoD Instruction 3100.11 (2016), which establishes policy, assigns responsibilities, and provides procedures for the management of risks associated with laser illuminations of objects in space. For laser activities in space or other activities that may direct energy above the horizon, DoD requires conduct of such activities to be in a safe and responsible manner in order to manage the associated risks to space systems, those systems' mission effectiveness, and humans in space. The instruction includes the requirement for a quantitative probabilistic risk assessment process to categorize DoD-owned or DoD-operated lasers that could direct energy above the horizon or in space and implements risk acceptance standards for DoD-owned or -operated resident space objects.

**Federal Communications Commission (FCC):** Although not considered "radio" communication under the ITU Radio Regulations, the FCC has submitted information on use of optical frequencies for communications purposes as additional information in ITU filings that are submitted on behalf of the companies it licenses.

**National Aeronautics and Space Administration (NASA):** Launched on September 15, 2018, the NASA ICESat-2 observatory hosts a photon-counting lidar in a near-polar orbit to precisely characterize elevation changes in the Earth's polar ice and glaciers. In addition, the lidar instrument collects measurements globally, especially to determine vegetation height and to support research in hydrology, oceanography, atmospheric sciences, and other Earth and applied sciences. ICESat-2 uses a low-power, green laser divided into six separate beams. With the spacecraft orbiting at about 483 km above the Earth, and given the low power of the laser, it poses no threat to anyone or anything on Earth, including the ice it is measuring. NASA conducted a comprehensive safety analysis of the ICESat-2 laser instrument and operations, documented in NASA publication ICESat-2-SYS-TN-2480 (29 October 2013).

## C. International cooperation, capacity-building and awareness

### Guideline C.1: Promote and facilitate international cooperation in support of the long-term sustainability of outer space activities

**Summary of Activity**
The United States remains committed to fostering strong working relationships with the international community, private sector, and public to emphasize the pressing need to preserve the outer space environment and promote the long-term sustainability of outer space.

**Noted Efforts of Specific Government Agencies**

**Department of Commerce: National Oceanic and Atmospheric Administration (NOAA):** NOAA participates in a variety of bilateral and multilateral bodies to support the sustainability of outer space activities, including the Coordination Group for Meteorological Satellites (CGMS), World Meteorological Organization (WMO), the Group on Earth Observations (GEO), the Committee for Earth Observation Satellites (CEOS), among others.

**Department of State (DOS)**: DOS engages in a number of international fora to promote the long-term sustainability of outer space. In addition to leading the U.S. delegation to the UNCOPUOS Legal Subcommittee and plenary session, the Department organizes events and meetings to facilitate international cooperation on space sustainability.

As one example, the Department hosted the "Space Enterprise Summit" in 2019, which welcomed representatives from the U.S. government, foreign governments, non-governmental organizations, and the private sector to discuss the burgeoning space industry and the importance of international cooperation in ensuring the long-term sustainability of outer space.

**Department of Transportation: Federal Aviation Administration (FAA):** The FAA actively promotes its regulations as a model for other countries to consider, as the regulations help to increase public safety during space launch and reentry activities. For example, under 51 USC § 50903, the Department of Transportation and FAA are to: "(1) encourage, facilitate, and promote commercial space launches and reentries by the private sector, including those involving space flight participants; and (2) take actions to facilitate private sector involvement in commercial space transportation activity, and to promote public-private partnerships involving the United States Government, State governments, and the private sector to build, expand, modernize, or operate a space launch and reentry infrastructure. (c) In carrying out the responsibilities under subsection (b), the Secretary shall encourage, facilitate, and promote the continuous improvement of the safety of launch vehicles designed to carry humans, and the Secretary may, consistent with this chapter, promulgate regulations to carry out this subsection."

**Federal Communications Commission (FCC):** FCC participates in international forums discussing space sustainability and provides technical support for U.S. participation in international activities and organizations including the Inter-agency Space Debris Coordination Committee and the UN Committee on the Peaceful Uses of Outer Space.

**Noted Inputs from the U.S. Private Sector**
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*Submissions were received from representatives of non-governmental organizations, commercial actors, and academia and do not necessarily reflect a consensus view among them.*

Non-Governmental Organizations:

- Some NGO representatives incorporate internationally-developed guidelines, standards, and best practices from the IADC, UNCOPUOS, and ISO/CCSDS into their procedures.

Commercial Industry:

- Some commercial industry representatives engage and lead global initiatives to encourage stakeholder cooperation, coordination, and participation in information-sharing to advance the long-term sustainability of space.

- Some commercial industry representatives promote the use of on-orbit servicing domestically and internationally as a means to advance space sustainability.

- Some commercial industry representatives empower an inclusive international community of innovators, learners, knowledge leaders, and risk-takers to address the pressing issues facing the outer space environment.

- Some commercial industry representatives convene participants and sponsors that span national security, economic and technical growth, and the public and international safety domains to discuss pressing outer space sustainability issues.

- Some commercial industry representatives contribute to international partnerships and cooperation to ensure that a practical and effective normative behavioral landscape continues to evolve.

**Guideline C.2: Share experience related to the long-term sustainability of outer space activities and develop new procedures, as appropriate, for information exchange**

**Summary of Activity**
The United States acknowledges the importance of fostering and participating in an international dialogue and building consensus among States, international intergovernmental organizations, and non-governmental entities to help develop and implement effective measures to enhance the long-term sustainability of outer space activities. U.S. departments and agencies continue to promote education and share information regarding sustainability-related space activities undertaken by government and commercial space actors.

**Noted Efforts of Specific Government Agencies**

**Department of Commerce: National Oceanic and Atmospheric Administration (NOAA):** NOAA participates, through a variety of bilateral and multilateral bodies, in sharing experiences and developing procedures for information exchange, including through the Coordination Group for Meteorological Satellites (CGMS), World Meteorological Organization (WMO), the Group on Earth Observations (GEO), the Committee for Earth Observation Satellites (CEOS), and others.

**Department of State (DOS):** DOS, along with NASA, are the U.S. leads for the Artemis Accords, a set of high-level, non-legally binding principles grounded in the 1967 Outer Space Treaty. The Artemis Accords establish a common framework to guide space exploration cooperation among signatories and underscore the importance of the safe and sustainable exploration and use of outer space. The Accords also emphasize international cooperation as essential to the safe and sustainable exploration of outer space and recognize the importance of continued engagement in multilateral fora.

**Department of Transportation: Federal Aviation Administration (FAA):** FAA promotes its commercial space transportation regulations and best practices for consideration and adoption by other States. The FAA: (1) signed non-binding bilateral arrangements that facilitate information exchange about regulations; (2) has given several presentations on safety and delivered written papers at the International Astronautical Congress; (3) hosted bilateral workshops that describe how the FAA regulates commercial space launches and reentries and the operation of non-federal launch and reentry sites (commonly referred to as spaceports); (4) hosted annual public space conferences; and (5) provides extensive information about safety and FAA regulations that are available on the FAA Office of Commercial Space Transportation website.

**Federal Communications Commission (FCC):** FCC staff participate in international forums discussing space sustainability and provide technical support for U.S. participation in international activities and organizations including the Inter Agency Space Debris Coordination Committee and the UN Committee on the Peaceful Uses of Outer Space.

The FCC makes documentation and decisions on licensing actions publicly available through the International Bureau Filing System (IBFS) and the FCC website. Rulemaking documents, including public comments, are also publicly available on the FCC website through the Commission Documents (EDOCS) and Electronic Comment Filing System (ECFS) databases.

**Noted Inputs from the U.S. Private Sector**

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Non-Governmental Organizations:

- Some NGO representatives promote industry associations that advocate for the range of activities within the space sector, including small satellites.

- Some NGO representatives organize interdisciplinary space events to accelerate near-term commercial space activities, enable long-term human exploration and settlement, and examine the policy implications of these activities.

- Some NGO representatives provide an effective forum in which the space industry can develop and apply best practices.

- Some NGO representatives advocate for increased information exchange relevant to safety-of-flight and collision avoidance through intra-operator coordination and SSA and STM service entities.

- Some NGO representatives publish technical and policy papers to inform the international community about the importance of holistically addressing space debris issues.

Commercial Industry:

- Some commercial industry representatives hold dialogues with commercial operators and international actors regarding best practices to promote the long-term sustainability of outer space and actively advocate for multistakeholder engagement on long-term sustainability issues.

**Guideline C.3: Promote and support capacity-building**

**Summary of Activity**
The United States works with the international community and the private sector to provide knowledge, data, and, as appropriate, resources to support capacity building in emerging space-faring nations.

**Noted Efforts of Specific Government Agencies**

**Department of Commerce: National Oceanic and Atmospheric Administration (NOAA):** NOAA facilitates access to and use of Earth observations in support of weather and climate prediction, environmental monitoring, public health, water resource management, wildfire detection, and space weather. NOAA provides capacity building to enhance user access and promote the use of NOAA's space-based observations, products and services. NOAA is actively involved in the Group on Earth Observations, including training and the regional information dissemination through the GEONETCast Americas system. NOAA supports capacity building through organizations such as the Committee on Earth Observation Satellites, World Meteorological Organization, Coordination Group for Meteorological Satellites, and International Charter "Space and Major Disasters".

NOAA has a robust capacity building program with respect to space-based Earth observations both bilaterally and through a number of multilateral bodies.

**Department of State (DOS):** DOS, in coordination with the U.S. interagency, facilitates information exchanges between U.S. technical agencies and other nations to foster a shared understanding of the safe, effective, and responsible use and exploration of outer space. This includes regularly occurring bilateral dialogues with other nations, participation in multilateral fora, such as UNCOPUOS, and hosting workshops on how to use space-based data and capabilities. DOS also organizes international leadership programs for foreign individuals in the space sector to come to the United States and meet with civil and private sector leaders in the space sector.

**National Aeronautics and Space Administration (NASA):** Earth observations benefit society every day by informing decisions related to agriculture, climate, disasters, ecological forecasting, energy, health and air quality, wildland fires, and water resources. The U.S. works to improve the skills and capabilities of people around the world to access and apply NASA Earth science. The NASA Capacity Building Program manages three specific activities to do this – DEVELOP, SERVIR, and Applied Remote SEnsing Training (ARSET). NASA is actively involved in the international Group on Earth Observations and the Committee on Earth Observation Satellites, which both support overall capacity-building efforts. In addition, NASA supports a Disasters Program with activities that use and strengthen skills to use Earth-observing data and applied research to improve the prediction of, preparation for, response to and recovery from hazards and disasters around the world.

Regarding space weather, NASA continues its active capacity building efforts thought the International Space Weather Initiative (ISWI) that targets developing space weather capabilities in developing nations with ground stations, and the International Space Weather Action Team

(ISWAT) that focuses on international collaborations of space weather modeling. Furthermore, NASA is committed to international collaborations using small satellite missions that advance understanding of space weather, such as the Korean Small scale magNetospheric and Ionospheric Plasma Experiment (SNIPE) mission and the U.S./Brazil Scintillation Prediction Observations Research Task (SPORT) mission.

**Noted Inputs from the U.S. Private Sector**

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Non-Governmental Organizations:

- Some NGO representatives advocate for the development of incentive-based frameworks to promote space sustainability.

- Some NGO representatives support policy fellowships to research frameworks for developing space nations to establish efficient and effective regulatory frameworks.

- Some NGO representatives identify challenges to capacity building efforts and work with regional space leaders to find appropriate solutions.

**Guideline C.4: Raise awareness of space activities**

**Summary of Activity**
The United States continues to develop and implement public outreach programs that better educate the general public and interested parties regarding space activities. These programs include domestic and international fellowship programs, public forums, space-focused education campaigns, conferences and symposiums, and other public affairs programs.

**Noted Actions of Specific Government Agencies**

**Department of Commerce: National Oceanic and Atmospheric Administration (NOAA):** NOAA has numerous outreach and education programs designed to raise awareness of space activities, particularly as related to Earth observations and the societal benefits of space-based observations for climate change, disaster preparedness and response.

**Federal Communications Commission (FCC):** The FCC participates in numerous symposiums and conferences annually that discuss and promote space activities.

**National Aeronautics and Space Administration (NASA):** When NASA was created in 1958, its founding legislation—the National Aeronautics and Space Act—directed the new agency to "provide for the widest practicable and appropriate dissemination of information to the media and general public concerning NASA activities and results." NASA science and exploration missions inspire individuals and further scientific inquiry throughout the world. These incredible missions, such as the James Webb Space Telescope or Artemis, raise awareness of space activities by reaching for new heights to explore the unknown for the benefit of humankind. NASA uses a variety of methods to raise awareness of space activities. NASA's social media presence continues to grow with more than 300 million total followers across all accounts and platforms. Through challenges and citizen scientist programs, NASA leverages expertise across industries and from the general public to advance its research and engage many communities. Engaging millions of students every year is also an important part of NASA's work. During the last year, www.NASA.gov has received an average of 6 million pageviews per week.

**Noted Inputs from the U.S. Private Sector**
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Non-Governmental Organizations:

- Some NGO representatives raise awareness of the particular needs of the global south for remote sensing data to address the effects of climate change and extreme weather events.

- Some NGO representatives raise awareness of the dependence of all nations on the use of space assets to address global challenges, as well as the importance of space weather monitoring and research to protect those assets.

Commercial Industry:

- Some commercial industry representatives raise awareness of the global challenges space debris poses to outer space operations for all operators.

- Some commercial industry representatives participate in a wide range of industry-led coalitions, both domestic and international, to discuss the importance of space sustainability.

- Some commercial industry representatives share experiences of operating anomalies, similar to practices in the aviation industry, to reinforce the adoption of safe practices for space operations. This can take the form of:
    - Developing and sharing best practices for the anomaly attribution process within the servicing community.
    - Participating in the development of anomaly resolution standards and sharing frameworks.
    - Where possible, share information within the satellite servicing community on specific examples of anomaly resolution and attribution that could impact the community as a whole.

- Some commercial industry representatives engage in outreach activities with schools and universities, employ seasonal and project-specific undergraduate and graduate level interns from diverse backgrounds, and speak at public and industry events.

- Some commercial industry representatives champion the importance of space sustainability efforts through public outreach, educational programs, partnerships, and events.

- Some commercial industry representatives foster a sense of excitement about the benefits of outer space and emphasize the importance of space sustainability in accomplishing those goals.

## D. Scientific and technical research and development

### Guideline D.1: Promote and support research into and the development of ways to support sustainable exploration and use of outer space

**Summary of Activity**
The United States continues to develop novel and innovative ways to support the sustainable use and exploration of outer space and promote these ideas within the international community. Both government and private sector initiatives have already led to significant advancements in the ability to use space safely and preserve the outer space environment for future generations.

**Noted Efforts of Specific Government Agencies**

**Department of Commerce: National Oceanic and Atmospheric Administration (NOAA):** NOAA provides space-based Earth observation data on a full, free and open basis to our international partners, as well as supports their ability to promote sustainability within their own countries. This includes NOAA's provision of the GEONETCast Americas service for the western hemisphere. In addition, NOAA, together with other USG agencies and international partners is working through a number of international bodies to support the use of space-based observations for sustainable development. This includes bilateral activities undertaken with USAID and also the Group on Earth Observations (GEO) Earth Observation for the Sustainable Development Goals (EO4SDG), our provision of the GEONETCast Americas service, and participation and leadership of the GEO initiatives GEOGlows and GEO BluePlanet. NOAA also participates in the Committee on Earth Observation Satellites (CEOS) initiatives such as COAST and numerous other international initiatives across space weather; weather, water and climate; climate change; sustainable fisheries; resilient coastal communities; and more.

**Department of Transportation: Federal Aviation Administration (FAA):** FAA is active in several areas to promote and support research applicable to space sustainability as it relates to commercial launch and reentry including with the Commercial Space Transportation Advisory Committee (COMSTAC) and has previously published research material with academia through the FAA Center of Excellence for Commercial Space Transportation.

**Federal Communications Commission (FCC):** The FCC experimental licensing program provides radio-frequency authorizations that are used in many research efforts conducted by universities and research institutions. These include missions to test new technologies that may offer improved methods for mitigation of orbital debris.

**National Aeronautics and Space Administration (NASA):** Space science and technology applications are essential to addressing current and future challenges and realizing the Sustainable Development Goals. It is only through continued and purposeful international collaboration that we can leverage our shared strengths to fully realize the potential impact of the Space Weather Program, Earth Observations, and the use of space technology can have in our work. Satellite Earth Observations deliver a unique view of our world and provide substantial amounts of data that facilitate new methods and insights into the Sustainable Development Goals and their Indicators.

NASA through its Heliophysics Space Weather Program funds efforts to reduce future debris with technology development of debris sensing instruments, with advancement of satellite drag models in improved debris tracking and the effects of space weather, all of which promote the development of a sustainable exploration and use of outer space.

To advocate and realize these contributions, the United States works with established international forums such as the Group on Earth Observations (GEO), which launched a dedicated Initiative, Earth Observations for the Sustainable Development Goals (EO4SDG), in 2016. NASA, the National Oceanic and Atmospheric Administration, and the United States Geological Survey, work to employ Earth Observations in smart practices and solutions on the use of this data in planning, tracking, and reporting.

The United States' work utilizing Earth Observations for this goal is further enhanced by the Committee on Earth Observation Satellites, whose purpose is to ensure international coordination of civil space-based Earth Observation programs. This Committee, alongside GEO, jointly authored the report "Earth Observations in Support of the 2030 Agenda for Sustainable Development," which highlights the potential role of Earth observations in supporting the global Indicator framework. The United States believes that a successful sustainable development agenda will require effective partnerships, such as these, for implementation.

**Noted Inputs from the U.S. Private Sector**

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Non-Governmental Organizations:

- Some NGO representatives develop and adopt guidelines that foster research and development and good stewardship practices during the exploration and use of outer space.

- Some NGO representatives develop and advocate for internationally recognized industry standards for space operations.

- Some NGO representatives continually evaluate new ways to ensure space flight safety, including new partnerships with governmental SSA and STC systems, improved algorithms, data sharing (beyond just orbit states and ephemerides and maneuvers), and more comprehensive data sharing from across the operator community.

Academic Institutions:

- Some academic institution representatives have developed a means to incentivize industry to design missions compatible with sustainable and responsible operations, and operate missions considering potential harm to the orbital environment and impact on other operators in addition to mission objectives and service quality. Such a model could include:

- the mission index to estimate the mission's marginal contribution to overall orbital risk;
- collision avoidance capabilities;
- ability and willingness of the operator to share data on the mission;
- the mission's detectability, identification and tracking;
- operator's compliance with standards and regulations; and
- commitment to use or demonstration of use of on-orbit servicing and external services

This method seeks to provide a practice tool that governments, satellite operators and insurers can reference, as well as build capability among emerging space actors as they seek to understand how to design responsible space missions

Commercial Industry:

- Some commercial industry representatives design and employ reusable launch vehicles.

**Guideline D.2: Investigate and consider new measures to manage the space debris population in the long term**

**Summary of Activity**
The United States has established debris mitigation practices and procedures and continues to review and update these regulations, as appropriate. The United States also released the "Orbital Debris Research and Development Implementation Plan in 2022 to address the challenges of orbital debris. There is also a large and advanced private sector within the United States that continues to identify new and innovative ways to address the challenges faced by orbital debris.

**Noted Efforts of Specific Government Agencies**

**Department of Commerce: National Oceanic and Atmospheric Administration (NOAA):** NOAA's future satellite architecture takes the mid-century projected debris environment into account while formulating future constellation designs.

**Department of Defense (DoD):** DoD implements the U.S. Orbital Debris Mitigation Standard Practices, which are both more quantitative and more stringent than the UNCOPUOS Space Debris Mitigation Guidelines. DoD's launches are fully consistent with the ODMSP as of launches beginning in 2018. DoD incorporates space sustainability concepts into its design and acquisition of its space architecture.

**Department of Transportation: Federal Aviation Administration (FAA):** New FAA rulemaking related to commercial space transportation for orbital debris mitigation is in development to update existing regulations to more-closely align with the U.S. Government Orbital Debris Mitigation Standard Practices, limit the growth of orbital debris, and reduce the creation of additional debris caused by on-orbit collisions. The new rulemaking is in-line with the LTS Guidelines.

**Federal Communications Commission (FCC):** The FCC initiated a proceeding in November of 2018 to update its regulations concerning orbital debris mitigation, which were originally adopted in 2004. As part of the ongoing proceeding, the FCC has collected public input on a number of topics, including new technologies that may provide options for improvements in debris mitigation.

**National Aeronautics and Space Administration (NASA):** The U.S. Government established the U.S. Government Orbital Debris Mitigation Standard Practices, which are both more quantitative and more stringent than the UN COPUOS Space Debris Mitigation Guidelines. NASA continues to investigate potential negative effects from new space operations, such as CubeSats and large constellations, and to provide new recommendations to mitigate the generation of new debris from such operations. NASA has participated in all major Inter-Agency Space Debris Coordination Committee (IADC) activities and contributed to studies that build consensus to improve the IADC Space Debris Mitigation Guidelines to manage the orbital debris problem.

**Noted Inputs from the U.S. Private Sector**

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Non-Governmental Organizations:

- Some NGO representatives incorporate by reference and promote IADC guidelines.

Academic Institutions:

- Some academic institution representatives have developed a model to quantitatively assess how challenging a given space objects' physical design and orbit are to detect, identify, and track from the Earth.

- Some academic institution representatives have developed a model to assess the orbital carrying capacity of low Earth orbit and examine whether it is compatible with the sustainable long-term evolution of the space environment and near-term safety of flight.

Commercial Industry:

- Some commercial industry representatives aim to reduce orbital debris and support the long-term sustainability of outer space by developing innovative technologies, advance business cases for these technologies, and engage with the international community.

- Some commercial industry representatives consider lower operational orbits to facilitate timely atmospheric reentry of satellites.