Report No. DODIG-2022-048

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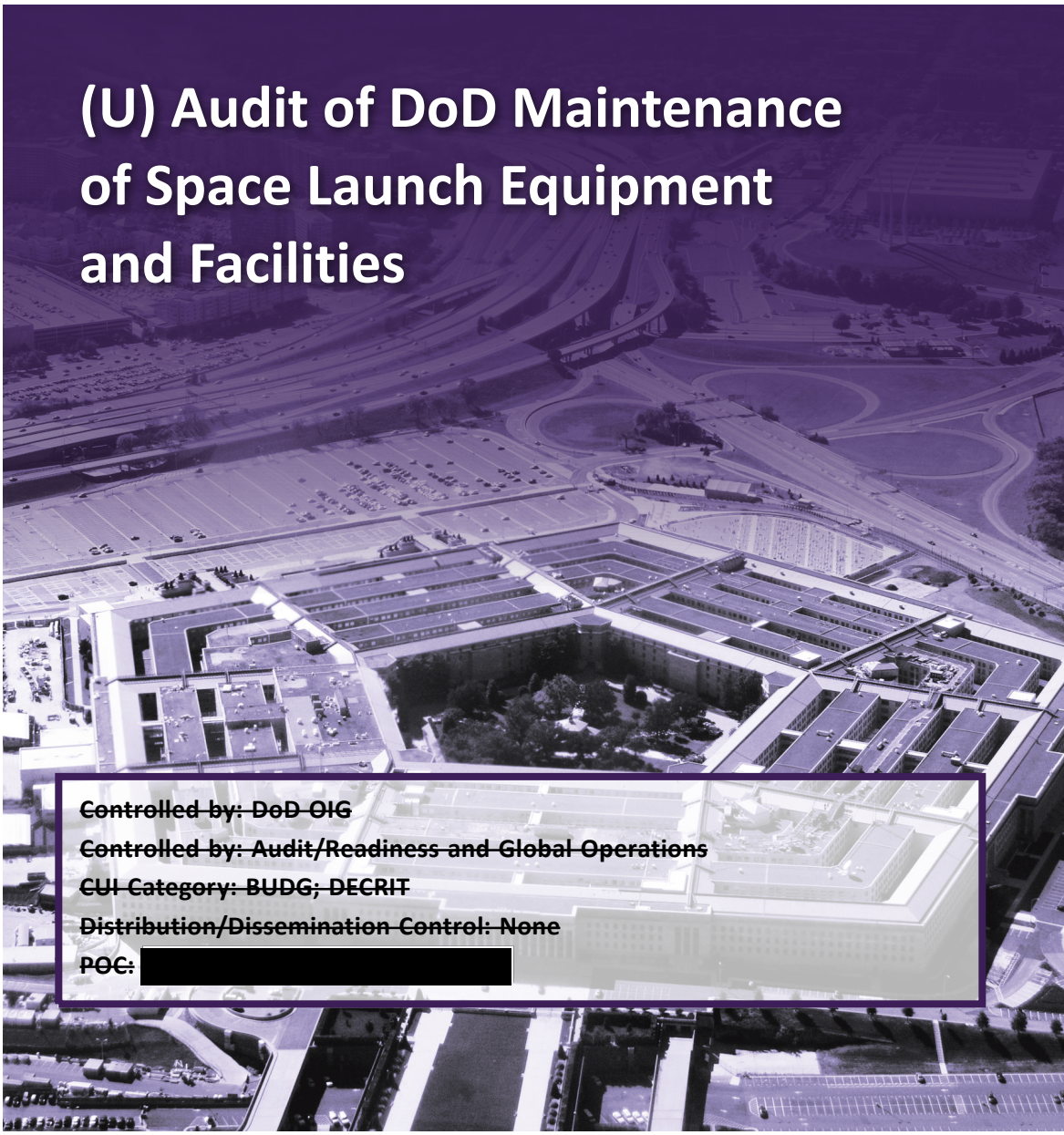
INSPECTOR GENERAL

U.S. Department of Defense

JANUARY 5, 2022

(U) Audit of DoD Maintenance of Space Launch Equipment and Facilities



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INSPECTOR GENERAL
INTEGRITY
EFFICIENCY
DEPARTMENT OF DEFENSE

(U) Results in Brief

(U) Audit of DoD Maintenance of Space Launch Equipment and Facilities

(U) January 5, 2022

(U) Objective

(U) The objective of this audit was to determine the extent to which the DoD maintained the equipment and infrastructure needed to support space launches and whether DoD facilities could support future launch requirements. We reviewed the Space Force's maintenance of launch range items at Vandenberg Space Force Base, California, and Patrick Space Force Base, Florida, and we determined whether range items enabled successful space launches.

(U) Background

(U) The Space Force became the newest Military Service when the President signed the FY 2020 National Defense Authorization Act. Among other responsibilities, the Space Force provides equipment and infrastructure to support launch requirements for the DoD's National Security Space Launch program; Federal civilian agencies, such as the National Aeronautics and Space Administration; and commercial activities. Launches occur along the eastern and western ranges, and each range includes Government-maintained range items, such as radars, optical devices, and weather towers. Range personnel use range equipment to help ensure public safety by monitoring the trajectory of a launch vehicle and aborting or destroying the launch vehicle if necessary. Range items also provide data to the launch provider for real time and post-launch analysis.

(U) Finding

(U) The Space Force maintained launch range items and supported DoD, Federal civilian agencies, and commercial space launches. Specifically, maintenance personnel supporting the eastern and western ranges completed 253 of 262 (97 percent) required maintenance inspections for the 20 range items we reviewed. In addition, range item performance enabled successful launches for the 30 launches we reviewed out of 90 DoD, Federal civilian agencies, and commercial space launches that occurred between January 2018 and March 2021.

(U) Although the Space Force maintained range items and enabled successful launches, according to Space Force data, 74 of all 260 (28 percent) eastern and western range items did not have the spare parts needed to repair or replace some range item components if necessary. This amount included 31 range items that did not have any spare parts for mission-critical range item components. If mission-critical components fail, the failure could result in post-launch data loss or a mission abort, or a pre-launch scrub (postponed to a new launch time) or hold (pause until later in the launch window). The Space Force lacked spare parts for these 74 range items because the spares were obsolete, which refers to parts that are no longer made or are not available for purchase.

(U) The Space Force is conducting ongoing and planned range item upgrades to address the most critical range item spare parts shortages. Of the 31 range items with spare parts shortages for mission-critical components, the Space Force:

- (U) upgraded 4 range items and secured funding for planned upgrades to an additional 9 range items,
- (U) planned upgrades, but is awaiting funding, for 1 range item upgrade,
- (U) relied on redundant systems for 4 range items, and
- (U) plans to divest 18 range items.

(U) The Space Force expects the planned upgrades, regardless of funding status, to be complete prior to 2024.

(U) Results in Brief

(U) Audit of DoD Maintenance of Space Launch Equipment and Facilities

(U) Finding (cont'd)

(U) The Chief of Space Operations also directed launch providers using the eastern and western ranges to adopt the Autonomous Flight Safety System (AFSS) by October 1, 2025. The AFSS is a launch-vehicle mounted system with the capability to track and, if necessary, terminate a launch vehicle's flight. This capability makes many range items that are currently used to ensure safety during a launch unnecessary. The range-item upgrade efforts and the Chief of Space Operations mandate that launch providers transition to AFSS are part of a broader initiative to modernize the eastern and western ranges. The Space Force refers to this modernization initiative as the "Range of the Future 2028." Under this initiative, the Space Force is upgrading its legacy range communication architecture to a modern architecture that will enable launch providers to use their own range instrumentation rather than rely on Space Force range items. This upgrade will enable the Space Force to decommission and replace some range items; this should further reduce the number of obsolete range items on which the Space Force relies to support launches.

(U) We determined that the Space Force actions to mitigate these spare parts shortages were appropriate, and we are not making recommendations to the Space Force regarding this area.

(U) While the Space Force maintained launch range items and supported space launch requirements, the Space Force is at an increased risk that aging range items with obsolete components could limit future launch capacity on the eastern and western ranges. The Space Force projects that the total number of launches it will support will increase from 49 in 2021 to 157 in 2027, which represents an increase of 220 percent. This increased operational tempo, combined with a lack of spare parts for mission critical range item components, increases the possibility that a non-mission capable range item will cause a launch hold or scrub. Furthermore, launch delays could occur on the eastern and western ranges if range items remain in a non-mission capable status for an extended period.

(U) The Space Force's intent for the "Range of the Future 2028" initiative is to create a modern range that can adapt to future launch demands. However, if the Space Force does not complete planned Range of the Future upgrade projects on schedule, or if the anticipated increase in commercial launch requirements is higher than predicted, then the Space Force ranges may not be able to support all future launch requirements.

(U) Management Comments and Our Response

(U) We considered management comments on a discussion draft copy of this report when preparing this final report. We did not make any recommendations; therefore, no management comments are required.

INSPECTOR GENERAL
DEPARTMENT OF DEFENSE
4800 MARK CENTER DRIVE
ALEXANDRIA, VIRGINIA 22350-1500

January 5, 2022

MEMORANDUM FOR CHIEF OF SPACE OPERATIONS
COMMANDER, SPACE OPERATIONS COMMAND
AUDITOR GENERAL, DEPARTMENT OF THE AIR FORCE

SUBJECT: (U) Audit of DoD Maintenance of Space Launch Equipment and Facilities (Report No. DODIG-2022-048)

(U) This final report provides the results of the DoD Office of Inspector General's audit. We considered management comments on a discussion draft copy of this report when preparing this final report. We did not make any recommendations; therefore, no management comments are required.

(U) We appreciate the cooperation and assistance received during the audit. If you have any questions, please contact me at [redacted].

Richard B. Vasquez
Assistant Inspector General for Audit
Readiness and Global Operations

(U) Contents

(U) Introduction

(U) Objective

(U) The objective of this audit was to determine the extent to which the DoD maintained the equipment and infrastructure needed to support space launches and whether DoD facilities could support future launch requirements. We reviewed the Space Force's maintenance of launch range items at Vandenberg Space Force Base (SFB), California, and Patrick SFB, Florida, and we determined whether range items enabled successful space launches.[1]

(U) Background

(U) On December 20, 2019, the Space Force became the newest Military Service when the President signed the FY 2020 National Defense Authorization Act into law. The Space Force is part of the Department of the Air Force, with the Secretary of the Air Force having overall responsibility. The Chief of Space Operations, who is also a member of the Joint Chiefs of Staff, serves as the senior military member of the Space Force.

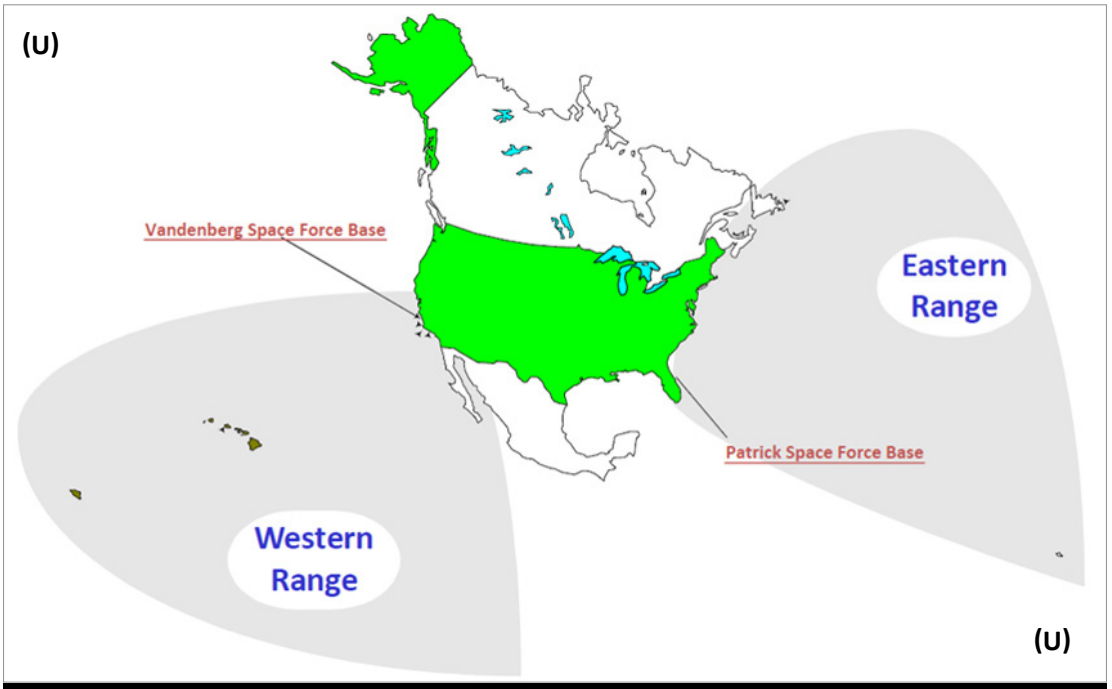
(U) The Space Force organizes, trains, and equips space forces to protect U.S. and allied interests in space and to provide space capabilities to the combatant commanders and joint forces. According to the National Space Policy, the DoD must provide affordable and timely space access for national security purposes, coordinate with Federal civilian agencies to support space-related activities, and ensure that U.S. space infrastructure is available for commercial use.[2] Therefore, the Space Force provides equipment and infrastructure to support National Security, federal civilian agencies, and commercial space launches. The National Security Space Launch program supports DoD launch requirements; civil launches primarily support Federal civilian agencies, such as the National Aeronautics and Space Administration and the National Oceanic Atmospheric Administration; and commercial launches support private sector activities, such as satellite communication and space tourism.

(U) DoD, Federal civilian agencies, and commercial launch providers conduct space launches from the eastern and western ranges. The Space Force manages these ranges, which comprise Government-owned equipment and facilities, from Vandenberg and Patrick SFB. The ranges include space launch areas that extend

[1] (U) Section 101, title 10, United States Code, defines a range as designated land, water, or airspace used by the DoD and includes maneuver and impact areas. According to Air Force Space Command Instruction 13-613, "Launch Forecasting, Planning, and Scheduling Procedures," July 16, 2018, a successful launch is when the launch vehicle performed its required functions.

[2] (U) "National Space Policy of the United States of America," December 9, 2020.

(U) over the Atlantic and Pacific Oceans, respectively. Figure 1 illustrates the boundaries of the eastern and western ranges. See Figure 2 for the DoD vehicles certified to launch national security payloads from the eastern and western ranges.



(U) Figure 1. Map of the Eastern and Western Ranges
Source: The Space Operations Command.

(U) Figure 2. DoD Vehicles (From Left): Atlas V, Falcon Heavy, and Delta IV
Source: The Space Operations Command.

(U) During our audit, four Space Force commands had responsibility for planning and supporting space launches at each range: the Space Operations Command (SpOC), Space Systems Command, Space Launch Delta 30, and Space Launch Delta 45.

(U) Space Operations Command and Space Systems Command

(U) SpOC, located at Peterson SFB, Colorado, provides intelligence, cyber, space, and combat support forces to the Joint Force. SpOC had responsibility for launch support operations through its subordinate commands, the Space Launch Deltas 30 and 45 located at Vandenberg SFB, California, and Patrick SFB, Florida, respectively. However, on August 13, 2021, the Space Force realigned those subordinate commands from SpOC to the Space Systems Command. The Space Systems Command, located at Los Angeles Air Force Base, California, is responsible for developing, equipping, and sustaining space capabilities.

(U) Space Launch Deltas 30 and 45

(U) Space Launch Delta 30 commands and controls the western range and directs resources in support of space launches, missile test launches, and aeronautical and space surveillance operations. Space Launch Delta 30 also provides mission, contracting, and logistical support, and is responsible for the maintenance and sustainment of western range launch-support equipment and infrastructure. From January 1, 2016, through March 31, 2021, Space Launch Delta 30 supported 25 space launches.[3]

(U) Similarly, Space Launch Delta 45 commands and controls the eastern range; provides launch support infrastructure; and is responsible for airfield operations, weather monitoring, and eastern range communications support. Space Launch Delta 45 is also responsible for the maintenance and sustainment of eastern range launch-support equipment and infrastructure. From January 1, 2016, through March 31, 2021, Space Launch Delta 45 supported 114 space launches.

(U) According to the Space Force, the eastern and western ranges will support an increase in the total number of space launches when comparing calendar year 2022 to 2027. The Space Force forecasted that the majority of this increase will be in commercial launches, while the number of DoD and Federal civilian agencies' launches will remain constant. Table 1 shows the number of launches that the Space Force projects will occur through 2027.

(U) According to the Space Force, the eastern and western ranges will support an increase in the total number of space launches when comparing calendar year 2022 to 2027.

[3] (U) In this report, when we refer to a number of space launches, we are excluding non-space launches conducted from the eastern and western ranges, such as missile test launches.

(U) Table 1. Space Force Projections of Increased Launches Through 2027

(U) Space Force Launch Projections*								
	Launch Type	2022	2023	2024	2025	2026	2027	Total Launches by Launch Provider
Eastern Range	Commercial	39	34	48	74	95	100	390
	Civil	13	10	20	15	19	13	90
	DoD	5	8	6	13	7	6	45
	Total Launches	**57**	**52**	**74**	**102**	**121**	**119**	**525**
Western Range	Commercial	17	19	22	28	30	28	144
	Civil	2	1	1	1	1	1	7
	DoD	4	3	2	9	4	9	31
	Total Launches	**23**	**23**	**25**	**38**	**35**	**38**	**182** (U)

(U) *This forecast shows the Space Force launch projections as of May 2021.
Source: The Space Operations Command.

(U) Space Launch Range Equipment and Infrastructure

(U) The eastern and western ranges comprise Government-owned and Government-maintained range items, such as radars, optical devices, and weather towers. Range personnel use range items to help ensure public safety by monitoring the trajectory of a launch vehicle and aborting the launch or destroying the launch vehicle if necessary. Range items also provide data to the launch provider for real time and post-launch analysis.

(U) According to Space Force officials, the specific range items needed for each launch depends on multiple factors, such as the type of launch vehicle and the data needs of the launch customer. The eastern and western ranges have 125 and 135 range items, respectively, that support 10 range subsystems.[4] Table 2 lists and describes each range subsystem and shows the number of range items in the subsystem. See Figure 3 for examples of range items at the eastern and western ranges.

[4] (U) Range items contain many subcomponents. The Space Force uses multiple terms to describe the hierarchy of these subcomponents, including configuration item, line replaceable unit, and component. In this report, we will use the term "component" to refer to each of these terms.

(U) Table 2. Description of Each Range Subsystem and the Number of Items

(U) Range Subsystem Name	Description	Eastern Range Items	Western Range Items
Area Surveillance	Provides the location and movement of vessels and aircraft in the launch area.	4	14
Command Destruct	Allows range safety officials to abort or destroy a launch vehicle if necessary.	7	10
Communication	Provides voice, video, and data transportation across the range.	27	10
Data Handling	Supports pre-mission and post-mission data processing of all launched vehicles.	6	7
Optical	Captures images for real-time and post-mission analysis.	13	5
Radar	Provides position data to the Range Safety system to monitor launch vehicle flight in real time.	11	5
Range Safety	Processes and displays range instrumentation data and vehicle telemetry data to monitor the vehicle performance and allows the termination of an errant launch vehicle.	3	18
Telemetry	Receives, records, and relays position and performance data from launch vehicles.	28	33
Timing and Sequencing	Provides time coordination for range operations.	7	7
Weather	Forecasts weather to support range operations and weather warning conditions.	19	26
Total Number of Range Items at Each Range		**125**	**135**
Total Number of Range Items		**260**	**(U)**

Source: The Space Operations Command.

(U) Figure 3. Range Items (From Left): A Weather Tower and Radar Station at the Eastern Range and a Telemetry Station at the Western Range
Source: The Space Operations Command.

(U) Launch and Test Range System Integrated Support Contract

(U) The Space and Missile Systems Center awarded the Launch and Test Range System Integrated Support Contract (LISC) in November 2014.[5] Among other requirements, the LISC contractor is responsible for Launch and Test Range System organizational level maintenance at the eastern and western ranges.[6] Examples of organizational level preventative maintenance include lubricating moving parts, replacing defective wiring, and performing corrosion control. Additionally, the LISC performance work statement requires the contractor to document range-item sustainment problems on a Diminishing Manufacturing Sources and Material Shortages (DMSMS) List. A DMSMS problem is the loss (or impending loss) of items, raw materials, or software for DoD items.[7]

(U) The Space Force also required the LISC contractor to complete technical reports, such as the Instrumentation and Subsystem Performance Report and Range Launch Performance Analysis Anomaly Reporting 7-Day Anomaly Report (post-launch reports). These post-launch reports document range item performance for each launch, and include root cause analysis and corrective actions.

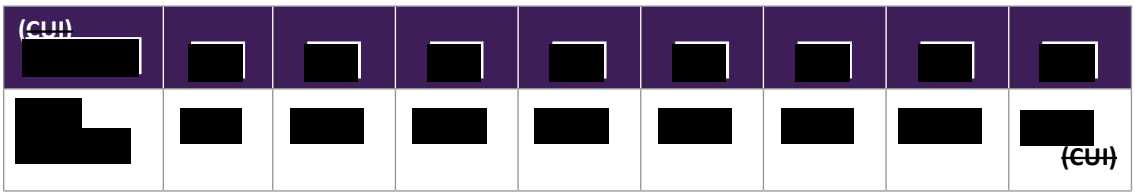
[5] (U) At the time of the LISC award, the Space and Missile Systems Center was a subordinate acquisition organization of the Air Force Space Command. The Space Force reorganized the Space and Missile Center as the Space Systems Command.

[6] (U) Organizational level maintenance is the routine maintenance activities performed by an organization on its assigned equipment.

[7] (U) DoD Instruction 4245.15, "Diminishing Manufacturing Sources and Material Shortages Management," November 5, 2020.

(U) From FY 2015 through FY 2021, the DoD obligated almost $908 million to the LISC for operations and sustainment support of range items. Table 3 displays the total yearly obligations to the LISC.

(U) Table 3. Amount Obligated to the LISC (in Millions)



* ~~(CUI)~~ [redacted]

Source: The Space Operations Command.

(U) What We Reviewed

(U) To determine whether the Space Force maintained launch range items, we selected 4 of 10 range subsystems (command destruct, radar, telemetry, and weather) at each range. Then we nonstatistically selected 10 range items from these subsystems at both the eastern and western range for a total of 20 range items in our review.[8] For each of these 20 range items, we analyzed the schedule and completion of preventative maintenance inspections (maintenance inspections).

(U) To determine whether range items enabled successful space launches, we:

- (U) reviewed a nonstatistical sample of post-launch reports of range items used during 30 of the 90 launches conducted between January 1, 2018, and March 31, 2021; and
- (U) interviewed SpOC and Space Launch Delta 30 and 45 officials regarding range performance during all 139 space launches that occurred on the eastern and western ranges from January 1, 2016, through March 31, 2021.

(U) Review of Internal Controls

(U) DoD Instruction 5010.40 requires DoD organizations to implement a comprehensive system of internal controls that provides reasonable assurance that programs are operating as intended and to evaluate the effectiveness of the controls.[9] We did not identify internal control weakness related to the Space Force's maintenance of launch range items and support during space launches.

[8] (U) The command destruct, radar, telemetry, and weather subsystems comprise 139 total items. We selected these subsystems because they include range items critical to ensuring public safety during launches and comprise large component pieces, such as radar dishes that are exposed to the weather and may experience more frequent maintenance problems as a result.

[9] (U) DoD Instruction 5010.40, "Managers' Internal Control Program Procedures," May 30, 2013, (Incorporating Change 1, June 30, 2020).

(U) Finding

(U) The Space Force Supported Launch Requirements, but Range Sustainment Challenges Exist

(U) The Space Force maintained launch range items and supported DoD, Federal civilian agencies, and commercial space launches. Specifically, maintenance personnel supporting the eastern and western ranges completed 253 of 262 (97 percent) required maintenance inspections for the 20 range items we reviewed. In addition, range item performance enabled successful launches for the 30 launches we reviewed out of 90 DoD, Federal civilian agencies, and commercial space launches, that occurred between January 2018 and March 2021.

(U) Although the Space Force maintained range items and enabled successful launches, according to Space Force data, 74 of all 260 (28 percent) items at the eastern and western ranges did not have the spare parts needed to repair or replace some range item components if necessary. This amount included 31 range items that did not have any spare parts for mission-critical range item components.[10] The Space Force lacked spare parts for the 74 range items because many of the spares were obsolete.[11]

(U) While the Space Force maintained launch range items and supported space launch requirements, the Space Force is at an increased risk that aging range items with obsolete components could limit future launch capacity on the eastern and western ranges. The Space Force projects that the total number of launches it will support will increase from 49 in 2021 to 157 by 2027, an increase of 220 percent. This increased operational tempo, combined with a lack of spare parts for mission critical range item components increases the possibility that a non-mission capable range item will cause a launch hold or scrub.[12] Furthermore, launch delays could occur on the eastern and western ranges if range items remain in a non-mission capable status for an extended period.

[10] (U) Mission critical components would, if they failed, result in post-launch data loss or a mission abort, or a pre-launch scrub or hold.

[11] (U) In the report, obsolete means these parts are no longer made or are not available for purchase.

[12] (U) A hold is when a launch countdown is paused, but the launch can still occur within an assigned launch timeframe. A scrub is when the launch is postponed to a different launch timeframe.

(U) The Space Force Properly Maintained Launch Range Items and Supported Space Launches

(U) The Space Force maintained launch range items and supported DoD, Federal civilian agencies, and commercial space launches. Specifically, we determined that maintenance personnel supporting the eastern and western ranges completed 253 of 262 required maintenance inspections for the 20 ranges items we reviewed, and range item performance enabled successful launches for the 30 launches we reviewed out of 90 DoD, Federal civilian agencies, and commercial space launches, that occurred between January 2018 and March 2021.

(U) Required Preventative Maintenance Inspections Completed

(U) Maintenance personnel supporting the eastern and western ranges completed 253 of 262 (97 percent) required maintenance inspections for the 20 range items we reviewed. According to the LISC performance work statement, the contractor is required to complete preventative maintenance procedures at specific intervals (for example, every 30, 90, and 180 days) in accordance with each range item's preventative maintenance master list.

(U) Maintenance personnel supporting the eastern and western ranges completed 253 of 262 (97 percent) required maintenance inspections for the 20 range items we reviewed.

(U) The Space Force uses the Integrated Maintenance Data System (IMDS) to schedule and track completion of all maintenance activities for range items. We obtained the preventative maintenance master list from IMDS for a nonstatistical sample of 20 range items from the eastern and western ranges, resulting in 789 required preventative maintenance procedures. We then selected a statistical sample of 63 of the 789 procedures that range maintenance personnel needed to complete between June 1, 2020, and May 31, 2021, and compared the list of required procedures to IMDS completion records. Because of the required frequency for each maintenance action, these 63 procedures resulted in 262 maintenance inspections. For example, one preventative maintenance procedure that is required every 30 days results in 12 maintenance inspections in a year. Examples of preventative maintenance procedures included cleaning components, corrosion control inspections, lubricating components, and replacing batteries. Table 4 displays the number of maintenance inspections, per range, that maintenance personnel completed.

(U) Table 4. Preventative Maintenance Completion Rates for Each Range

(U) Range	Required Maintenance Inspections	Completed Maintenance Inspections	Percent Completed
Eastern Range	94	87	93
Western Range	168	166	99
Total	**262**	**253**	**97** (U)

Source: The DoD OIG.

(U) Western range maintenance personnel stated that they did not complete two maintenance inspections because IMDS was not fully operational during a planned data migration from July 2020 through January 2021. Maintenance personnel explained that when IMDS was not fully operational, they used a manual process to track maintenance inspections, and they mistakenly overlooked and did not complete these two inspections. In addition, eastern range maintenance personnel stated that they did not complete seven maintenance inspections because the IMDS maintenance auto scheduler was not operating properly and did not schedule all maintenance procedures. An example of an incomplete maintenance inspection we reviewed is a biennial western range procedure, scheduled for August 2020, to replace water valves on a telemetry antenna. In this instance range maintenance personnel, rather than waiting until August 2022 for the next scheduled interval, completed this missed maintenance inspection in September 2021.

(U) We analyzed the data of completed maintenance inspections, and we determined that western range maintenance personnel completed 100 percent of the required inspections since the IMDS data migration was completed in January 2021. Similarly, eastern range maintenance personnel submitted a trouble ticket to the IMDS help desk to resolve the auto scheduler issue. Eastern range maintenance personnel told us they developed temporary procedures to ensure they schedule all maintenance inspections while they wait for the IMDS help desk to resolve the auto scheduler issue. Because range maintenance personnel completed 97 percent of the preventative maintenance inspections and took action to correct the causes of the missed maintenance inspections, we concluded that the Space Force properly maintained the range items we reviewed. Therefore, we are not making recommendations to address the missed maintenance inspections.

(U) Range Item Performance Helped Accomplish Successful Launches

(U) Range item performance enabled successful launches for the 30 launches we reviewed out of 90 DoD, Federal civilian agencies, and commercial space launches, that occurred between January 2018 and March 2021. According to the United States Code, the United States must, to the maximum extent practicable, be able to launch national security payloads whenever needed, and the National Space Policy requires that U.S. Government technology and infrastructure are available for commercial use.[13]

(U) Range item performance enabled successful launches for the 30 launches we reviewed out of 90 DoD, Federal civilian agencies, and commercial space launches, that occurred between January 2018 and March 2021.

(U) To verify that the Space Force enabled successful space launches, we selected a nonstatistical sample of 30 DoD, civil, and commercial launches completed between January 2018 and March 2021, and, for each launch, we reviewed post-launch reports. The post-launch reports described:

- (U) instances when range items did not perform as expected before or during the launch (anomalies);
- (U) whether corrective actions were taken to fix the anomalies; and
- (U) the impacts of those range item anomalies on the launch, including whether any anomalies led to a launch hold or scrub.

(U) We found various anomalies with different levels of impact during a launch. For example, during a 2020 launch attempt, a telemetry antenna receiver failed during pre-launch operations. In this example, range personnel removed and replaced the antenna receiver, and the range item performed normally for the remainder of the launch attempt. We considered range items to have supported successful space launches for all launches where we found no record of a range item anomaly, or for those launches during which anomalies occurred but did not cause a launch hold or scrub.

(U) We analyzed the post-launch reports and concluded that although range items experienced problems before or during a launch, none of those problems caused a launch hold or scrub. Table 5 summarizes the results of our review of the post-launch technical reports for each launch in our sample.

[13] (U) 10 U.S.C. § 2273 (2009), "Policy Regarding Assured Access to Space: National Security Payloads."

(U) Table 5. Results of Post-Launch Reporting Analysis

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Source: The DoD OIG.

(U) In addition to our analysis of the 30 space launches, we asked Space Force officials to explain any instances where range item performance resulted in a launch hold or scrub. SpOC and eastern and western range officials stated that range item performance did not delay any of the 139 space launches completed between January 2016 and March 2021. Specifically, Space Launch Delta 45 officials stated that the last time the eastern range delayed a launch because of a range-item problem was because of a radar tracking issue in 2015. Similarly, according to Space Launch Delta 30 officials, the western range rescheduled one space launch in 2016 because a wildfire destroyed communication lines before a launch, leading to a delay of several weeks.

(U) Based on our analysis of the post-launch reports and Space Force testimonial evidence, we concluded that the Space Force supported launch requirements as required by the United States Code and National Space Policy.

(U) Launch Range Sustainment Challenges Exist

(U) Although the Space Force maintained range items and enabled successful launches, 74 of all 260 (28 percent) eastern and western ranges' items did not have the spare parts needed to repair or replace some range item components when necessary. The LISC performance work statement requires the contractor to identify all range item sustainment problems on a list of DMSMS cases. Each DMSMS case included multiple data points, including the potential impact of the range item component failing, the number of spare parts for the component, and the planned actions to mitigate each DMSMS case. According to the April 2021 DMSMS case list, 31 range items did not have the spare parts needed to repair or replace mission-critical range item components when necessary. One example of a DMSMS case involved a missile lift-off trigger on the western range countdown system. The lift-off trigger unit was obsolete and replacement parts were not available. The DMSMS list noted that a project to replace this item with a modern lift off capability was approved and funded, and the estimated completion date was June 2022.

(U) The Space Force lacked spare parts for 68 of 74 range item components because, according to the DMSMS list, the spares were obsolete.

(U) The Space Force lacked spare parts for 68 of 74 range item components because, according to the DMSMS list, the spares were obsolete.[14] For example, the Space Force did not have spares for a western range telemetry antenna, which was first operational in 1967, because the manufacturer was out of business. According to the Space Force, the average age of range items with a potential mission impact and no available spares was more than 30-years old. During our site visit to

[14] (U) Six range items on the DMSMS list did not provide sufficient information for us to conclude the parts were obsolete.

(U) Vandenberg SFB, multiple personnel responsible for range item maintenance stated that they sometimes searched for spare parts for some components from resale sites, such as eBay.

(U) Space Force Took Action to Address Sustainment Challenges

(U) We found the Space Force took appropriate action to address eastern and western range sustainment problems. We asked Space Force personnel from SpOC, the Space Systems Command, and Space Launch Deltas 30 and 45 to describe their planned actions to mitigate DMSMS cases for 31 range items with potential mission-critical impacts and zero spare parts.[15] We determined that Space Force officials acted to mitigate these cases through a combination of on-going and planned range-item upgrades, in some cases, accepting the risk of the range item failing because there were redundant range items available, and divesting some range items. Of the 31 range items with a potential mission critical impact and zero spares, the Space Force:

- (U) completed upgrades to 4 range items; for example, the Space Force upgraded an uninterruptable power supply on a command transmitter on the western range;
- (U) funded upgrades for 9 range items (to be performed by contractors and the Ogden Air Logistics Center); for example, the Space Force will use the existing maintenance contract to replace an antenna system on the eastern range;
- (U) planned upgrades but was waiting for project funding for 1 range item; specifically, the Space Force was waiting to fund a western range radar upgrade;
- (U) is not planning to upgrade or divest 4 range items; an example of a range item without a planned upgrade is a western range radio frequency monitoring van; in this instance, western range personnel explained they had multiple vans they could use if one failed; and
- (U) plans to divest at least 18 of the 31 range items with DMSMS cases with potential mission-critical impacts and replace them with newer technology; for example, the Space Force will replace its legacy voice communications with voice-over internet protocol.[16]

(U) The Space Force expects the planned upgrades, regardless of funding status, to be complete prior to 2024.

[15] (U) We did not review the Space Force's actions to mitigate DMSMS cases that, if the item failed, would not result in launch delays or scrubs.

[16] (U) The total number of planned actions is 36, while the total number of range items we are referring to is 31; this is because some range items have multiple DMSMS cases with multiple mitigation plans. For example, a western range command transmitter has both a complete upgrade and will be divested.

(U) In addition to conducting and planning upgrades for range items with critical spare part shortages, the Space Force plans to mitigate many range item sustainment problems by using autonomous flight safety systems (AFSS). AFSS is an independent, launch-vehicle mounted system with the capability to track and, if necessary, terminate a launch vehicle's flight. This capability makes many range items unnecessary to ensure safety during a launch.

(U) Space Launch Delta 45 officials provided us an example of the impact the AFSS had on the range item support needed for each launch. Specifically, a recent launch of a vehicle that was not equipped with AFSS required 29 range items to support the launch. By comparison, a recent launch of a vehicle equipped with AFSS required only six range items to support the launch. In November 2019, the Chief of Space Operations required all space launch providers who want to launch from the eastern and western ranges to adopt AFSS on their launch vehicles by October 1, 2025. SpOC officials told us that they expect all space launch providers to transition by 2023. After launch providers adopt AFSS, the Space Force plans to divest some range items that will no longer be needed to support space launches. Examples include eastern and western range command destruct and range safety items.

(U) The range item upgrades, and the Chief of Space Operations mandate that launch providers use AFSS, are part of a larger range modernization initiative the Space Force refers to as the "Range of the Future 2028." The Space Force intends for the Range of the Future to, among other priorities, increase launch range capacity and enhance range capability. As part of the initiative, the Space Force is upgrading its legacy ranges communication architecture to a modern architecture, such as using voice over internet protocol, that will enable launch providers to use their own range instrumentation rather than rely on Space Force range items.

(U) During a June 2021 Range of the Future update, SpOC and Space Systems Command officials told the Chief of Space Operations that seven of the most critical architecture projects were in-progress and on schedule, while three remaining projects would begin later in 2021. These upgrades will enable the Space Force to decommission and replace some range items and will enable launch providers to use their own range instruments. This action further reduces the number of obsolete range items on which the Space Force will rely to support launches. Table 6 shows the project name, status, and impact of the project.

(U) Table 6. Status of Range of the Future Architecture Projects

(U) Project Name	Status	Expected Impact
Eastern Range Network Modernization	In Progress and On Schedule	Replaces legacy range networks with an internet protocol network.
Western Range Network Modernization	Pending Start Date	
RSHP (Phase 1)	In Progress and On Schedule	Establishes a modern data center, enables launch customers to establish their own roles on the network, and enhances network security.
RSHP (Phase 2)	In Progress and On Schedule	
RSHP (Phase 3)	In Progress and On Schedule	
RSHP (Phase 4)	In Progress and On Schedule	
Eastern Range TEPS	In Progress and On Schedule	Allows for centralized processing of telemetry data and increases launch capacity by enabling multi launch-mission monitoring.
Western Range TEPS	In Progress and On Schedule	
Eastern Range Plug and Play	Pending Start Date	Provides an initial capability for launch customers to use their own range instruments. (U)
Western Range Plug and Play	Pending Start Date	

(U) LEGEND

RSHP Range Services Hosting Platform

TEPS Telemetry End-to-End Processing System

Source: The Space Operations Command.

(U) Based on the Space Force's ongoing and planned upgrades to address the most critical DMSMS cases, the Chief of Space Operations mandate that launch providers use AFSS, and the overall range modernization efforts the Space Force is taking to address its range item sustainment problems, we are not making recommendations to the Space Force regarding this issue.

(U) Space Force Ranges at Risk of Limiting Launch Capacity

(U) The Space Force is at an increased risk that aging range items with obsolete components could limit launch capacity on the eastern and western ranges.

(U) While the Space Force maintained launch range items and supported space launch requirements, the Space Force is at an increased risk that aging range items with obsolete components could limit launch capacity on the eastern and western ranges. The Space Force projects that the total number of launches it will support will increase 220 percent by 2027. This increased operational tempo,

(U) combined with a lack of spare parts for mission critical range item components increases the possibility that a non-mission capable range item will cause a launch hold or scrub. Furthermore, launch delays could occur on the eastern and western ranges if range items remain in a non-mission capable status for an extended period. The Space Force acknowledged the challenges of its current range capability in its Range of the Future 2028 Strategic Intent, stating:

> (U) Our Ranges are quickly becoming the limiting constraint in meeting today's demand and this will only get worse as the demand increases. Our reliance on the success of the commercial space sector demands that we keep their activities resident on our Ranges. If we cannot evolve to meet commercial industry needs, we risk losing them to less constrained, more user-friendly locations, including foreign locations.[17]

(U) The Space Force's intent of the Range of the Future initiative is a modern range that can adapt to future launch demand. We believe this initiative is a reasonable attempt to support future launch requirements; however, until the Range of the Future is fully realized, the Space Force will continue to support space launches with aging range items that lack mission-critical spare parts. These aging items increase the risk that if the Space Force does not complete planned Range of Future upgrade projects on schedule, or if the anticipated increase in commercial launch requirements are higher than predicted, Space Force ranges may not be able to support all future launch requirements.

(U) Management Comments

(U) We considered management comments on a discussion draft copy of this report when preparing this final report. We did not make any recommendations; therefore, no management comments are required.

[17] (U) "U.S. Space Force Range of the Future 2028 Strategic Intent," February 2020.

(U) Appendix A

(U) Scope and Methodology

(U) We conducted this performance audit from February 2021 through November 2021 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

(U) The scope of our audit included Government-owned launch range items located at Patrick and Vandenberg SFB and included all space launches conducted from the eastern and western ranges from January 1, 2016, through March 31, 2021. We conducted this audit at Space Launch Delta 45 facilities at Patrick SFB, Florida, and Space Launch Delta 30 facilities at Vandenberg SFB, California. We also conducted teleconferences with SpOC officials at Peterson SFB, Colorado.

(U) To document range item maintenance procedures and challenges, during our site visits we toured range facilities and interviewed Government and contract employees responsible for operations and maintenance of launch range items. To understand DoD launch support requirements, we reviewed the United States Code and the National Space Policy.

(U) To learn launch range maintenance requirements, we reviewed DoD guidance, contract documents, such as the performance work statement, and contractually-required range item anomaly reports. We used the following criteria as our basis for our analysis.

- (U) 10 U.S.C. § 2273 (2009) "Policy Regarding Assured Access to Space: National Security Payloads."
- (U) "National Space Policy of the United States of America," December 9, 2020
- (U) Air Force Space Command Instruction 13-613, "Launch Forecasting, Planning, and Scheduling Procedures," July 16, 2018
- (U) "Western Range Instrumentation Handbook," October 23, 2018
- (U) "Eastern Range Capabilities Documentation and Instrumentation Handbook," July 15, 2020
- (U) Launch and Test Range Integrated Support Contract and its performance work statement

- (U) DoD Instruction 4245.15, "Diminishing Manufacturing Sources and Material Shortages Management," November 5, 2020
- (U) DoD Instruction 5010.40, "Managers' Internal Control Program Procedures," May 30, 2013, (Incorporating Change 1, June 30, 2020)

(U) This report was reviewed by the Space Force to identify whether any of its reported information, including legacy FOUO information, should be safeguarded and marked in accordance with the DoD CUI Program. In preparing and marking this report, we considered any comments submitted by the Space Force about the CUI treatment of its information. If the Space Force failed to provide any or sufficient comments about the CUI treatment of its information, we marked the report based on our assessment of the available information.

(U) Audit Universe and Sample Selection

(U) We used a combination of nonstatistical and statistical samples.[18] First, to determine whether the Space Launch Deltas completed scheduled preventative maintenance inspections, we selected a nonstatistical sample of 4 of 10 range subsystems (command destruct, weather, telemetry, and radar) at each range and then nonstatistically selected two or three range items from each subsystem, per range, for 20 range items. We obtained the preventative maintenance master list from IMDS for a nonstatistical sample of 20 range items from the eastern and western ranges, resulting in 789 preventative maintenance procedures.

(U) With assistance from the DoD OIG Quantitative Methods Division (QMD), we selected a statistical sample of 63 of the 789 procedures that range maintenance personnel needed to complete between June 1, 2020, and May 31, 2021, and compared the procedures to IMDS completion records. Because of the required frequency for each, these 63 procedures resulted in 262 required maintenance inspections. For example, one preventative maintenance procedure that is required every 30 days results in 12 required maintenance inspections in a year. We considered any maintenance procedure with a missed inspection to contain an error. See Appendix B for a description of the statistical sample plan and projection.

(U) To determine whether the range items enabled successful space launches, we reviewed evidence related to 139 space launches completed on the eastern and western ranges from January 2016 through March 2021. Specifically, to determine whether any space launches were delayed, canceled, or resulted in a mission failure because of range item performance, we reviewed post-launch reports for a nonstatistical sample of 30 of 90 space launches that were completed between

[18] (U) The results of a nonstatistical sample cannot be projected to the overall population.

(U) January 1, 2018, and March 31, 2021. We also reviewed written responses from SpOC and Space Launch Deltas 30 and 45 officials to our questions about whether any range items caused launch delays, cancellations, or mission failures from January 2016 through March 2021.

(U) Finally, to determine whether the Space Force was experiencing challenges sustaining range items, we obtained and analyzed the DMSMS technical report. We used the DMSMS report to develop a list of mission critical range item component shortages and reviewed the Space Force's planned actions to mitigate these shortages.

(U) Internal Control Assessment and Compliance

(U) We assessed internal controls and compliance with laws and regulations necessary to satisfy the audit objective. Specifically, we assessed Space Launch Delta 45 and 30's internal control activities for ensuring range item preventative maintenance completion and monitoring activities for evaluating range item performance. Control activities are actions management establishes through policies and procedures to achieve objectives while monitoring includes establishing activities to assess the quality of performance over time and promptly resolve any findings.

(U) We determined that Space Launch Deltas 45 and 30 designed and implemented control and monitoring activities for the completion of preventative maintenance inspection and range item performance, respectively. However, because our review was limited to these internal control components and underlying principles, it may not have disclosed all internal control deficiencies that may have existed at the time of this audit.

(U) Use of Computer-Processed Data

(U) We obtained range item maintenance documentation and scheduling data from the IMDS. IMDS is the standard Air Force and Space Force automated maintenance information management system. IMDS is designed to support aircraft communications-electronics, and equipment maintenance activities at worldwide operating bases.

(U) To verify that the IMDS data were reliable, we interviewed SpOC maintenance database analysts to discuss limitations, access controls, and data integrity. We obtained the IMDS Software User Manual and reviewed the capabilities of the system and internal controls in place. Lastly, we obtained examples of the IMDS maintenance data prior to selecting our samples to review for accuracy and completeness. We determined that the data we obtained were sufficiently reliable for purposes of this audit.

(U) Use of Technical Assistance

(U) We received assistance from QMD to develop the statistical sample plan for our review of the completion of preventative maintenance inspections and advised us on projecting the sample results. See Appendix B for the statistical sample plan and projection.

(U) Prior Coverage

(U) During the last 5 years, the GAO and the DoD OIG issued two reports discussing Space Launch-related topics. Unrestricted GAO reports can be accessed at http://www.gao.gov. Unrestricted DoD OIG reports can be accessed at http://www.dodig.mil/reports.html/.

(U) GAO

(U) Report No. GAO-21-154, "Commercial Space Transportation: FAA Should Examine a Range of Options to Support U.S. Launch Infrastructure," December 22, 2020

> (U) The GAO found that launch providers stated U.S. space transportation infrastructure is generally sufficient for them to meet their customers' requirements. The launch providers sought future improvements to the infrastructure, but were undecided on how to improve it. Some launch providers stated that infrastructure improvements would be required to increase launch capacity, while other launch providers believed new infrastructure and additional launch sites would increase the U.S.'s overall launch capacity.

(U) DoD OIG

(U) Report No. DODIG-2018-045, "Evaluation of the Evolved Expendable Launch Vehicle Program Quality Management System," December 20, 2017

> (U) The DoD OIG determined that Space Exploration Technologies, United Launch Alliance, and Aerojet Rocketdyne did not perform adequate quality assurance management of the EELV program.

(U) Appendix B

(U) Statistical Sample

(U) Population. The population consisted of 789 preventive maintenance procedures that range maintenance personnel needed to complete between June 1, 2020, and May 31, 2021.

(U) Parameters. QMD used a 90-percent confidence level and 10-percent margin of error to calculate a sample size of 63 for a simple random sample.

(U) Sample Plan. QMD used the RAND() function in MS Excel to randomize the population, from which the sample of 63 preventive maintenance procedures were selected without replacement.

(U) Analysis and Interpretation

(U) Fieldwork Results

(U) We analyzed the 63 preventive maintenance procedures in the sample and found that 6 included an error, indicating that the 9 missed maintenance inspections we found occurred within 6 of the 63 procedures.

(U) Statistical Projection

(U) Based on the analysis results we provided, QMD personnel calculated the following statistical projection to the population with a 90-percent confidence level.

(U) Table 7. Error Projection

(U)	Lower Bound	Point Estimate	Upper Bound
Rate (Percent)	2.8	9.5	16.2
Number	22	75	128 (U)

Source: The DoD OIG.

(U) We projected with a 90-percent confidence level that the percentage of preventative maintenance procedures that included an error was between 2.8 percent and 16.2 percent, with a point estimate of 9.5 percent. The corresponding number of preventative maintenance procedures that included an error was between 22 and 128 of 790, with a point estimate of 75.

(U) Acronyms and Abbreviations

AFSS	Autonomous Flight Safety System
DMSMS	Diminishing Manufacturing Sources and Material Shortages
IMDS	Integrated Maintenance Data System
LISC	Launch and Test Range System Integrated Support Contract
QMD	Quantitative Methods Division
SFB	Space Force Base
SpOC	Space Operations Command
U.S.C.	United States Code


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703.604.8324

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