United States Government Accountability Office

May 2021

OIL AND GAS

Interior Should Strengthen Management of Key Data Systems Used to Oversee Development on Federal Lands

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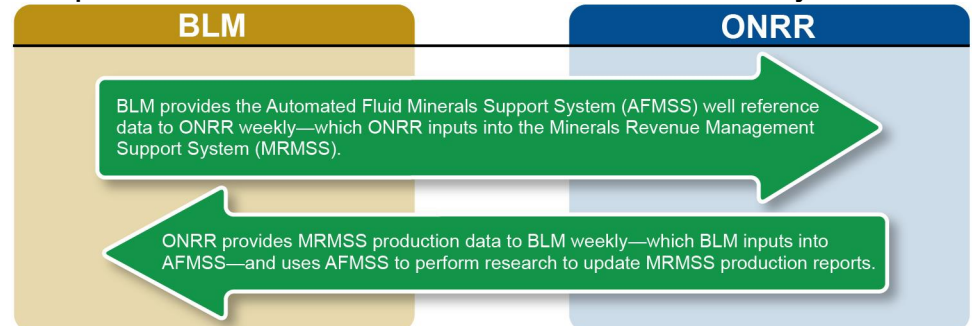
GAO-21-209

May 2021

OIL AND GAS

Interior Should Strengthen Management of Key Data Systems Used to Oversee Development on Federal Lands

Why GAO Did This Study

Development of oil and gas resources on federal lands helps supply the U.S. with energy and generates billions of dollars annually in revenues. To oversee this development, Interior relies on aging data systems, which it is planning to replace.

GAO was asked to review the data systems Interior uses to oversee oil and gas development on federal lands and waters. This report (1) describes how Interior uses key data systems to oversee oil and gas development on federal lands, (2) examines challenges Interior faces in using these systems, and (3) evaluates Interior's implementation of leading practices in developing requirements for replacement systems.

GAO reviewed documents, interviewed officials from federal and state agencies, visited BLM and ONRR offices in Colorado and New Mexico, and assessed Interior's implementation of relevant leading practices.

What GAO Recommends

GAO is making six recommendations, including that Interior develop a plan to improve data sharing among its key data systems and that Interior update its guidance for developing new data systems to address how program offices are to implement agile development.

Interior concurred with GAO's recommendations.

What GAO Found

The Department of the Interior (Interior) uses three key data systems to oversee oil and gas development on leased federal lands: the Automated Fluid Minerals Support System (AFMSS), Legacy Rehost 2000 (LR2000), and the Minerals Revenue Management Support System. Interior's Bureau of Land Management (BLM) and Office of Natural Resources Revenue (ONRR) staff rely on data across these systems to carry out responsibilities such as processing permits for drilling wells and ensuring appropriate payments are made based on production.

According to agency documents and officials, limited automated sharing of data among these systems is one of four challenges. Although the systems use some of the same information, such as lease and well numbers, they do not fully connect or communicate with each other, complicating oversight. For example, GAO calculated, based on agency estimates, that ONRR spends the equivalent of approximately 10 full-time employees in staff hours every year on conversion and error correction due to fragmented systems. Best practices call for coordinating and sharing data assets across federal agencies. Though Interior is developing replacement data systems, it does not have a finalized plan to facilitate comprehensive data sharing among them. Without such a plan, Interior risks continuing to spend staff time that could be better spent on other priorities.

Example of Oil and Gas Data Shared between BLM and ONRR Data Systems

BLM provides the Automated Fluid Minerals Support System (AFMSS) well reference data to ONRR weekly—which ONRR inputs into the Minerals Revenue Management Support System (MRMSS).

ONRR provides MRMSS production data to BLM weekly—which BLM inputs into AFMSS—and uses AFMSS to perform research to update MRMSS production reports.

Source: GAO analysis of Bureau of Land Management (BLM) and Office of Natural Resources Revenue (ONRR) data. | GAO-21-209

Text of Example of Oil and Gas Data Shared between BLM and ONRR Data Systems

- BLM provides the Automated Fluid Minerals Support System (AFMSS) well reference data to ONRR weekly—which ONRR inputs into the Minerals Revenue Management Support System (MRMSS).

- ONRR provides MRMSS production data to BLM weekly—which BLM inputs into AFMSS—and uses AFMSS to perform research to update MRMSS production reports.

Interior has not fully implemented leading practices in developing requirements to ensure the replacement systems meet user needs. Such practices have been found to improve development of federal data systems. BLM officials said they are developing replacement systems using an agile software development approach, which builds software incrementally based on users' requirements and continuously evaluates functionality, quality, and customer satisfaction. For

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example, BLM program offices responsible for developing systems to replace AFMSS and LR2000 stated that they meet quarterly with system stakeholders to prioritize and agree on features and functionality. However, the program offices do not have a defined process to implement the agile approach because it is not addressed in Interior's guidance on data system development. By updating the guidance to reflect how program offices can implement an agile development approach, Interior would have better assurance that its new data systems will function as intended to meet user needs and reduce budget and schedule risks.

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Abbreviations

AFMSS	Automated Fluid Minerals Support System
BLM	Bureau of Land Management
CDO	Chief Data Officer
CIO	Chief Information Officer
FDS	Federal Data Strategy
FITARA	Federal Information Technology Acquisition Reform Act
Interior	Department of the Interior
IT	information technology
IT4RM	Information Technology for Resource Management
LR2000	Legacy Rehost 2000
MLRS	Minerals and Land Records System
MRMSS	Minerals Revenue Management Support System
NOC	National Operations Center
OCIO	Office of the Chief Information Officer
OGOR	Oil and Gas Operations Report
OIG	Office of Inspector General
OMB	Office of Management and Budget
ONRR	Office of Natural Resources Revenue
SDLG	Solution Development Lifecycle Guide

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U.S. GOVERNMENT ACCOUNTABILITY OFFICE
A Century of Non-Partisan Fact-Based Work

441 G St. N.W.
Washington, DC 20548

May 27, 2021

The Honorable James Lankford
Ranking Member
Subcommittee on Government Operations
   and Border Management
Committee on Homeland Security and Governmental Affairs
United States Senate

Dear Senator Lankford:

Development of oil and gas resources on leased federal lands and waters supplies the U.S. with important energy resources and generates billions of dollars annually in revenues.[1] Two agencies within the U.S. Department of the Interior (Interior) share oversight responsibilities for federal onshore oil and gas development: the Bureau of Land Management (BLM) and the Office of Natural Resources Revenue (ONRR). BLM and ONRR use data systems in conducting their respective responsibilities, which include leasing and permitting lands for development and ensuring that production of oil and gas is appropriately accounted for and that appropriate royalties are paid. In particular, these agencies use three key, mission-critical systems: BLM's Automated Fluid Minerals Support System (AFMSS), which tracks oil and gas wells; the Legacy Rehost 2000 (LR2000) system, which tracks oil and gas leases; and ONRR's Minerals Revenue Management Support System (MRMSS), which reports on and tracks operators' oil and gas production and associated payment information.

These key data systems have aged—the oldest system, LR2000, was created in 1998, and the youngest, AFMSS, was developed in 2001. The systems present challenges to Interior's adoption of modern, innovative approaches to doing business, and Interior is working to replace them. In fiscal year 2019, Interior spent approximately $39.2 million on the management and modernization of the three key data systems, including

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[1]According to the U.S. Department of the Interior (Interior), which oversees such development, these revenues represent one of the federal government's largest sources of nontax revenues.

GAO-21-209 Key Oil and Gas Data Systems

development of their replacements.[2] In September 2020, we identified BLM's ongoing effort to modernize AFMSS as one of the 16 most critical information technology (IT) acquisitions across the federal government.[3] The Secretary of the Interior has said that the department's decentralized management of IT resources presents serious challenges, including inefficient and duplicative IT spending, poor interoperability and integration among mission IT systems, and limited visibility and understanding of the full IT environment at various levels.[4] In an effort to rectify these challenges, Interior implemented its plan to establish formal lines of authority for IT and information resources management between the Office of the Chief Information Officer (OCIO) and agency leadership. This approach was to enable Interior to better manage existing resources across the department and work to eliminate duplicative efforts and increase efficiency, according to Interior.[5]

The Software Engineering Institute has developed highly regarded and widely used guidance on IT acquisition and development, including leading practices for developing and managing data system

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[2]Interior spent approximately $17.1 million on BLM's AFMSS and its replacement system; $3.6 million on LR2000 and its replacement; and $18.5 million on ONRR's MRMSS, which it is in the early stages of planning to replace.

[3]BLM plans to replace AFMSS with AFMSS II. As of July 2020, AFMSS and some modules of AFMSS II were operating concurrently until all replacement modules are completed and the aging AFMSS system can be decommissioned. GAO, *Information Technology: Key Attributes of Essential Federal Mission-Critical Acquisitions*, GAO-20-249SP (Washington, D.C.: Sept. 8, 2020).

[4]Department of the Interior, Secretary of the Interior, *Strengthening and Securing Information Management and Technology at the Department of the Interior,* Order No. 3340 (Washington, D.C.: Aug. 15, 2016).

[5]Department of the Interior, Office of the Secretary, *DOI's Information Resources Management (IRM) Strategic Plan* (Washington, D.C.: May 29, 2015).

requirements.[6] According to the Software Engineering Institute, the requirements for a data system describe the functionality needed to meet user needs and perform as intended in the operational environment. We have previously reported on the importance of requirements for federal data systems to help reduce risks.[7] Implementation of leading practices for requirements—such as eliciting stakeholder needs, validating requirements, and managing requirements changes—has been found to improve outcomes for federal data systems. When agencies implement leading practices for requirements, they can help reduce the risks associated with development and acquisition of federal data systems.

You asked that we review the use of data systems in Interior's management of oil and gas development on leased federal lands and waters. This report (1) describes how Interior uses key data systems to oversee oil and gas development on federal lands, (2) examines challenges Interior faces in managing and using these systems, and (3) evaluates Interior's implementation of leading practices for requirements for these key data systems.

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[6]In this report, we will refer to these as "leading practices for requirements." The Software Engineering Institute is a federally funded research and development center operated by Carnegie Mellon University. Its mission is to establish and advance software as a strategic advantage for national security, and to lead and direct research and transition of software engineering and related disciplines in academia, industry, and government. Carnegie Mellon University, Software Engineering Institute, *Capability Maturity Model® Integration for Development,* Version 1.3 (Pittsburgh, PA: November 2010). As we reported in 2006, in requirements development, an organization gathers, generates, and analyzes customer, products, and product-component requirements. This includes elicitation, analysis, and communication of customer and stakeholder requirements, as well as technical requirements. In requirements management, an organization manages the business and system requirements and identifies inconsistencies among requirements and the project's plans and work products. This includes managing all technical and nontechnical requirements through the life cycle, as well as any changes to the requirements as they evolve. GAO, *Business Systems Modernization: IRS Needs to Complete Recent Efforts to Develop Policies and Procedures to Guide Requirements Development and Management*, GAO-06-310 (Washington, D.C.: Mar. 20, 2006).

[7]See, for example: GAO, *Information Technology: FEMA Needs to Address Management Weaknesses to Improve Its Systems*, GAO-16-306 (Washington, D.C.: Apr. 5, 2016); *Information Technology: Critical Factors Underlying Successful Major Acquisitions*, GAO-12-7 (Washington, D.C.: Oct. 21, 2011); *Information Technology: Census Bureau Needs to Implement Key Management Practices*, GAO-12-915 (Washington, D.C.: Sept. 18, 2012); and *Secure Border Initiative: DHS Needs to Reconsider Its Proposed Investment in Key Technology Program*, GAO-10-340 (Washington, D.C.: May 5, 2010).

To describe how Interior uses key data systems to oversee oil and gas development on federal lands,[8] we reviewed relevant laws and regulations, as well as BLM and ONRR documents such as procedural handbooks, management policies, and the systems' operational analyses. We also interviewed Interior officials, including BLM officials from five of 10 BLM state offices—Colorado, Nevada, New Mexico, Utah, and Wyoming—and eight of 33 field offices that manage oil and gas development—Canon City, Colorado; Carson City, Nevada; Carlsbad and Farmington, New Mexico; Salt Lake City and Vernal, Utah; and Buffalo and Lander, Wyoming. We selected this nongeneralizable sample of offices to include a range of oil and gas workloads based on the number of oil and gas wells each office manages.[9] We also interviewed personnel at Interior's OCIO, BLM's National Operations Center (NOC), and ONRR's Denver office. Further, we conducted site visits to BLM and ONRR offices in Colorado and New Mexico to receive in-person demonstrations of the data systems and to discuss the use and management of the oil and gas systems.

To examine challenges that Interior faces in managing and using its key data systems, we reviewed prior Interior Office of Inspector General (OIG) reports, GAO reports, Interior's guidance, and other relevant documents from Interior, BLM, and ONRR. Additionally, we conducted interviews and site visits with the selected offices to identify current challenges in using Interior's key oil and gas data systems, to determine the extent to which these challenges are impacting users and the organization, and to assess management efforts to address the challenges as the systems are being

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[8]Interior manages onshore and offshore oil and gas development on federal and Indian lands. Onshore, Interior oversees 700 million acres of subsurface minerals mostly through BLM. Offshore, Interior oversees oil, gas, and wind development through the Bureau of Ocean Energy Management. This report discusses only onshore oil and gas development on federal lands.

[9]We considered BLM field offices that manage more than 10,000 wells to have a large workload; those that manage between 1,000 and 10,000 wells to have a medium workload; and those that manage fewer than 1,000 wells to have a small workload, based on BLM's fiscal year 2018 AFMSS data. We met with three BLM field offices that managed a large workload, two field offices that managed a medium workload, and three field offices that managed a small workload. Further, since operators electronically submit information to ONRR and the office does not enter other types of data, we decided not to meet with additional ONRR offices. The findings from the interviews with officials from these selected offices cannot be generalized, in a statistical sense, to those we did not include in our review. However, given that all field offices are using the same data platforms, there is no reason to believe that these findings are anomalous to the field offices in our sample.

modernized. We combined the specific challenges identified in documents, interviews, and site visits with selected officials into broader categories, and we focused our report on the categories of challenges most frequently cited.

We compared Interior's efforts to address the challenges with relevant policies, such as BLM's Data Administration and Management policy manual,[10] Interior's IT Solution Development Lifecycle Guide (SDLG),[11] and the best practices identified by the Federal Data Strategy (FDS).[12] We interviewed state government oil and gas regulatory officials from four states—Colorado, Nevada, New Mexico, and Wyoming—about their management of oil and gas development on state lands, the best practices they follow to develop and manage their data systems, their coordination with BLM offices, and their insights on Interior's oil and gas data systems.[13] We conducted a site visit to a state regulatory agency in Colorado to receive an in-person demonstration of the data system the state uses and to discuss the use and management of the oil and gas system.

To evaluate Interior's implementation of leading practices for requirements for its key data systems, we reviewed leading practices for requirements and relevant Interior and ONRR guidance. First, we reviewed the Software Engineering Institute's guidance on requirements to identify leading practices in four areas: (1) develop customer requirements, (2) develop product requirements, (3) analyze and validate requirements, and (4) manage requirements.[14] Each of the practices in

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[10]Department of the Interior, Bureau of Land Management, Manual Transmittal Sheet, *1283 - Data Administration and Management (Public)* (July 10, 2012).

[11]Department of the Interior, Office of the Chief Information Officer, *Information Technology Development Lifecycle Guide* (Washington, D.C.: September 2005).

[12]In June 2019, the Office of Management and Budget (OMB) established FDS, consisting of operational principles and best practices to help agencies address challenges such as with data sharing within and across federal agencies, training, and data quality. Office of Management and Budget, Executive Office of the President, Memorandum for the Heads of Executive Departments and Agencies*, Federal Data Strategy – A Framework for Consistency* (Washington, D.C.: June 4, 2019).

[13]We reached out to state oil and gas regulatory agencies in each of the five states we selected, based on our BLM field office methodology. We also reached out to the Utah State agency but did not receive a response back to our request.

[14]Carnegie Mellon University, Software Engineering Institute, *Capability Maturity Model® Integration for Development, Version 1.3* (Pittsburgh, PA: November 2010).

those four areas included a number of subpractices to be met in order to achieve the overall practice.

Second, to evaluate Interior's implementation of leading practices for requirements for its key data systems, we analyzed agency documentation such as software requirements specifications, program planning documents, and improvement and change requests from users to identify the extent to which Interior and the responsible program offices implemented the leading practices. We also observed demonstrations of program offices' use of software to develop and manage requirements for AFMSS II, BLM's update to the aging AFMSS system; and the Mineral and Land Records System (MLRS), BLM's replacement for the aging LR2000 system. In the absence of documentation, we evaluated the extent to which the demonstrations addressed leading practices and subpractices. Appendixes I through V provide additional information on our evaluation of these practices and subpractices. Two analysts reviewed evidence of Interior's implementation of the various practices and agreed to the final ratings for each practice and subpractice. On the basis of our assessment of the documentation, discussions with agency officials, and software demonstrations, we rated the agency's implementation of the subpractices as follows:

- fully demonstrated, if the documents or software demonstrations supported all aspects of the practice;

- partially demonstrated, if the documents or software demonstrations supported some, but not all, aspects of the practice; and

- not demonstrated, if the documents or software demonstrations did not support any aspect of the practice, or agency officials were not able to provide documentation or software demonstrations in support of the practice.

We did not rate a system if it was not yet operational and could not be assessed against the leading practices for requirements management. We also evaluated the extent to which ONRR and BLM have documented processes that address leading practices for requirements. We interviewed Interior, BLM, and ONRR officials responsible for the development and management of the key data systems. We discussed our observations in interviews with cognizant officials from Interior, BLM, and ONRR program offices responsible for these systems.

We conducted this performance audit from November 2018 to May 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.

Background

OCIO, BLM, and ONNR's Responsibilities and Organizational Structure

According to Interior, the OCIO provides leadership to Interior and its agencies in all areas of information management and technology. The office is to fulfill the department's mission of enabling transparency and accessibility of information and services to the public through effective and innovative use of technology and information resources. This includes ensuring compliance with basic standards of quality information, providing information management and assurance, and maintaining records management across the department.

According to BLM, the agency manages the federal government's onshore oil and gas program with the goals of facilitating safe and responsible energy development while providing a fair return for the American taxpayer. To do this, BLM issues leases for private entities to develop oil and gas resources on roughly 700 million acres of (1) BLM land, (2) other federal agencies' land, and (3) private land where the federal government owns the mineral rights. According to BLM, at the end of fiscal year 2018, about 26 million federal acres were leased to oil and gas companies (operators) on 38,147 leases considered in effect. Of that amount, about 12.8 million acres were producing oil and gas in economic quantities from over 96,000 wells on about 24,000 oil and gas leases (see fig. 1).

Figure 1: BLM Managed Over 24,000 Producing Oil and Gas Leases on About 12.8 Million Producing Acres of Federal Lands in 29 States in Fiscal Year 2018
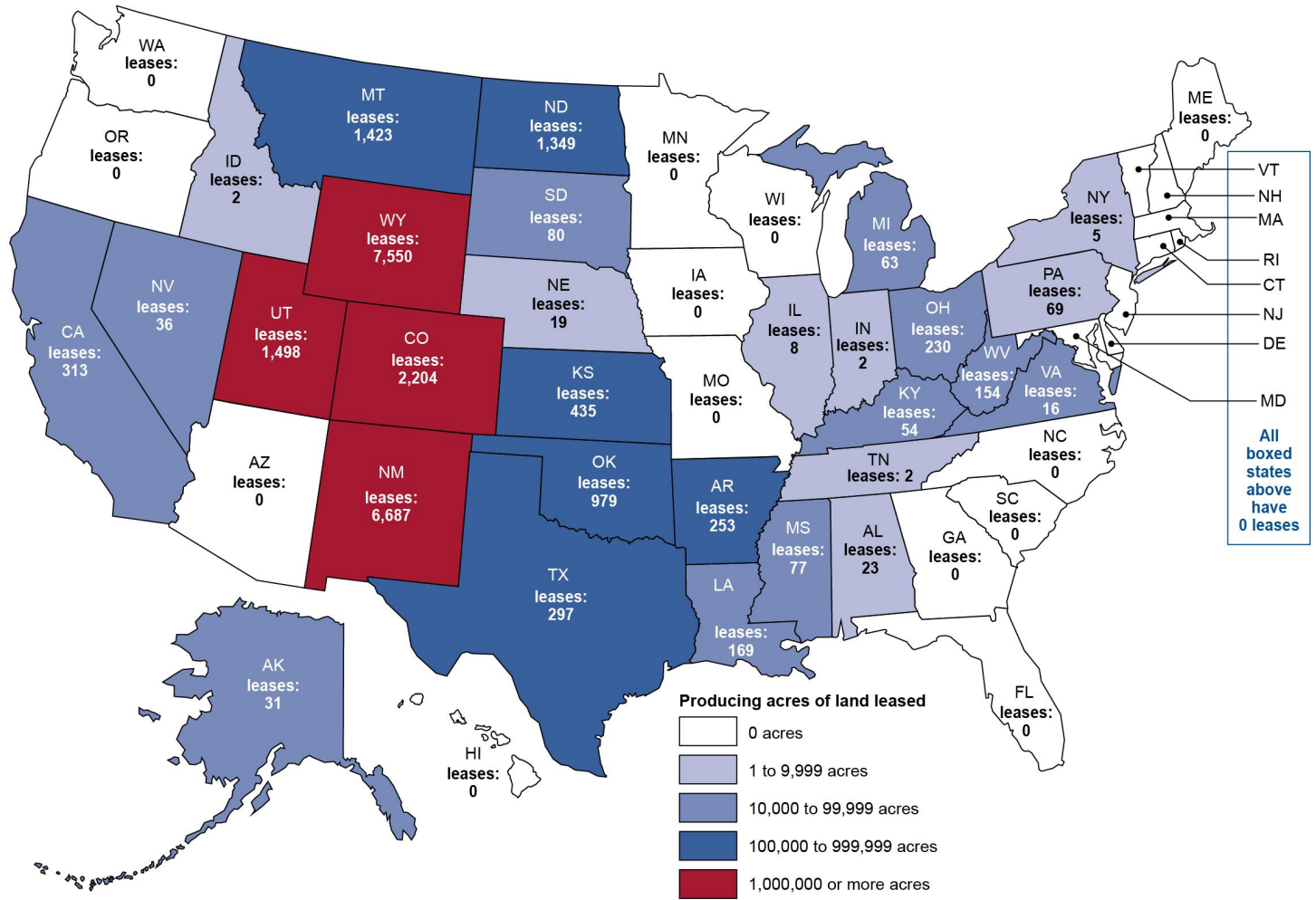
Sources: GAO analysis of Bureau of Land Management (BLM) statistical data; Map Resources (map). | GAO-21-209

Data table for Figure 2: BLM Managed Over 24,000 Producing Oil and Gas Leases on About 12.8 Million Producing Acres of Federal Lands in 29 States in Fiscal Year 2018

Geographic State	Number of Producing Leases (FY 2018)	Acreage of Producing Leases (FY 2018)
Alabama	23	7,201
Alaska	31	18,847
Arizona	0	0
Arkansas	253	122,481

Geographic State	Number of Producing Leases (FY 2018)	Acreage of Producing Leases (FY 2018)
California	313	78,604
Colorado	2,204	1,502,100
Connecticut	0	0
Delaware	0	0
Florida	0	0
Georgia	0	0
Hawaii	0	0
Idaho	2	2,333
Illinois	8	1,581
Indiana	2	68
Iowa	0	0
Kansas	435	108,992
Kentucky	54	32,916
Louisiana	169	56,311
Maine	0	0
Maryland	0	0
Massachusetts	0	0
Michigan	63	30,886
Minnesota	0	0
Mississippi	77	38,131
Missouri	0	0
Montana	1,423	692,880
Nebraska	19	8,825
Nevada	36	24,437
New Hampshire	0	0
New Jersey	0	0
New Mexico	6,687	3,788,712
New York	5	1,182
North Carolina	0	0
North Dakota	1,349	602,884
Ohio	230	33,136
Oklahoma	979	148,439
Oregon	0	0
Pennsylvania	69	4,761
Rhode Island	0	0
South Carolina	0	0

Geographic State	Number of Producing Leases (FY 2018)	Acreage of Producing Leases (FY 2018)
South Dakota	80	46,444
Tennessee	2	736
Texas	297	183,495
Utah	1,498	1,111,012
Vermont	0	0
Virginia	16	14,491
Washington	0	0
West Virginia	154	55,956
Wisconsin	0	0
Wyoming	7,550	4,076,711
TOTAL	24,028	12,794,553

Note: States that do not have producing oil and gas leases also do not have any producing acreage of leased land.

BLM administers its programs through its headquarters office in Grand Junction, Colorado; 12 state offices; 38 district offices; and 127 field offices. Of these, 10 state offices and 33 field offices manage oil and gas programs, and these are located primarily in the Mountain West, the center of much of BLM's oil and gas development. BLM headquarters typically develops guidance and regulations for the agency; and the state, district, and field offices generally manage and implement the agency's programs. Figure 2 shows the administrative boundaries of the 12 BLM state offices with the locations of the offices themselves, along with ONRR's headquarters and administrative offices.

Figure 2: Boundaries and Locations of the 12 BLM State Offices and the Locations of the Seven ONRR Offices
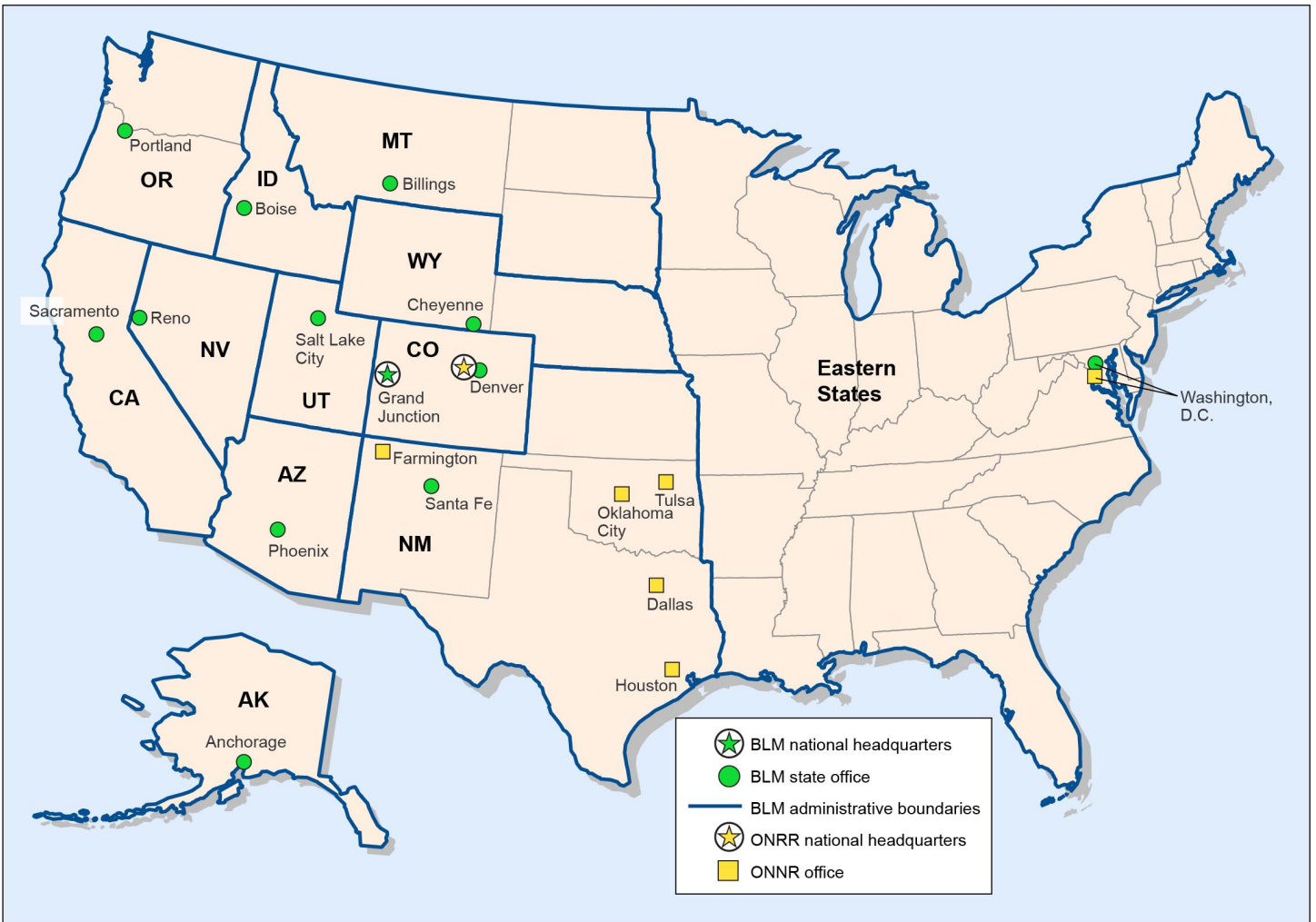
Sources: GAO analysis of Bureau of Land Management (BLM) and Office of Natural Resources Revenue (ONRR) data; Map Resources (map). | GAO-21-209

ONRR manages and ensures full payment of revenues owed to the federal government for the development of the nation's energy and natural resources offshore and on onshore federal and Indian lands.[15]

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[15]In 2010 and 2011, Interior reorganized the Minerals Management Service's Minerals Revenue Management into ONRR. For the purposes of this report, we refer to the current relevant bureaus when describing our prior recommendations and actions the bureaus have taken. GAO, *Oil and Gas Resources: Interior's Production Verification Efforts and Royalty Data Have Improved, but Further Actions Needed*, GAO-15-39 (Washington, D.C.: Apr. 7, 2015).

The Mineral Leasing Act of 1920, as amended, requires companies (operators) that obtain federal oil and gas leases to generally pay royalties and fees to the federal government, which Interior's ONRR collects.[16] ONRR administers its program through its headquarters office in the Denver federal center in Lakewood, Colorado. ONNR has five field offices near energy development areas in New Mexico, Oklahoma, and Texas and an Interior liaison office in Washington, D.C.

High-Risk Areas: Interior's Management of Oil and Gas Resources and Federal IT Acquisitions

Since 2011, we have designated Interior's management of federal oil and gas resources as a high-risk area vulnerable to fraud, waste, abuse, and mismanagement,[17] due to challenges we identified such as weaknesses in Interior's human capital management and shortcomings in Interior's revenue collection policies.[18] For example, we reported in 2019 that Interior has taken steps to implement recommendations we made to improve human capital management but continues to experience problems training and retaining sufficient staff.[19]

In addition, we have designated the government-wide management of IT acquisitions and operations, which includes Interior, as a high-risk area since 2015.[20] While the executive branch has undertaken numerous initiatives to better manage the more than $90 billion that is annually invested in IT, we have found that federal IT investments too frequently fail or incur cost overruns and schedule slippages while contributing little to mission-related outcomes. These investments often suffer from a lack of disciplined and effective management, such as project planning, requirements definition, and program oversight and governance. We reported in our 2019 High-Risk Update that the Office of Management and Budget (OMB) and other agencies were making progress in

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[16]30 U.S.C. § 226(b)(1)(A), (c)(1).

[17]GAO, *High-Risk Series: An Update*, GAO-11-278 (Washington, D.C.: Feb. 16, 2011).

[18]We also included Interior on the high-risk list due to inherent challenges Interior faces in reorganizing its offshore and revenue collection functions.

[19]GAO, *High-Risk Series: Substantial Efforts Needed to Achieve Greater Progress on High-Risk Areas*, GAO-19-157SP (Washington, D.C.: Mar. 6, 2019).

[20]GAO, *High-Risk Series: An Update*, GAO-15-290 (Washington, D.C.: Feb. 11, 2015).

implementing federal reforms designed to improve federal management of IT acquisitions.[21] We further reported that more work remained at agencies to further implement the requirements and by OMB to provide sustained oversight to ensure agency actions are completed and the desired results are achieved.

Overview of Leading Practices for Requirements of Software and Systems

When acquiring or developing new software or modifying existing data systems, project teams and developers must define the requirements and must also manage changes to those requirements. Requirements establish what the system is to do, how well it is to do it, and how it is to interact with other systems. Well-defined and managed requirements are the foundation of effective system development and acquisition efforts. *The Software Engineering Institute's Capability Maturity Model® Integration for Development, Version 1.3*, identifies leading practices in four areas related to developing and managing requirements: [22]

- Develop customer requirements: collect stakeholder needs, expectations, constraints, and interfaces, and translate them into customer requirements.

- Develop product requirements: refine and elaborate customer requirements to develop product and product component requirements.

- Analyze and validate requirements: analyze and validate the requirements with respect to the end user's intended environment; and

- Manage requirements: manage requirements and identify inconsistencies with project plans and work products.

These four practices include a total of 15 subpractices, which are further described in appendixes I through V.

According to the Software Engineering Institute, organizations should also establish and maintain plans that outline the processes for performing and achieving these leading practices for requirements and that set and reinforce expectations for relevant stakeholders. The Software

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[21]GAO-19-157SP.

[22]Carnegie Mellon, *Capability Maturity Model® Integration.*

Engineering Institute recommends having a documented and disciplined process for developing and managing requirements to reduce the risk of developing a system that does not meet user needs, cannot be adequately tested, and does not perform or function as intended.

Overview of Incremental and Agile Software Development

Federal agencies are moving away from long and sequential software development approaches and implementing more incremental development approaches.[23] As we have previously reported and testified, federal IT projects have often failed. Even after projects have exceeded budgets by millions of dollars and experienced years in schedule delays, the results have not met requirements. As part of Congress's effort to reform the government-wide management of IT, in December 2014, the federal information technology acquisition reform provisions (commonly referred to as FITARA) of the Carl Levin and Howard P. "Buck" McKeon National Defense Authorization Act for Fiscal Year 2015 were enacted.[24] FITARA provides that OMB shall require in its annual IT capital planning guidance that each covered agency's Chief Information Officer (CIO) certify that IT investments are adequately implementing incremental development.[25] In OMB's guidance, adequate incremental development is defined as, for the development of software or services, planned and actual delivery of new or modified technical functionality to users at least every 6 months.

Agile software development—one form of incremental development—calls for the rapid delivery of software. [26] Probably the most well-known feature of agile software development is iterative product development and delivery—that is, development of software in segments that are

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[23]Incremental or modular development is where an investment may be broken down into discrete projects, increments, or useful segments, each of which is undertaken to develop and implement the products and capabilities that the larger investment must deliver. Dividing investments into smaller parts helps to reduce investment risk, deliver capabilities more rapidly, and permit easier adoption of newer and emerging technologies.

[24]Pub. L. No. 113-291, div. A, tit. VIII, subtit. D, 128 Stat. 3292, 3438-50 (2014).

[25]Pub. L. No. 113-291, § 831 (codified at 40 U.S.C. § 11319(b)(1)(B)(ii)).

[26]Agile software development supports the delivery of software in small, short increments rather than in the typically long, sequential phases. More a philosophy than a methodology, agile emphasizes this early and continuous software delivery, as well as using collaborative teams, and measuring progress with working software. GAO, *Agile Assessment Guide: Best Practices for Agile Adoption and Implementation,* GAO-20-590G (Washington, D.C.: Sept. 28, 2020).

continuously evaluated against requirements. This method is well suited for programs in which the final product is to include distinct features, some of which may be discovered during the process rather than planned at the beginning. These frequent iterations can effectively measure progress and allow developers to respond quickly to feedback from customers, thus reducing technical and programmatic risk. With its emphasis on early and continuous delivery of working software, agile can be a valuable tool for federal agencies in mitigating schedule and budget risks.

Interior Uses Three Key Data Systems to Oversee Oil and Gas Development on Federal Lands

Interior uses three key data systems to supply the department and its agencies with information to oversee oil and gas development on federal lands: LR2000, AFMSS, and MRMSS.[27] According to Interior's documentation and our interviews with officials, BLM and ONRR work across these systems to manage leasing actions, operations, compliance verification, and noncompliance enforcement and resolution, among other processes.

BLM and ONRR Use Three Key Data Systems to Manage Lease, Well, and Production Data

Interior uses three key data systems to oversee oil and gas development on federal lands. BLM is the lead agency for two of these systems—LR2000 and AFMSS—and ONRR is the lead for the other—MRMSS.

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[27]Interior manages onshore and offshore oil and gas development on federal and Indian lands. This report discusses only onshore oil and gas development on federal lands. For the purposes of this report, we excluded systems used to manage oil and gas activities on Indian lands, offshore, small systems used for a limited number of states, and newly developed systems.

LR2000. BLM uses LR2000 to process information associated with oil and gas leases.[28] According to BLM, LR2000 provides internal users (the agency) and external users (such as operators and the public) with access to data extracted from BLM's lease files that support the BLM land, mineral, and resources programs.[29] In addition, LR2000 includes data on bonds that lease holders or operators provide to ensure complete and timely reclamation of the well sites and compliance with the terms and conditions of the lease. In fiscal year 2012, BLM began the process of replacing LR2000 with MLRS. According to an agency document, much of the LR2000 technology is obsolete, and the effectiveness of maintaining and adding features to LR2000 has declined while costs have increased.[30] According to agency officials, as of May 2020, MLRS is still in the early stages of development. According to Interior, in fiscal year 2019 the department spent about $1.4 million on IT investment for LR2000 and $2.2 million on MLRS. According to BLM, the total cost through 2021 for developing MLRS is $17 million, as of December 2020.

AFMSS. BLM uses AFMSS to collect, manage, and share information on wells' statuses from the initial permitting of a well through its final plugging and abandonment, including all well inspection and enforcement activities.[31] The system's core data include data on wells and operator compliance. According to BLM, the system is over 20 years old and is being updated to make it more cost-effective to maintain and meet changing demands. BLM rolled out the first module of the newer system, AFMSS II, in 2015. In September 2020, we reported that BLM had expected to complete the rollout of AFMSS II in February 2020 and decommission the prior iteration of AFMSS in August 2020 but that both

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[28]In addition to information on oil and gas leases, LR2000 also records information on mineral and other energy-related leases (e.g., coal, solar, and wind) on federal lands. According to BLM officials, BLM is currently developing another type of leasing information system—the National Fluids Lease Sale System—that is intended to automate certain aspects of the leasing processes.

[29]Department of the Interior, Bureau of Land Management, National Operations Center, *Legacy Rehost 2000 (LR2000): Operational Analysis Fiscal Year 2019* (Denver, CO: May 23, 2019).

[30]Department of the Interior, Bureau of Land Management, *Mineral and Land Records System (MLRS): Concept of Operations*, Version No. 1.0 (Aug. 31, 2017).

[31]BLM first chartered AFMSS in 1993 and initially deployed the system in 1997 as a single system using 31 separate databases. Department of the Interior, Bureau of Land Management, National Operations Center, *Automated Fluid Minerals Support System: Operational Analysis Fiscal Year 2019* (Denver, CO: May 13, 2019).

dates had been delayed due to the Coronavirus Disease 2019 pandemic, according to a BLM official.[32] The agency plans to completely retire AFMSS once AFMSS II is fully implemented and operational. According to BLM officials, in fiscal year 2019 the department spent approximately $3.5 million on IT investment for AFMSS and $6.5 million developing AFMSS II. According to BLM officials, the total life cycle cost for the aging AFMSS system through 2020 was approximately $68.6 million. In 2020, we reported that the total anticipated life cycle costs for AFMSS II is $52.2 million over a 10-year period.[33]

MRMSS. ONRR uses MRMSS to report on and track operators' oil and gas production and associated payment information throughout the different stages of a lease.[34] According to an agency document, MRMSS is ONRR's primary tool for day-to-day operations, and the agency depends on the system and its data.[35] Companies (operators) are required to submit monthly reports to MRMSS that track revenue and production and account for volumes of oil and gas produced on all federal lands.[36] ONRR also uses MRMSS to process the bonuses, rents, and royalty payments received from leased lands. MRMSS includes a financial accounting system that compares reported production information to royalties paid to ensure royalties paid are consistent with reported production volumes. ONRR officials said the agency is planning to upgrade MRMSS and is in the early stages of concept development. According to Interior, in fiscal year 2019 the department spent about $18.5 million on IT investment for MRMSS. According to ONRR officials, the total contractual life cycle cost for the MRMSS system since 1999 is $350 million, as of November 2020.

These systems are managed by program offices as four investments. AFMSS and AFMSS II are managed under the BLM-AFMSS investment,

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[32]GAO-20-249SP.

[33]GAO-20-249SP.

[34]MRMSS is also used to collect well information and other reference data from BLM's field offices for onshore Indian leases and the Bureau of Safety and Environmental Enforcement's regional and district offices for offshore leases. Department of the Interior, Office of Natural Resources Revenue, *Financial Management Reporting and Solid Minerals Services, Minerals Revenue Reporter Handbook: Oil and Gas Resources, Report of Sales and Royalty Remittance (Form ONRR-2014),* ONRR Release 3.0 (May 1, 2015).

[35]Department of the Interior, Office of Natural Resources Revenue, *Operational Analysis Report: Minerals Revenue Management Support System,* Version 1.6 (June 19, 2019).

[36]*See* 30 C.F.R. Part 1210.

LR2000 is managed under the BLM-LR2000 investment; MLRS—update to LR2000—is managed under the BLM-MLRS investment; and MRMSS is managed under the ONRR-MRMSS investment.

BLM and ONRR Work Across the Key Data Systems to Share Information and to Fulfill Shared Oversight Responsibilities

BLM and ONRR work across the key systems to fulfill their oversight responsibilities, sharing data between the systems at numerous points and also relying on data from across AFMSS, LR2000, and MRMSS to make oversight decisions regarding oil and gas development. BLM and ONRR are required to reach concurrence or consult to complete 65 of 171 mutual oversight responsibilities, according to Interior procedures.[37] For a number of oversight points, agency standard operating procedures require officials to make decisions based on information that is found across the key data systems.[38] To accomplish this, data are either shared between the systems so that the data are sent from an originating system to another system for reference, or officials must consult data across multiple systems.

While each system is managed by the lead agency, the agencies share data among these systems for oversight activities they conduct at milestones throughout the life of a lease. [39] For example:

- **Issuing a lease.** Once BLM issues a lease and establishes it in LR2000, BLM provides ONRR with relevant lease, accounting, and

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[37]Regarding the remaining 106 mutual processes, BLM and ONRR may still notify each other or be in contact regarding certain actions. Department of the Interior, *Onshore Federal and Indian Energy and Mineral Lease Management Standard Operating Procedures*, Memorandum (Washington, D.C.: Sept. 18, 2013).

[38]Department of the Interior, *Onshore Federal and Indian Energy and Mineral Lease Management Standard Operating Procedures*.

[39]According to Interior's 2019 Standard Operating Procedures training, BLM and ONRR contribute to the completion of eight out of 11 of the same processes, including preleasing actions, leasing actions, formal agreements, operations, compliance verification, noncompliance enforcement and resolution, protests and appeals, and reports and information sharing. The three examples we include in this report require BLM and ONRR staff to share work across the key data systems to complete them.

payment information. ONRR is subsequently responsible for collecting annual rental and other payments for the lease, using MRMSS.

- **Approving a permit to drill a well.** Operators apply to BLM for permits to drill wells through AFMSS II. Once a permit is approved in AFMSS II, the BLM office manually sends the well information to ONRR, which uploads the information into MRMSS. MRMSS's financial accounting system monitors activity on all federal and Indian mineral leases and agreements, accounts for royalties and related information, compares production information to actual royalties paid on that production, and analyzes results and interprets them for reasonableness.[40] This system supports ONRR's operational responsibilities to conduct production reporting and verification activities, such as receiving, processing, and correcting production reports; and collecting production and sales data.

- **Production.** Operators generally must electronically submit monthly production reports to MRMSS for all wells, from the date drilling is completed until the well is permanently plugged and abandoned.[41] According to ONRR, there are many data exchanges between ONRR, operators, BLM, and others during this process. For instance, ONRR staff share MRMSS information when they receive operator-submitted production data; initially validate submitted data against well and lease data supplied by BLM's AFMSS and LR2000, respectively; and provide accepted and updated production MRMSS data to BLM in a manual file transmission. Some exchanges are labor intensive and require manual effort to share files, according to ONRR documentation. ONRR officials stated that files are also exchanged through a semiautomated messaging system.

Figure 3 below illustrates some examples of the data sharing between BLM and ONRR at milestones throughout the life of a lease for oil and gas development on federal lands.

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[40]According to ONRR officials, the agency is obligated to ensure that the correct revenues are reported and paid through audits, compliance reviews, and other enforcement activities.

[41]An Oil and Gas Operations Report (OGOR) is a summary of all operations conducted on a lease or agreement during a specific production month. An OGOR consists of three parts: (1) OGOR-A: federal or Indian leases that contain wells not permanently plugged and abandoned, including leases with workover, production, and shut-in wells; (2) OGOR-B: federal or Indian leases that have production disposition; and (3) OGOR-C: federal or Indian leases that have storage data inventory activities until the inventory is disposed. Department of the Interior, Office of Natural Resources Revenue, *Minerals Revenue Reporter Handbook*, ONRR Release 3.0 (May 1, 2015).

Figure 3: Examples of Data Sharing among BLM and ONRR's Data Systems at Milestones in the Life of a Lease for Oil and Gas Development on Federal Lands

Milestone	BLM	ONRR
Issue lease	After issuing a lease, BLM provides ONRR with accounting and payment information from Legacy Rehost (LR2000). ONRR is subsequently responsible for collecting annual rental payments for the lease in the Minerals Revenue Management Support System (MRMSS). →	
Approve permit to drill	Once an operator's application for permit to drill is submitted and approved in the Automated Fluid Minerals Support System (AFMSS). BLM sends the well information to ONRR, which uploads it into MRMSS. →	
Lease first enters production	BLM must issue a first production notice and notify and provide ONRR with required leasing information and well information from AFMSS so ONRR can establish a producing royalty payor account and establish the well in MRMSS.[a] →	
Additional well(s) enter production	BLM updates AFMSS and issues the first production notice to ONRR to establish the well(s) in MRMSS. →	
Production	BLM provides AFMSS well reference data to ONRR weekly—which ONRR inputs into MRMSS. →	
	← ONRR provides MRMSS production data to BLM weekly—which BLM inputs into AFMSS—and uses AFMSS to perform research to update MRMSS production reports.	
Lease is in a nonproducing status	BLM staff transfer the LR2000 lease account to ONRR. →	

Source: GAO analysis of Bureau of Land Management (BLM) and Office of Natural Resources Revenue (ONRR) data. | GAO-21-209

Text of Figure 3: Examples of Data Sharing among BLM and ONRR's Data Systems at Milestones in the Life of a Lease for Oil and Gas Development on Federal Lands

- Issue lease: After issuing a lease, BLM provides ONRR with accounting and payment information from Legacy Rehost (LR2000). ONRR is subsequently responsible for collecting   annual rental payments for the lease in the Minerals Revenue Management Support System (MRMSS).

- Approve Permit to Drill: Once an operator's application for permit to drill is submitted and approved in the Automated Fluid Minerals Support System (AFMSS). BLM sends the well information to ONRR, which uploads it into MRMSS.

- Lease first enters production: BLM must issue a first production notice and notify and provide ONRR with required leasing information and well information from AFMSS so ONRR can establish a producing royalty payor account and establish the well in MRMSS.a

- Additional well(s) enter production: BLM updates AFMSS and issues the first production notice to ONRR to establish the well(s) in MRMSS.

- Production

  - BLM provides AFMSS well reference data to ONRR weekly—which ONRR inputs into MRMSS.

  - ONRR provides MRMSS production data to BLM weekly—which BLM inputs into AFMSS—and uses AFMSS to perform research to update MRMSS production reports.

- Lease is in a non producing status: BLM staff transfer the LR2000 lease account to ONRR.

Source: GAO analysis of Bureau of Land Management (BLM) and Office of Natural Resources Revenue (ONRR) data. | GAO-21-209

aAs of fiscal year 2020, the royalty rate was generally 12.5 percent. Exceptions include a sliding scale for older leases, reduced royalty rates on certain leases with declining production, and reinstated leases, according to BLM.

In addition to frequently exchanging data across the key data systems, BLM and ONRR officials also work across the systems to perform oversight activities for oil and gas development. For instance, BLM officials work across the three systems to conduct bond reviews to ensure appropriate bonds—financial assurances that operators must provide to

ensure compliance with all lease terms and conditions—are in place.[42] BLM staff are to conduct bond adequacy reviews, where BLM staff will review well status data from AFMSS, well production data from MRMSS, compliance data from both systems, and lease and bond data from LR2000.[43] According to BLM, even though some production data are maintained in AFMSS, BLM officials consult ONRR's MRMSS's well production data because MRMSS contains operator-submitted records that may include more up-to-date information than is in AFMSS and because AFMSS does not have production data for all wells.[44] Similarly, BLM inspectors are to perform a review of AFMSS, MRMSS, and other information, such as lease information in LR2000, prior to performing a field production inspection, according to BLM guidance.[45]

Interior Faces Challenges with Data Quality, Data Sharing, Functionality, and Training in Managing and Using Key Data Systems for Oversight

Poor data quality from unfollowed data standards, limited data sharing among systems, limited system functionality, and inconsistent training of system users are top challenges Interior faces in managing and using its key data systems for oversight of oil and gas development on federal lands. Collectively, these challenges have contributed to Interior's use of

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[42]Operators are able to provide bonding by using a surety bond—a third-party guarantee that operators obtain from private insurance companies—or a personal bond accompanied by negotiable Treasury securities, a cashier's check, a certified check, a certificate of deposit, or an irrevocable letter of credit. *See* 43 C.F.R. § 3104.1.

[43]BLM directs its field office staff to conduct bond adequacy reviews on all bonds at least once every five years, or whenever a review is otherwise warranted. For more information on bonds and BLM's bond review process, see: GAO, *Oil and Gas Wells: Bureau of Land Management Needs to Improve Its Data and Oversight of Its Potential Liabilities*, GAO-18-250 (Washington, D.C.: May 16, 2018) and *Oil and Gas: Bureau of Land Management Should Address Risks from Insufficient Bonds to Reclaim Wells*, GAO-19-615 (Washington, D.C.: Sept. 18, 2019).

[44]Department of the Interior, Bureau of Land Management, *Non-Indian Automated Fluid Minerals Support System,* Software User Guide for General Users, L&RPO: AFMSS_NIAFMSS_SUG(GU)_DV3.00_(2007-02-01) (Denver, CO: Feb. 1, 2007).

[45]BLM is to inspect at least once annually lease sites producing or expected to produce significant quantities of oil or gas in any year or that have a history of noncompliance with applicable provisions of law or regulations. 30 U.S.C. § 1711(b)(1).

thousands of staff hours and have undermined staff confidence in and impeded Interior's oversight of oil and gas activities.

Data Quality Standards Have Not Been Consistently Defined or Followed

BLM has not consistently defined or followed data quality standards across the agency, which has negatively affected data quality and undermined staff confidence in oil and gas data. BLM's Data Administration and Management policy manual establishes a system of controls related to data quality across the agency, but these controls have not been fully implemented.[46] BLM field and state office officials we interviewed raised concerns over the quality of data in BLM's key systems, especially regarding the potential effect of poor data quality as they prepare to migrate data from the aging systems (AFMSS and LR2000) to the newer systems (AFMSS II and MLRS, respectively). For example, according to a BLM state official, in 2018 an employee found hundreds of change requests in LR2000 for federal actions affecting public lands that were incomplete and needed to be addressed. If the requests had not been caught in time, they could have caused many issues during the eventual data migration to MLRS, according to the BLM state official. In addition, in a January 2018 report, Interior's OIG found BLM's AFMSS data to be unreliable due, in part, to inaccurate well status information.[47] Interior's OIG found that 40 percent of wells in AFMSS had a different status compared with the same wells in MRMSS.[48]

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[46]Department of the Interior, Bureau of Land Management, *1283 Data Administration and Management*, Rel. No. 1-1742 (July 10, 2012).

[47]Department of the Interior, Office of Inspector General, *Bureau of Land Management's Idle Well Program,* Report No.: 2016-EAU-061 (Washington, D.C.: Jan. 17, 2018).

[48]According to the report, about 20 percent of potentially idled wells could have been removed from BLM's list of wells to review if the data were consistent across the systems. Interior's OIG found that 362 out of 1,806 mismatched wells showed as being plugged and abandoned or as currently producing, according to ONRR's system. The Interior OIG found that BLM officials updated AFMSS manually during well reviews or as needed, as opposed to automating updates of the data, even though BLM had access to production data stored in ONRR's MRMSS. Thus, the report found that the status of individual wells in AFMSS and data used for BLM's annual well reports were not timely and were inconsistent with production data. The report recommended automated updating of the well status information in AFMSS with MRMSS data to allow BLM to have more up-to-date and accurate information. Department of the Interior, *Bureau of Land Management's Idle Well Program,* p.11.

Moreover, in past reports we have found various examples of data quality inconsistencies across BLM's data systems. In 2018, we reported that well review information reported by field offices differed across BLM, resulting in inconsistent information in BLM's annual well review reports.[49] We reported that such inconsistencies may have been the result of a lack of clarity in BLM's well review policy that did not specify what constitutes a well review and did not have specific instructions for how to conduct a well review, such as how to count or report reviews. Additionally, in 2019, we analyzed bonds that were linked to wells in BLM's data—bond numbers are a variable in both AFMSS and LR2000—and identified that 20 percent of the wells in AFMSS did not have a matching bond number in LR2000.[50] To address data concerns, Interior staff work across these systems to correct inconsistencies, according to BLM and ONRR officials. For instance, ONRR officials compare their well data against AFMSS data to check for errors and inconsistencies and manually transmit files to BLM offices to work through the errors on their end, according to ONRR officials. Despite these efforts to address data quality concerns, BLM state and field staff said they do not trust that the data in AFMSS are for the correct well or that documents attached to the well files in LR2000 are correct. Due to this lack of trust in the data, BLM officials stated they rely on other outside data systems, such as the state oil and gas regulatory agency's websites.[51]

BLM officials stated they have additional concerns regarding the older, historical data because the systems were built before user manuals were created for them, and BLM did not have the capabilities to enforce data

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[49]We recommended that the Director of BLM take steps to improve AFMSS data quality, for example, by conducting more edit checks and by having data stewards certify the quality of the data. (See GAO-18-250.) BLM concurred with this recommendation and in December 2019 issued Instruction Memorandum 2020-006 entitled, "Idled Well Reviews and Data Entry," which replaced the Instruction Memorandum 2012-181. The revised policy provides instructions for data entry for well reviews into AFMSS and provides instructions for data validation review and certification.

[50]We found that 1,547 out of the 3,357 unique bond numbers in LR2000 had wells tied to them in AFMSS. These 1,547 bonds covered about 80 percent of the wells in AFMSS. The other 20 percent of wells in AFMSS either did not list a bond number, or the bond number listed was not in LR2000. (See GAO-19-615.)

[51]State oil and gas regulatory agency officials told us they oversee oil and gas development at the state level. Additionally, state regulatory agencies are responsible for conducting field inspections; tracking the statuses of wells; processing applications for permits to drill; and, in some cases, tracking bad actors and abandoned wells.

entry controls on the front end.[52] As a result, historical data are more likely to have errors or be missing information, in part because that information was not required to be entered until later versions of the system. BLM officials we interviewed have said they encounter data that were entered before newer data controls were created in 2012. Officials stated that this situation caused them to be less certain about the accuracy of older data records.

BLM's policy manual states that BLM is to rely on designated and trained data stewards at all levels of the agency to ensure data in these systems are of known and sufficient quality. According to BLM's Data Administration and Management policy manual, data stewards are experts in specific subject areas who are responsible for setting data accuracy standards and tracking data quality and data quality efforts, in part to facilitate data sharing across programs.[53] However, BLM was unable to consistently identify data stewards—National Operations Center officials did not identify any data stewards for AFMSS and LR2000, and officials at only three out of eight field offices and three out of five state offices we reviewed could identify any of their designated data stewards. By consistently designating data stewards at relevant levels, BLM management will have better assurance that its data are of sufficient quality to meet agency needs in conducting oversight.

Automated Data Sharing between Key Oil and Gas Data Systems Is Limited

There is limited automated data sharing among AFMSS, LR2000, and MRMSS, and we identified instances where the ability to track and share data among the systems required manual sharing and labor-intensive processes. As discussed above, BLM records information about the administration of leases in LR2000 and records information on wells located on those leases in AFMSS. ONRR records oil and gas production

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[52]In our May 2014 report, we stated that, in December 2010, Interior's OIG report found that there were concerns about the reliability of data in the AFMSS database. Specifically, the report stated that data entry controls were inadequate. GAO, *Oil and Gas: Updated Guidance, Increased Coordination, and Comprehensive Data Could Improve BLM's Management and Oversight*, GAO-14-238 (Washington, D.C.: May 5, 2014); and Department of the Interior, Office of Inspector General, *Bureau of Land Management's Oil and Gas Inspection and Enforcement Program,* Report Number: CR-EV-BLM-0001-2009 (Washington, D.C.: Dec. 2, 2010).

[53]Department of the Interior, *1283 Data Administration and Management.*

and revenue from those leases in MRMSS. These data systems share some information with each other by providing read-only snapshots of data to other key data systems. For example, AFMSS users are able to see certain information from LR2000 related to bonds provided by lease holders or operators for wells,[54] and well production data from MRMSS.

However, this data sharing is not automated. According to ONRR officials and documentation, some data are currently shared when agencies manually transmit files of data to each other every week and then upload the data through a labor-intensive process of conversion and error correction. In addition, other files are exchanged weekly via a messaging system that is semiautomated, according to BLM and ONRR officials and documentation. ONRR officials said this transfer schedule means that the data in ONRR's system could be up to a week out of date. After the data are received, the data go through a conversion and error correction process because the systems have different data quality controls and naming conventions, according to ONRR officials. We calculated, based on ONRR estimates that officials provided, that this conversion and error correction process uses over 22,750 hours of ONRR staff time—approximately 10 full-time employees—annually.[55] In addition, BLM uses approximately 200 hours annually for this process, according to BLM officials.

We also identified instances where neither BLM nor ONRR was able to link information about leases across the systems. For example, BLM officials told us that they were unable to comprehensively match revenues

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[54]In May 2018, we reported on the discrepancies between the bonds listed in AFMSS and those listed in LR2000. Officials told us that bonds may be missing from AFMSS because BLM field offices are responsible for manually entering LR2000 bond numbers into AFMSS. (See GAO-18-250.) In September 2019, we reported that 20 percent of wells in AFMSS either did not list a bond number or the bond number listed was not in LR2000. (See GAO-19-615.)

[55]According to ONRR officials, the ONRR estimate of time spent for error correction does not account for potential time saved by other agencies from ONRR's efforts, such as BLM staff not needing to spend time correcting those errors, or other possible downstream effects. ONRR officials told us that this estimate does account for time saved for error correction for well reference data, including offshore data that the Bureau of Safety and Environmental Enforcement collects. We calculated this estimate based on an ONRR face-to-face user survey. ONRR identified the median amount of time (35 hours) spent on error correction, as reported by production analysts responsible for this effort in a face-to-face survey by ONRR. We multiplied this by the number of full-time-equivalent employees ONRR has dedicated to this effort per pay period (25), and the number of pay periods (26) per standard year.

to lease data, even though doing so is important to Interior's ability to fulfill its requirements under the Mineral Leasing Act of 1920, as amended. Under this act, Interior relies on the competitive leasing process to ensure fair market value for onshore oil and gas resources, but its efforts to do so are hindered by its inability to comprehensively compare revenues across different types of leases. According to BLM and ONRR officials, each of these systems uses different lease numbering conventions, and so the same lease is recorded three different ways, and agency staff use a crosswalk to manually link individual lease-related data (LR2000) to their well data (AFMSS) and to revenues and production data (MRMSS) on an as-needed, case-by-case basis. Though BLM and ONRR do not do so, for our November 2020 report, we developed a process to match leases in LR2000 to MRMSS data to demonstrate that it is possible to comprehensively compare revenues across different types of leases.[56]

Furthermore, the systems use different conventions to record operator names that do not allow for automated matching of operator name data across the systems. According to staff at one of the selected BLM state offices, some operators will start lease applications that must be recorded in LR2000 with their names as one entity but may use different names for the same operator when updating their paperwork later in the process. This results in duplication problems within LR2000 and staff having to review each document and move the information to the correct operator. Additionally, BLM officials at a selected field office told us that operator names recorded in AFMSS are character-number limited, so staff must abbreviate some operator names.[57] These abbreviated names then do not match the operator name reported in LR2000, according to BLM officials at the selected field office.[58]

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[56]In our November 2020 report, we used LR2000 data to construct a common lease identifier and matched about 98 percent of leases in ONRR's revenue data to leases in BLM's data. The matched leases accounted for over 99 percent of total revenues in MRMSS for federal onshore oil and gas leases. GAO, *Oil and Gas: Onshore Competitive and Noncompetitive Lease Revenues*, GAO-21-138 (Washington, D.C.: Nov. 19, 2020).

[57]According to BLM officials, operator names are not character-number limited in AFMSS II.

[58]We assessed operator names because LR2000 and AFMSS do not contain identifiers designed to link operators across systems, according to officials at a selected BLM state office.

In contrast, Colorado maintains a dataset for wells within the state in which operators each have a unique identifier.[59] This facilitates oversight by allowing state regulators to identify that operator's actions throughout the state, because they can review any record by using an operator's unique identifier, according to Colorado state officials. In addition to using unique identifiers, Colorado state officials told us its system uses a number of drop-downs for data entry, which they deem critical to account for the variations to an operator's name and different locations.[60] Colorado state officials told us that the number of records for one operator can exceed over 10,000 and that staff can more readily access and review any of these records by using an operator's unique identifier number. Moreover, Colorado has publicly available datasets that are accessible on its website and that possess other functions, such as user-friendly mapping capabilities that quickly and easily show useful information such as horizontal well paths and land ownership (federal, state, or private, and rights of way).

Agency officials told us they are also aware that their databases have different lease numbering conventions and formatting, and no unique operator identifiers, and that this circumstance limits their ability to cross-reference data.[61] BLM and ONRR officials told us that system users have developed various workarounds to address the limited automated data sharing and the inability to track certain information across the systems. For example, BLM and ONRR officials told us users take steps to manually enter data and move back and forth between systems multiple times for one task, requiring multiple log-ins and duplicate entry of information. In addition, state and field offices within BLM have created various additional databases and spreadsheets to conduct their work.

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[59]We spoke with officials from four state oil and gas regulatory agencies located in Colorado, Nevada, New Mexico, and Wyoming. Officials from the other three state agencies told us that their systems also include, or plan to include, some of the same functionality, including publicly accessible data and use of unique identifiers and that one agency is planning for future inclusion of mapping capabilities.

[60]The Ground Water Protection Council helps state regulatory agencies develop their own oil and gas data systems. For over 25 years, the council developed a customizable, publicly accessible Risk Based Data Management System for its agency members to develop and use when managing and analyzing oil and gas program data and water resources management information. More than 22 state regulatory agencies—including three of the four state agencies we spoke with—utilize this system, or a similar system, to manage their oil and gas activities.

[61]According to BLM officials, the agency may match BLM and ONRR lease numbers to assess whether leases are in good standing or to check lease transfers.

These supplemental processes require the offices to import data from the official systems or to manually enter copied data.[62] These supplemental processes range from simple Excel spreadsheets used to track workflow to additional databases to fill in the gaps.

OMB's Federal Data Strategy (FDS) and BLM policy both highlight the importance of data sharing, and Interior has taken some steps to improve data sharing across the key data systems. The FDS, finalized in June 2019, identified several best practices to guide agencies to fully leverage data, including connecting data across agencies, coordinating and sharing data assets across federal agencies, and harnessing safe data linkages to address key agency questions.[63] Furthermore, BLM's policy states that information systems should be structured to encourage the sharing and exchange of data within Interior.[64] In addition, according to the Fiscal Year 2017 Operational Analysis for LR2000, users recommended improving information sharing between AFMSS and ONRR's MRMSS.[65]

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[62]For example, Information Technology for Resource Management (IT4RM) is a database developed and used in some New Mexico BLM field offices and the state office, according to officials from a selected BLM office. Prior to the rollout of AFMSS II, IT4RM was compatible with AFMSS and users were able to import data directly into it from AFMSS.

[63]The FDS includes three categories of practices: (1) building a culture that values data and promotes public use; (2) governing, managing, and protecting data; and (3) promoting efficient and appropriate data use. Each category consists of a number of practices, instructing the agencies to do various actions, including the following: connect data function across agencies; prepare to share; prioritize data governance; maintain data documentation; leverage data standards; identify opportunities to overcome resource obstacles; increase capacity for data management and analysis; harness safe data linkage; and support federal stakeholders. Office of Management and Budget, *Federal Data Strategy – A Framework for Consistency*, OMB Memorandum No M-19-18 (Washington, D.C.: June 4, 2019).

[64]The BLM 1283 Data Administration and Management policy manual states that the specific objectives of BLM's Data Management program include, to (1) reduce the cost and time required to transform, translate, or research the meaning of differently named, but otherwise identical, data elements; and (2) structure information systems in ways that encourage horizontal, as well as vertical, sharing and exchange of data within Interior and with other government agencies, nongovernmental organizations, and private sector organizations, including universities.

[65]Department of the Interior, Bureau of Land Management, National Operations Center, *Legacy Rehost 2000 (LR2000) Operational Analysis Fiscal Year (FY) 2017*, LR2000-XXX_OA_DV8.00 (Denver, CO: Feb. 28, 2018).

Steps that Interior has taken to improve data sharing across the key data systems include the following:

- Interior created the Chief Data Officer (CDO) position within OCIO. The CDO's responsibilities include life cycle data management and aligning agency data management with best practices, such as those that the FDS identified.[66] Interior's CDO was named in August 2019 and may provide leadership for improving data flows across the agencies over time.

- According to BLM officials, BLM combined multiple databases in AFMSS (including databases for over 33 offices) into a single database in AFMSS II, which could facilitate connecting AFMSS II to other systems in the future.

- BLM and ONRR have outlined a draft vision statement describing, at a high level, how data sharing might be improved between their systems.

However, Interior officials stated there is currently no finalized plan to more comprehensively share data among AFMSS, LR2000, and MRMSS. BLM and ONRR are currently planning for, or actively updating or modernizing their key data systems, but the newer systems are not being designed to facilitate comprehensive, automated data sharing. BLM officials stated that BLM had planned to automate data sharing, but ONRR requested that BLM wait until after the modernization of MRMSS. Without a plan to comprehensively address data sharing during the course of updating and modernizing its key systems, including automating data sharing functions and adopting common identifiers for leases and operators, Interior risks perpetuating its challenges related to data sharing, such as spending staff time on data matching and error correction that could be better spent on other priorities.

[66]A 2019 OMB memorandum called for the designation of a CDO at each federal agency who has authority and responsibility for data governance and life cycle data management. An Interior directive states the CDO is responsible for advising the CIO and the Secretary on strategic and resource requirements for the data resource management program. Office of Management and Budget, *Phase I Implementation of the Foundations for Evidence-Based Policymaking Act of 2018: Learning Agendas Personnel, and Planning Guidance*, OMB Memorandum for Heads of Executive Departments and Agencies, M-19-23 (Washington, D.C.: July 10, 2019); and Department of the Interior, Office of the Secretary, *DOI Data Resource Management – Managing Data as a Strategic Asset,* OCIO Directive 2018-004 (Washington, D.C.: June 29, 2018).

Functionality of Key Oil and Gas Data Systems Is Limited and Affects Ease of Use

BLM's key oil and gas data systems do not have certain desired functionality making them difficult to navigate and use, according to BLM staff from selected state and field offices. Our review of Interior's key oil and gas data systems found instances of functionality that was missing, inadequate, or prematurely retired before a replacement had been implemented. In some of these instances, BLM plans to address the functionality issues as it updates the systems. Specifically, examples of limited functionality include the following:

- A data field used to indicate risk to inspectors is unreliable. BLM officials at a selected state office told us that before BLM inspectors depart for a field inspection, they run a report from AFMSS that, among other information, indicates whether the location has health and safety hazards the inspector needs to prepare for. BLM staff from a selected state office demonstrated that while the data field for hazards in AFMSS may say "No," other information in AFMSS may indicate hazards actually are present and told us that nothing in the system flags the discrepancy. Since the information in the hazard data field is unreliable, BLM state office staff we interviewed said that it is left up to the inspectors' experience to know where else in AFMSS to look for necessary information to see if there is a hazard.

- Certain functionality has regressed in the move to AFMSS II, according to BLM field office staff. For example, officials from a selected BLM field office told us that AFMSS system users had access to ad hoc reports to conduct well queries, but that functionality has been removed with the switch to AFMSS II. According to BLM officials from a selected field office, AFMSS II should have had the same capabilities, but BLM staff said the report capability was removed 2- to 3-years prematurely.[67]

- Inspection staff at one selected BLM field office use computer tablets in the field to input data in fillable forms, but staff still manually reenter the data into AFMSS once they return to the office, according to BLM field office staff we interviewed. A selected BLM state office has digital forms that automatically fill in common information on the inspection forms, but inspectors still have to print out paper versions to bring on their inspections and manually reenter the data into AFMSS once they

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[67]A BLM document indicates that the agency planned to replace this capability in AFMSS II.

return to the office, which could increase the potential for errors. This duplicate data entry takes inspection staff additional time that they could use toward completing other tasks. In September 2020, we reported that BLM plans for AFMSS II to allow inspectors to capture mobile inspection data on an electronic device and then upload the results to a database that will interface with AFMSS II.[68] This automated updating of information to AFMSS II may reduce the amount of time required for data entry.

Training for BLM Systems Users Has Been Inadequate

Training for BLM's AFMSS and LR2000 has been inadequate at times. BLM offers in-person and virtual training for AFMSS and LR2000 users, which seven of the field offices and two of the state offices we reviewed supplement with their own training programs. For example, according to officials from one field office, certain newly hired staff receive a one-time orientation training, and BLM also provides online resources such as webinars, online videos, and user guides for the systems. According to officials from five of the BLM state and field offices we interviewed, and documentation that we reviewed, training has been inadequate in two main ways. First, officials from three field offices told us there has not been any in-person data entry training for AFMSS in the years since AFMSS II was introduced. Further, BLM field officials told us in interviews that staff may have experienced difficulties when signing up for past national trainings due to overcrowding, wait-lists, invitation-only offerings, and requirements for a certain number of on-the-job training hours. Moreover, the one-time BLM orientation training offered to newly hired staff is offered for one specialty, and it is not a continuous offering, according to field office staff. In previous years, since staff only had taken the in-person training when they were hired, staff relied on other resources, such as online resources and webinars, to reinforce skills, or learn new skills and read materials that may have been added to future trainings.

A second way training has been inadequate is that in recent years online resources that BLM provides can be outdated. Officials from one BLM field office stated that the training videos on AFMSS II are often outdated because the system has changed since they were created. According to staff from one BLM field office we interviewed, guidance and reference information for LR2000 from BLM, such as user guides and intranet links,

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[68]GAO-20-249SP.

are commonly outdated, which undermines their usefulness as training resources. For example, as of February 2020, BLM's intranet page showed user guides for an old reporting platform for LR2000 that was replaced by a new system in fiscal year 2017. A BLM field office official we interviewed stated that no user guides for the new reporting system were available. Such limitations in BLM's online resources may have contributed to respondents to 2016 and 2017 LR2000 user surveys indicating they felt online training to be insufficient to replace classroom training.[69]

Field and state offices we reviewed provided in-house training to staff to supplement the limited training from the national BLM office. Specifically, BLM officials at seven of the eight field offices and two of the five state offices we interviewed said they had to either create their own training programs or train employees on an informal basis. Such informal training methods involve learning how to use the systems by asking questions of more experienced users or simply referring to the operator's manual. For example, one state office official stated, "Everything that I have learned about both AFMSS and LR2000 came from other staff members within the field offices, either showing me how to do something or telling me which 'button' to click. I'm not even sure if there was an actual training plan in those offices."

As a result of this inadequate training, field office staff that we interviewed expressed concerns about potentially not having a technical knowledge that is important to carry out certain aspects of their jobs. In addition, a 2019 BLM Operational Analysis stated that 45 percent of LR2000 users reported difficulty creating ad hoc reports. Ad hoc reports are manually generated because they are not built into the system.[70]

Training has been inadequate, in part, because BLM does not have complete training plans for its systems, even though agency guidance calls for training plans. For example, Interior's overall guidance for developing and maintaining data systems, IT Solutions Development

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[69]Of those users who have had online training, twice as many users indicate that it is insufficient to replace classroom training. Department of the Interior, Bureau of Land Management, National Operations Center, *Legacy Rehost 2000 (LR2000) Operational Analysis FY2017*, LR2000_XXX_OA_DV8.00 (2018-02-28) (Denver, CO: Feb. 28, 2018).

[70]Department of the Interior, Bureau of Land Management, National Operations Center, *Legacy Rehost 2000 (LR2000) Operational Analysis FY2019*, LR2000_XXX_OA_DV9.02 (2019-05-23) (Denver, CO: May 23, 2019).

Lifecycle Guide (SDLG), specifies that training plans are to be developed that identify users and how they will be trained.[71] We reviewed the training resources BLM provided for oil and gas aspects of AFMSS, AFMSS II, LR2000, and MLRS.[72] For example, we received training reference materials, including a training announcement, instruction memorandums, and data system materials. However, BLM did not provide complete training plans for any of the key and updated data systems within the scope of our review that identify users and how they will be trained. Specifically, the materials provided demonstrate training activities but not how those activities were planned in advance to ensure user training needs are met. Without training plans that identify users and how they will be trained, BLM's training resources may not be efficiently targeted, and users may continue to have difficulty carrying out some tasks for their jobs.

Interior Has Not Fully Implemented Leading Practices for Requirements of Key Data Systems and Has Not Updated Relevant Guidance

Interior has not fully implemented leading practices for requirements of key data systems it relies on to oversee oil and gas development on federal lands, and it has not updated relevant guidance. More specifically, for its aging key data systems, Interior has not demonstrated implementation of leading practices associated with developing customer requirements, establishing product requirements, and analyzing and validating requirements. Additionally, while Interior has partially demonstrated implementation of leading practices for requirements for its

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[71]Department of the Interior, Office of the Chief Information Officer, *Information Technology Solution Development Lifecycle Guide* (Washington, D.C.: Sept. 15, 2005). Moreover, BLM's Data Administration and Management policy manual states that BLM will provide appropriate data-related training for all employees to maintain their technical competency as it relates to BLM data. In addition to the SDLG guidance and BLM data administration and management manual, BLM's 2011 project management plan requires the National Operations Center to create a similar training plan for the IT Development Team and other staff, as well as working with users and the National Training Center to modify and develop user training corresponding to automated work flows. Department of the Interior, Bureau of Land Management, *Project Management Plan for Fluid Minerals Post-Lease Process Automation* (Sept. 29, 2011).

[72]Officials also provided an MLRS training plan for mining claims, which we did not review because mining claims are not within the scope of this review.

new systems, BLM is using a process to develop these new systems that is not reflected in Interior's guidance.

Interior Did Not Demonstrate Implementation of Leading Practices for Requirements for Its Aging Key Data Systems

Interior did not demonstrate implementation of leading practices identified by the Software Engineering Institute that relate to developing customer requirements, developing product requirements, and analyzing and validating requirements for its aging key data systems—AFMSS, LR2000, and MRMSS.[73] For two of these systems (MRMSS and LR2000), Interior partially demonstrated implementation of the institute's leading practice for managing requirements, and for one system (AFMSS), Interior did not demonstrate implementation of the leading practice.

Table 1 summarizes our assessment of Interior's implementation of leading practices for requirements for the three aging systems. Appendixes I, II, and III provide more detailed information on our assessment.

Table 1: Summary Assessment of Interior's Implementation of Leading Practices for Requirements for Legacy Systems

Leading practice for requirements	Automated Fluid Minerals Support System	Legacy Rehost 2000	Minerals Revenue Management Support System
Develop customer requirements	Not demonstrated	Not demonstrated	Not demonstrated
Develop product requirements	Not demonstrated	Not demonstrated	Not demonstrated
Analyze and validate requirements	Not demonstrated	Not demonstrated	Not demonstrated
Manage requirements	Not demonstrated	Partially demonstrated	Partially demonstrated

Legend:

● = Fully demonstrated implementation: agency documents supported all aspects of the practice.
◓ = Partially demonstrated implementation: agency documents supported some, but not all, aspects of the practice.
○ = Not demonstrated: agency documents did not support any aspect of the practice, or agency officials were unable to provide such support.

Source: GAO analysis of Department of the Interior documents and demonstrations and Capability Maturity Model® Integration (CMMI®) for Development, Version 1.3. | GAO-21-209

[73]Carnegie Mellon, *Capability Maturity Model® Integration.*

Interior did not demonstrate, through documentation, its implementation of practices for developing customer requirements, developing product requirements, and analyzing and validating requirements for its aging systems—AFMSS, LR2000, and MRMSS.[74] With respect to managing requirements, BLM did not demonstrate implementation of the practice for AFMSS and partially demonstrated implementation of the practice for LR2000. Specifically, for the five subpractices that relate to managing requirements, BLM officials demonstrated the first subpractice— understanding the requirements—for LR2000 by obtaining feedback from stakeholders through surveys. However, BLM did not demonstrate the remaining four subpractices for LR2000: obtaining commitment to the requirements from project participants; managing changes to requirements as they evolved; maintaining traceability of requirements to high-level system features and documentation; and ensuring alignment between project work and requirements.

ONRR partially demonstrated implementation of the practice for managing requirements for MRMSS. Specifically, regarding the five subpractices, ONRR officials demonstrated four of them: understanding the meaning of the requirements; obtaining commitment to the requirements from project participants; managing changes to requirements as they evolved; ensuring alignment between project work and requirements for MRMSS. ONRR partially demonstrated the fifth subpractice: maintaining traceability between requirements.

BLM and ONRR officials noted multiple reasons why they were unable to fully demonstrate implementation of leading practices for requirements for these aging systems. For example, BLM and ONRR officials stated that the current project teams were not part of the project teams that developed these system requirements during the 1990s and 2000s. Furthermore, BLM and ONRR officials said that the program office did not maintain the necessary documents.

BLM officials noted that they attempted to manage requirements by having a robust and rigorous program for information technology change and configuration management. However, BLM's AFMSS program office was unable to demonstrate that it addressed the subpractices of managing requirements, such as reviewing project plans for consistency

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[74]For leading practices for requirements development, we rated practices as not demonstrated when program officials could not provide key requirements documentation necessary to demonstrate implementation of the practices.

with requirements changes and taking corrective actions to address inconsistencies in project documentation.

Interior's SDLG provides guidance on the types of documents that should be generated during each phase of software development—including documents related to developing customer requirements, developing product requirements, analyzing and validating requirements, and managing requirements—and notes that documents are required to be maintained by the program office.[75] While the SDLG specifies requirements-related documentation to be maintained, Interior's CIO does not have a mechanism to ensure that program offices do so. Without a mechanism to ensure that program offices maintain requirements-related documentation, officials may be limited in their understanding of what systems must be able to do and the basis for those requirements.

Interior Has Taken Steps to Implement Leading Practices for Requirements for New Data Systems, but Program Offices Lacked Defined Processes for Doing So

BLM program offices for two of Interior's new key data systems—AFMSS II and MLRS—partially implemented leading practices for requirements when developing the new data systems, as shown in table 2.[76] Appendixes IV and V provide detailed information on our assessment of BLM's implementation of leading practices for requirements for the new systems.

Table 2: Summary Assessment of Department of the Interior's Implementation of Leading Practices Requirements for the Automated Fluid Minerals Support System II and Mineral and Land Records System

Leading practice	Automated Fluid Minerals Support System II	Mineral and Land Records System
Develop customer requirements	Partially demonstrated	Partially demonstrated
Develop product requirements	Partially demonstrated	Partially demonstrated

[75]Department of the Interior, Office of the Chief Information Officer, *Information Technology Solution Development Lifecycle Guide* (Washington, D.C.: September 2005).

[76]At the time of our review, MLRS was not yet operational. Therefore, we did not rate the program's demonstration of implementing the practice associated with managing requirements. BLM officials said that the first module of MLRS was expected to be deployed by November 2020.

Leading practice	Automated Fluid Minerals Support System II	Mineral and Land Records System
Analyze and validate requirements	Partially demonstrated	Partially demonstrated
Manage requirements	Partially demonstrated	Not rated[a]

Legend:

● = Fully demonstrated implementation: agency documents or software demonstrations supported all aspects of the practice.
◗ = Partially demonstrated implementation: agency documents or software demonstrations supported some, but not all, aspects of the practice.
○ = Not demonstrated: agency documents or software demonstrations did not support any aspect of the practice, or agency officials were unable to provide such support.

Source: GAO analysis of Department of the Interior documents and demonstrations and Capability Maturity Model® Integration (CMMI®) for Development, Version 1.3. | GAO-21-209

[a]The system was in development and was not yet operational and, therefore, could not be assessed against the leading practices for requirements management.

The BLM program offices were taking a number of positive steps to implement leading practices to develop customer requirements, develop product requirements, and analyze and validate requirements for AFMSS II and MLRS. For example,

- to address the practice of developing customer requirements, BLM officials demonstrated how the agency's software development tool captures the needs, expectations, and constraints of stakeholders for both systems;

- to address the practice associated with establishing product requirements, BLM documented technical architecture design documentation and testing system functionality; and

- to address validating requirements, BLM defined required functionality and quality attributes through documents that explain the systems' work flows and requirements that have been approved as system requests but not yet implemented.

With respect to managing requirements for AFMSS II, BLM demonstrated obtaining commitment to requirements from project participants, as evidenced in a system roadmap and other planning documents.[77] In addition, BLM officials demonstrated that the agency's software development tool managed and recorded changes to requirements, maintained traceability between requirements, and aligned requirements changes to system documentation.

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[77]The term "project participants" refers to those individuals who carry out activities necessary to implement requirements.

While BLM was able to demonstrate certain steps the agency has taken to develop and manage the two systems' requirements, the AFMSS II and MLRS program offices did not define the plans and processes to guide them in developing customer requirements, establishing product requirements, analyzing and validating requirements, and managing requirements.[78]

While BLM took steps to demonstrate implementation of leading practices for requirements for AFMSS II and MLRS, BLM program offices did not fully demonstrate implementation of leading practices because they did not have defined plans and processes for doing so. For instance, BLM did not establish defined expectations for which stakeholders should be involved in providing input and at what stages when developing customer requirements. In another example, the BLM program offices did not establish procedures for the timing, frequency, and stakeholder representation in the analysis and validation of requirements.

BLM officials explained that, while the program offices for AFMSS II and MLRS did not define such processes, each program office has implemented the corresponding activities of requirements development and management in practice. Further, BLM officials explained that they did not see the benefits of rewriting guidance that is included in the agile framework that they are using for these systems' development.[79] Nonetheless, without plans and processes that define the program offices' agreed-upon methods and approach to carrying out requirements activities, it remains unclear whether the steps that BLM took were adequate and consistent with expectations from Interior and BLM management and stakeholders.

In September 2020, we reported that leading practices for adopting agile software development include defining program processes and team activities based on agency policy or guidance.[80] Program offices should define plans and processes for technical and project support tools that are to be used, reviews and other mechanisms through which critical

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[78]The Software Engineering Institute recommends that organizations should define plans and processes to effectively implement leading practices for requirements.

[79]According to BLM officials, the AFMSS II and MLRS program offices are applying the Scaled Agile Framework® in their development efforts. This framework is intended to provide guidance on enterprise-wide approaches for implementing agile principles at various levels of an organization. "About Scaled Agile Framework," accessed January 14, 2021, https://www.scaledagileframework.com/about/.

[80]GAO-20-590G.

system features are to be identified, development of system requests, requirements prioritization, and demonstrations or other interactions for acceptance of system requests. Defining such plans and processes is important for ensuring that program offices and development teams successfully transition from using traditional software development methods to agile methods. This is especially important, given the problems that Interior has experienced with requirements and functionality of its aging data systems.

Moreover, Interior's guidance for data system development calls for program offices to define their development approach. Interior developed its SDLG to provide a structured, integrated approach to data system development and to ensure that all systems' development aligns with the department's mission and supports business needs while minimizing risks and maximizing returns. The SDLG provides that all IT system development and maintenance efforts, whether developed by Interior or on behalf of Interior, are to conform to this guidance. Interior's SDLG provides that, during the planning phase, project managers are to develop, tailor, and identify the internal management, engineering, business management, and contract management processes that will be used by the project office for all subsequent life cycle phases. This includes describing how stakeholders are to analyze business and technical requirements and the testing strategies that will be used.

Until BLM ensures that processes for developing and managing requirements for AFMS II and MLRS are defined and documented in a manner consistent with existing or updated IT department and agency policies, BLM may not establish a shared understanding of requirements with systems users and stakeholders and may not be able to ensure that the new systems provide the capabilities to support BLM's oversight of oil and gas development.

Interior's Guidance Does Not Address BLM's or ONRR's Approach for Developing Key Data Systems

BLM and ONRR officials stated that they are not using the SDLG to guide them in developing and managing requirements for key data systems. Rather, BLM officials stated that they are using an agile software development approach for AFMSS II and MLRS that Interior's SDLG does not address. This approach includes meeting with system stakeholders at quarterly sessions for program increment planning to prioritize and agree upon particular features and functionality to be developed in regular, 2-

week increments, according to BLM officials. Meanwhile, ONRR officials explained that they are following an internal change management plan and process to manage requirements for MRMSS.[81]

According to BLM officials, they are not implementing the SDLG for AFMSS II and MLRS because the SDLG is oriented toward a traditional, waterfall development approach and does not translate well to the agile development approach that they are using.[82] Additionally, ONRR officials said that they were not following the SDLG and instead were following ONNR's 2020 change management guide, which was developed as a result of a recommendation from an Interior OIG audit from 2016.[83]

When implemented effectively, an agile approach presents an opportunity for an organization to improve its acquisition and development of software and can be a valuable tool for helping to mitigate schedule and budget risks. In September 2020, we found that implementing leading practices for agile adoption—such as ensuring that acquisition policies and procedures support agile methods and establishing agency guidance that is appropriate for agile acquisition strategies—can increase the likelihood that an organization will achieve successful outcomes through these methods. Such implementation also can help them manage and mitigate the challenges in making the transition from waterfall development.[84]

However, Interior's SDLG does not address agile methods by including specific policies and guidance that support how a program office should apply agile development methodologies in a manner that is consistent with the department's expectations. For example, the SDLG, which was originally developed to support a waterfall development methodology, identifies a number of documents that programs must complete at various phases of a system's development. These include a system concept, a systems engineering management plan, a validation and verification strategy, a system design document, and an integration test plan. But Interior's guidance does not address which agile-related activities and

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[81]Department of the Interior, Office of Natural Resources Revenue, *MRMSS Change Management Plan and Process*, version 1.1 (Washington, D.C.: Jan, 15, 2020).

[82]A waterfall software development approach typically consists of long, sequential phases before software products are delivered.

[83]Department of the Interior, Office of Inspector General, Office of Natural Resources Revenue, Financial Management Division, Report No.: CR-IN-ONRR-0007-2014 (Washington, D.C.: June 3, 2016).

[84]GAO-20-590G.

work products (for example, user requests to be considered for future development, stories that describe features to be developed, or agreements on features to be developed within a time period) are to be used as inputs when developing such documentation. The guidance also does not address the circumstances in which documentation requirements should remain the same, are no longer required, or could be tailored when applying an agile approach.

For instance, a program implementing an agile development approach might already capture system and functional requirements through user requests to be considered for future development and other work products. In such instances, producing separate documentation to identify these requirements could be duplicative and quickly become outdated. On the other hand, such programs may still be expected to produce a system engineering plan that establishes the timing, frequency, and methods of reviews in an agile environment that would meet the expectations of traditional system development milestones that the SDLG calls for. These milestones include preliminary design review, critical design review, and user acceptance testing.

By updating its SDLG or other relevant IT policies and guidance to address how program offices are to implement methodologies for agile software development, Interior would have better assurance that its new data systems will function as intended to meet user needs and reduce budget and schedule risks.

Conclusions

Interior has recognized challenges in its management of IT resources and has taken steps to modernize three key data systems—two managed by BLM and one by ONRR—that it relies on to oversee oil and gas development on federal lands. However, staff we interviewed routinely noted that concerns with data quality across BLM's systems undermined their confidence in and ability to rely on data from these systems. Though BLM policy calls for data stewards, the agency has not identified data stewards for its systems at the headquarters, state, or field office level. By consistently designating data stewards at relevant levels, BLM management will have better assurance that its data are of sufficient quality to meet agency needs in conducting oversight.

Even though BLM and ONRR staff work across these three data systems to carry out their responsibilities, the systems have limited automatic data

sharing, and it can be difficult and time consuming to track information across them. Interior's CIO plays an important role in ensuring that BLM's and ONRR's data system investments are serving the agencies' overall goals. Yet OCIO does not have a plan to more comprehensively share data during the course of updating and modernizing these three key systems. Without such a plan, Interior risks perpetuating its challenges related to data sharing.

Training users of these data systems is important for ensuring that officials are fully and efficiently able to accomplish their duties. Accordingly, Interior guidance states that each system should have training plans that identify users and how they will be trained. However, we found that BLM does not have complete training plans for its existing or replacement systems within the scope of our review. Without training plans that identify users and how they will be trained, BLM's training resources may not be efficiently targeted, and users may have difficulty carrying out some tasks for their jobs.

We have repeatedly reported on the importance of leading practices for requirements in ensuring that federal data systems meet user needs.[85] Program offices responsible for key data systems demonstrated they had taken some steps to implement leading practices for requirements, but they did not fully implement leading practices in several regards. For example, program offices did not maintain documentation associated with how they developed requirements for any of the three key data systems—AFMSS, LR2000, and MRMSS. Interior policy specifies that program offices are to maintain such documentation, but the Interior CIO does not have a process in place to ensure that program offices maintain the requirements-related documentation. Without such a process, Interior may be limited in its understanding of what systems must be able to do and the basis for those requirements.

In addition, while BLM took steps to implement leading practices for requirements for its two replacement systems (AFMSS II and MLRS), the program offices responsible for these systems did not have defined plans and processes for these practices. Until BLM defines and documents processes for developing and managing requirements for AFMSS II and MLRS consistent with existing or updated IT policies and guidance, the agency may not establish a shared understanding of requirements with systems users and stakeholders. It also may not be able to ensure that

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[85]GAO-12-7 and GAO-16-306.

the new systems provide needed capabilities to support BLM's oil and gas development activities.

In addition, although Interior agencies have moved to more agile development approaches for software, Interior CIO's system development guidance does not provide specific policies or guidance on how program offices should apply agile approaches in developing software for the new systems. BLM officials stated that they are not using Interior guidance because they are using an agile development approach that Interior's guidance does not address. By updating its SDLG or other relevant IT policies and guidance to address how program offices are to implement agile development approaches for software, Interior would have better assurance that its new data systems will function as intended to meet user needs and reduce budget and schedule risks.

Recommendations for Executive Action

We are making a total of six recommendations, three to BLM and three to Interior:

The Director of BLM should consistently designate data stewards at relevant levels to ensure data are of known and sufficient quality. (Recommendation 1)

The Secretary of the Interior should direct the Chief Information Officer to develop a plan to address data-sharing challenges in the course of updating and modernizing key oil and gas data systems, including automating data sharing and adopting common identifiers for leases and operators. (Recommendation 2)

The Director of BLM should develop training plans for key data systems that identify users and how they will be trained. (Recommendation 3)

The Secretary of the Interior should direct the Chief Information Officer to develop a process to ensure that program offices maintain requirements-related documentation supporting the development and management of requirements for future IT and data systems at BLM and ONRR. (Recommendation 4)

The Director of BLM should define and document processes for developing and managing requirements for AFMSS II and MLRS in a

manner consistent with existing or updated IT policies and guidance. (Recommendation 5)

The Secretary of the Interior should direct the Chief Information Officer to update Interior's Solution Development Lifecycle Guide or other relevant IT policies and guidance to address how program offices are to implement agile methodologies for the development of software. (Recommendation 6)

Agency Comments

We provided a draft of this product to Interior for comment. In its comments, reproduced in appendix VI, Interior stated that it appreciated our review of and feedback related to the data systems used to oversee oil and gas development on leased federal lands. Interior concurred with all of our recommendations.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to the appropriate congressional committees, the Secretary of the Interior, and other interested parties. In addition, the report is available at no charge on the GAO website at http://www.gao.gov.

If you or your staff have any questions about this report, please contact us at (202) 512-3841 or ruscof@gao.gov or at (202) 512-6240 or dsouzav@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix VII.

Sincerely yours,

Frank Rusco
Director, Natural Resources and Environment

Vijay A. D'Souza
Director, Information Technology and Cybersecurity

Appendix I: Assessment of ONRR's
Implementation of Leading Practices for
Requirements for the Minerals Revenue
Management Support System

Appendix I: Assessment of ONRR's Implementation of Leading Practices for Requirements for the Minerals Revenue Management Support System

This appendix includes details on our assessment of the Office of Natural Resources Revenue's (ONRR) implementation of leading practices for requirements for the Minerals Revenue Management Support System (MRMSS). We reviewed leading practices in four areas: (1) develop customer requirements, (2) develop product requirements, (3) analyze and validate requirements, and (4) manage requirements.[1] The practices in those four areas include 15 subpractices that should be met in order to fully implement specific practices.

We found that ONRR fully demonstrated implementation of four of the 15 subpractices, partially demonstrated implementation of one subpractice, and did not demonstrate implementation of the 10 remaining subpractices. Table 3 details our ratings of ONRR's implementation of leading practices and subpractices for requirements for MRMSS.

Table 3: Detailed Assessment of the Office of Natural Resources Revenue's (ONRR) Implementation of Leading Practices for Requirements for the Minerals Revenue Management Support System (MRMSS)

	Leading practices and subpractices	Rating	Description
Develop customer requirements	Elicit stakeholder needs	Not demonstrated	ONRR did not have documentation of its efforts to develop customer requirements, including addressing these two subpractices for MRMSS. ONRR officials stated that the current program team was not involved in the original development of requirements for the system in the 1990s and in the early 2000s when it was modernized and that the program team did not maintain documentation from its prior development efforts.
	Transform stakeholder needs into customer requirements	Not demonstrated	

[1]Carnegie Mellon University, Software Engineering Institute, *Capability Maturity Model® Integration (CMMI®) for Development,* Version 1.3 (Pittsburgh, PA: November 2010).

**Appendix I: Assessment of ONRR's
Implementation of Leading Practices for
Requirements for the Minerals Revenue
Management Support System**

	Leading practices and subpractices	Rating	Description
Develop product requirements	Establish product and product component requirements	Not demonstrated	ONRR did not have documentation of its efforts to develop product requirements, including addressing these three subpractices for MRMSS. ONRR officials stated that the current program team was not involved in the original development of requirements for the system in the 1990s and in the early 2000s when it was modernized and that the program team did not maintain documentation from its prior development efforts.
	Allocate product component requirements	Not demonstrated	
	Identify interface requirements	Not demonstrated	
	Establish operational concepts and scenarios	Not demonstrated	ONRR did not have documentation of its efforts to analyze and validate requirements for MRMSS, including addressing these five subpractices. ONRR officials stated that the current program team was not involved in the original development of requirements for the system in the 1990s and in the early 2000s when it was modernized and that the program team did not maintain documentation from its prior development efforts.
	Establish a definition of required functionality and quality attributes	Not demonstrated	
	Analyze requirements to ensure that they are necessary and sufficient	Not demonstrated	
	Analyze requirements to achieve balance	Not demonstrated	
	Validate requirements	Not demonstrated	
Manage requirements	Understand requirements	Fully demonstrated	ONRR developed an understanding of MRMSS's requirements with users and subject matter experts. For example, in fiscal year 2020, ONRR established and implemented a system change request process through which it documented objective criteria for evaluating and accepting new or revised requirements, included stakeholder reviews and approvals of business and functional requirements, and reached an understanding between the system's users and the program team about the meaning of requirements.
	Obtain commitment to requirements	Fully demonstrated	ONRR obtained commitment to requirements from program team members and stakeholders. For example, ONRR established and implemented a change management process, which includes steps for obtaining commitment through key documentation and related documentation such as system change requests and kick-off meetings. Through these efforts, ONRR demonstrated that program team members reviewed the impacts of new or revised requirements on existing commitments and negotiated and prioritized changes with stakeholders.
	Manage requirements changes	Fully demonstrated	ONRR managed changes to MRMSS's requirements. For example, ONRR established a process for managing changes to system requirements and documented historical changes and the rationale for system changes through a change request spreadsheet. In addition, the agency included a checklist and summary of benefits in its system change request process to evaluate and discuss potential impacts from proposed system changes.

**Appendix I: Assessment of ONRR's
Implementation of Leading Practices for
Requirements for the Minerals Revenue
Management Support System**

Leading practices and subpractices	Rating	Description
Maintain bidirectional traceability of requirements	Partially demonstrated	ONRR maintained traceability between individual MRMSS requirements and work products such as a detailed design document. However, ONRR did not demonstrate traceability from source requirements to requirements for system components, functions, and interfaces.
Ensure alignment between project work and requirements	Fully demonstrated	ONRR ensured alignment between project work, such as design documents, and changes in MRMSS's requirements. For example, ONRR established and implemented a system change request process through which it documented requirements and the resulting changes to work products such as design documents.

Legend:

● = Fully demonstrated implementation: the documents supported all aspects of the subpractice.
◑ = Partially demonstrated implementation: the documents supported some, but not all, aspects of the subpractice.
○ = Not demonstrated: the documents did not support any aspect of the subpractice, or agency officials were not able to provide documentation in support of the subpractice.

Source: GAO analysis of Department of the Interior documents and demonstrations and Capability Maturity Model® Integration (CMMI®) for Development, Version 1.3. | GAO-21-209

Appendix II: Assessment of the Bureau of
Land Management's Implementation of
Leading Practices for Requirements for the
Automated Fluid Minerals Support System

Appendix II: Assessment of the Bureau of Land Management's Implementation of Leading Practices for Requirements for the Automated Fluid Minerals Support System

This appendix includes detailed information on our assessment of the Bureau of Land Management's (BLM) implementation of leading practices for requirements for the Automated Fluid Minerals Support System (AFMSS). We reviewed leading practices in four areas: (1) develop customer requirements, (2) develop product requirements, (3) analyze and validate requirements, and (4) manage requirements.[1] The practices in those four areas included 15 subpractices that should be met in order to fully implement specific practices.

We found that BLM did not demonstrate that it had fully or partially implemented any of the 15 subpractices. Table 4 details our ratings of BLM's implementation of leading practices and subpractices for requirements for AFMSS.

Table 4: Detailed Assessment of the Bureau of Land Management's (BLM) Implementation of Leading Practices for Requirements for the Automated Fluid Minerals Support System (AFMSS)

	Leading practices and subpractices	Rating	Description
Develop customer requirements	Elicit stakeholder needs	Not demonstrated	BLM did not have documentation of its efforts to develop customer requirements, including addressing these two subpractices for AFMSS. BLM officials stated that the current project team was not involved in the development of requirements for the system and that the project office did not maintain documentation from its prior development efforts.
	Transform stakeholder needs into customer requirements	Not demonstrated	
Develop product requirements	Establish product and product component requirements	Not demonstrated	

[1]Carnegie Mellon University, Software Engineering Institute, *Capability Maturity Model® Integration* (CMMI®) *for Development,* Version 1.3 (Pittsburgh, PA: November 2010).

Appendix II: Assessment of the Bureau of
Land Management's Implementation of
Leading Practices for Requirements for the
Automated Fluid Minerals Support System

	Leading practices and subpractices	Rating	Description
	Allocate product component requirements	Not demonstrated	BLM did not have documentation of its efforts to develop product requirements, including addressing these three subpractices for AFMSS. BLM officials stated that the current project team was not involved in the development of requirements for the system and that the project office did not maintain documentation from its prior development efforts.
	Identify interface requirements	Not demonstrated	
Analyze and validate requirements	Establish operational concepts and scenarios	Not demonstrated	BLM did not have documentation of its efforts to analyze and validate requirements, including addressing these five subpractices for AFMSS. BLM officials stated that the current project team was not involved in the development of requirements for the system and that the project office did not maintain documentation from its prior development efforts.
	Establish a definition of required functionality and quality attributes	Not demonstrated	
	Analyze requirements to ensure that they are necessary and sufficient	Not demonstrated	
	Analyze requirements to achieve balance	Not demonstrated	
	Validate requirements	Not demonstrated	
Manage requirements	Understand requirements	Not demonstrated	BLM did not maintain documentation of its prior or current efforts to manage AFMSS's requirements. BLM officials stated that the current project team was not involved in the management of the system's requirements during the 1990s and 2000s. BLM officials noted that the agency currently has a robust, rigorous, and well-documented information technology change and configuration management program. However, BLM did not have documentation of its efforts to understand the system's requirements, including activities such as establishing criteria for individuals that can provide requirements, establishing objective criteria for evaluating and accepting requirements, and analyzing requirements to ensure that criteria are met.
	Obtain commitment to requirements	Not demonstrated	BLM did not maintain documentation of its prior or current efforts to manage AFMSS's requirements. BLM officials stated that the current project team was not involved in the management of the system's requirements during the 1990s and 2000s. BLM officials noted that the agency currently has a robust, rigorous, and well-documented information technology change and configuration management program. However, BLM did not have documentation of its efforts to obtain commitment to the system's requirements, including activities such as assessing the impact of requirements changes on existing commitments and negotiating changes to existing commitments before the project commits to new requirements or requirements changes.

Appendix II: Assessment of the Bureau of
Land Management's Implementation of
Leading Practices for Requirements for the
Automated Fluid Minerals Support System

Leading practices and subpractices	Rating	Description
Manage requirements changes	Not demonstrated	BLM did not maintain documentation of its prior or current efforts to manage AFMSS's requirements. BLM officials stated that the current project team was not involved in the management of the system's requirements during the 1990s and 2000s. BLM officials noted that the agency currently has a robust, rigorous, and well-documented information technology change and configuration management program. However, BLM did not have documentation of its efforts to manage changes to the system's requirements, including activities such as documenting all requirements and requirements changes, maintaining a history of requirements changes and their rationale, and evaluating the impact of changes to stakeholders.
Maintain bidirectional traceability of requirements	Not demonstrated	BLM did not maintain documentation of its prior or current efforts to manage AFMSS's requirements. BLM officials stated that the current project team was not involved in the management of the system's requirements during the 1990s and 2000s. BLM officials noted that the agency currently has a robust, rigorous, and well-documented information technology change and configuration management program. However, BLM did not have documentation of its efforts to maintain traceability among requirements and other system documentation, including activities such as ensuring that the source of lower-level requirements is documented and maintaining traceability from lower-level requirements to elements of the system's architecture, interfaces, functions, and other components.
Ensure alignment between project work and requirements	Not demonstrated	BLM did not maintain documentation of its prior or current efforts to manage AFMSS's requirements. BLM officials stated that the current project team was not involved in the management of the system's requirements during the 1990s and 2000s. BLM officials noted that the agency currently has a robust, rigorous, and well-documented information technology change and configuration management program. However, BLM did not have documentation of its efforts to ensure that project plans remained aligned with requirements, including activities such as reviewing project plans for consistency with requirements changes and taking corrective actions to address inconsistencies.

Legend:

● = Fully demonstrated implementation: the documents supported all aspects of the subpractice.
◐ = Partially demonstrated implementation: the documents supported some, but not all, aspects of the subpractice.
○ = Not demonstrated: the documents did not support any aspect of the subpractice, or agency officials were not able to provide documentation in support of the subpractice.

Source: GAO analysis of Department of the Interior documents and demonstrations and Capability Maturity Model® Integration (CMMI®) for Development, Version 1.3. | GAO-21-209

Appendix III: Assessment of the Bureau of
Land Management's Implementation of
Leading Practices for the Legacy Rehost 2000
System

Appendix III: Assessment of the Bureau of Land Management's Implementation of Leading Practices for the Legacy Rehost 2000 System

This appendix includes detailed information on our assessment of the Bureau of Land Management's (BLM) implementation of leading practices for requirements for the Legacy Rehost 2000 (LR2000) system. We reviewed leading practices in four areas: (1) develop customer requirements, (2) develop product requirements, (3) analyze and validate requirements, and (4) manage requirements.[1] The practices in those four areas include 15 subpractices that should be met in order to fully implement specific practices.

We found that BLM partially implemented one subpractice and did not demonstrate implementation of the remaining 14 subpractices. Table 5 details our ratings of BLM's implementation of leading practices and subpractices for requirements for LR2000.

Table 5: Detailed Assessment of the Bureau of Land Management's (BLM) Implementation of Leading Practices for Requirements for the Legacy Rehost 2000 (LR2000) System

	Leading practices and subpractices	Rating	Description
Develop customer requirements	Elicit stakeholder needs	Not demonstrated	BLM did not have documentation of its efforts to develop **customer** requirements, including addressing these two subpractices for LR2000.
	Transform stakeholder needs into customer requirements	Not demonstrated	
Develop product requirements	Establish product and product component requirements	Not demonstrated	BLM did not have documentation of its efforts to develop product requirements, including addressing these three subpractices for LR2000.

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[1]Carnegie Mellon University, Software Engineering Institute, *Capability Maturity Model® Integration (*CMMI®) *for Development,* Version 1.3 (Pittsburgh, PA: November 2010).

Appendix III: Assessment of the Bureau of
Land Management's Implementation of
Leading Practices for the Legacy Rehost 2000
System

	Leading practices and subpractices	Rating	Description
	Allocate product component requirements	Not demonstrated	
	Identify interface requirements	Not demonstrated	
Analyze and validate requirements	Establish operational concepts and scenarios	Not demonstrated	BLM did not have documentation of its efforts to analyze and validate requirements, including addressing these five subpractices for LR2000.
	Establish a definition of required functionality and quality attributes	Not demonstrated	
	Analyze requirements to ensure that they are necessary and sufficient	Not demonstrated	
	Analyze requirements to achieve balance	Not demonstrated	
	Validate requirements	Not demonstrated	
Manage requirements	Understand requirements	◖	BLM obtained feedback from user surveys to better understand LR2000's requirements. For example, according to a May 2019 Operational Analysis, BLM made several major enhancements—such as reconfiguring a transaction database and adding new case types—as a result of user survey feedback during fiscal year 2017.
			However, BLM did not document other important aspects of how it has developed an understanding of requirements with stakeholders. For example, BLM did not document criteria for who provides requirements or for the evaluation and acceptance of requirements. In addition, the program office did not document its analysis of requirements to ensure that established criteria were being met.
	Obtain commitment to requirements	Not demonstrated	BLM did not document commitments to requirements from program staff and stakeholders, including reviews of the impact on existing commitments resulting from changes in requirements.
	Manage requirements changes	Not demonstrated	BLM did not demonstrate its management of changes to requirements for LR2000. According to a May 2019 Operational Analysis, BLM has a Project Change Management Board that is to provide feedback on and prioritize changes to LR2000 from representative users on a quarterly basis. However, BLM did not document the board's charter or its feedback and priorities with respect to users' changes. In addition, BLM did not maintain historical changes for the system with a rationale for each change and evaluations of the impact from requirements changes.

Appendix III: Assessment of the Bureau of
Land Management's Implementation of
Leading Practices for the Legacy Rehost 2000
System

Leading practices and subpractices	Rating	Description
Maintain bidirectional traceability of requirements	Not demonstrated	BLM did not document its efforts to maintain traceability from lower-level requirements to higher-level system functions and features.
Ensure alignment between project work and requirements	Not demonstrated	BLM did not document its efforts to ensure alignment between program documentation, such as project plans and system design artifacts, and requirements changes.

Legend:

● = Fully demonstrated implementation: the documents supported all aspects of the subpractice.
◒ = Partially demonstrated implementation: the documents supported some, but not all, aspects of the subpractice.
○ = Not demonstrated: the documents did not support any aspect of the subpractice, or agency officials were not able to provide documentation or software demonstrations in support of the subpractice.

Source: GAO analysis of Department of the Interior documents and demonstrations and Capability Maturity Model® Integration (CMMI®) for Development, Version 1.3. | GAO-21-209

Appendix IV: Assessment of the Bureau of
Land Management's Implementation of
Leading Practices for the Automated Fluid
Minerals Support System II

Appendix IV: Assessment of the Bureau of Land Management's Implementation of Leading Practices for the Automated Fluid Minerals Support System II

This appendix includes detailed information on our assessment of the Bureau of Land Management's (BLM) implementation of leading practices for requirements for the Automated Fluid Minerals Support System II (AFMSS II). We reviewed leading practices in four areas: (1) develop customer requirements, (2) develop product requirements, (3) analyze and validate requirements, and (4) manage requirements.[1] The practices in those four areas include 15 subpractices that should be met in order to fully implement specific practices.

We found that BLM partially implemented all 15 subpractices. Table 6 details our ratings of BLM's demonstration of implementing leading practices and subpractices for requirements for AFMSS II.

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[1]Carnegie Mellon University, Software Engineering Institute, *Capability Maturity Model® Integration* (CMMI®) *for Development,* Version 1.3 (Pittsburgh, PA: November 2010).

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Table 6: Detailed Assessment of the Bureau of Land Management's (BLM) Implementation of Leading Practices for Requirements for the Automated Fluid Minerals Support System II (AFMSS II)

	Leading practices and subpractices	Rating	Description
Develop customer requirements	Elicit stakeholder needs	Partially demonstrated	BLM took steps to elicit stakeholders' needs, expectations, and constraints. For example, BLM developed a team roster to identify product owners and other stakeholders who would provide input on needs for each component of AFMSS II. In addition, the program office used system change requests to identify new or revised needs and expectations of stakeholders as well as constraints regarding technical factors that may affect requirements. BLM also demonstrated stakeholder needs, expectations, and constraints that the agency had captured in its software development tool through user stories,[a] which are desired software features described from the perspective of an end user.
			However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from the Department of the Interior (Interior) and BLM management and stakeholders.
	Transform stakeholder needs into customer requirements	Partially demonstrated	BLM took steps to transform stakeholders' needs, expectations, and constraints into prioritized customer requirements. Specifically, requirements specifications for the first module of the system and program increment planning documents identified steps taken by the program office to translate requirements from needs identified by stakeholders. Additionally, the program office demonstrated the priority levels that it identified for individual user stories and interfaces for transferring data between this system and other BLM and Office of Natural Resources and Revenue (ONNR) systems that it captured within its software development tool.
			However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.
Develop product requirements	Establish product and product component requirements	Partially demonstrated	BLM took steps to establish and maintain product (system) requirements based on customer requirements. For example, program increment planning documentation and user stories identified system requirements based on customer requirements. In addition, the program office established revised requirements for data migration based on stakeholders who collaborated and submitted a system change request. BLM also demonstrated that the program office identified requirements within related categories of system functionality and identified linkages among requirements that had dependencies within its software development tool.
			However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.

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	Leading practices and subpractices	Rating	Description
	Allocate product component requirements	Partially demonstrated	BLM took steps to allocate requirements to AFMSS II's components and features. The program office documented various stages at which requirements were to be addressed with delivered software and identified dependencies among related requirements in its development schedule and within its software development tool.
			However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.
	Identify interface requirements	Partially demonstrated	BLM took steps to identify requirements for interfaces between BLM and ONRR systems through documents that captured the needs of users and in architecture diagrams. As an example, BLM identified the technical details needed to interface AFMSS II and the Minerals Revenue Management Support System databases to exchange data. In another example, BLM also identified interfaces between AFMSS II and Legacy Rehost 2000.
			However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.
Analyze and validate requirements	Establish operational concepts and scenarios	Partially demonstrated	BLM documented an AFMSS II system architecture diagram and other technical details within an operating manual that defined the environment in which the system was to operate. However, BLM did not establish operational concepts and scenarios for features that were to be added to the system.
			Additionally, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.
	Establish a definition of required functionality and quality attributes	Partially demonstrated	BLM took steps to establish a definition of AFMSS II's required functionality through its work flows associated with its business application for permit to drill and notices of staking. Specifically, these work flows described the order in which activities are to be performed and the users that are involved in each step. In addition, BLM demonstrated that it captured in its software development tool users' expectations of functionality and quality through user story descriptions and completion criteria.
			However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.

Appendix IV: Assessment of the Bureau of
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	Leading practices and subpractices	Rating	Description
	Analyze requirements to ensure that they are necessary and sufficient	Partially demonstrated	BLM took steps to analyze requirements to ensure that they were necessary and sufficient. For instance, in 2014, the program office documented detailed requirements specifications for one of AFMSS II's modules. In addition, the program office analyzed and obtained feedback from stakeholders concerning requirements for system functionality that were necessary for the next iteration of development during meetings on program increment planning. However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.
	Analyze requirements to achieve balance	Partially demonstrated	BLM took steps to analyze requirements to balance stakeholder needs and constraints. For example, its implementation and transition plan included strategies to roll out system modules while balancing stakeholder needs and constraints, and planning meetings for the system's incremental development included analyzing requirements to plan system development efforts while obtaining feedback from stakeholders. In addition, BLM demonstrated that its software development tool captured agreements from stakeholders on system requirements. However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.
	Validate requirements	Partially demonstrated	BLM took steps to validate that AFMSS II would perform as intended. For example, the program office conducted software testing to validate technical features of the system during incremental iterations of the system's development. According to BLM officials, both software developers and end users were involved in these tests. However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.
Manage requirements	Understand requirements	Partially demonstrated	BLM took steps to develop an understanding with stakeholders and end users on the meaning of the requirements. Specifically, BLM's AFMSS II program planning documents defined the requirements to be developed incrementally and obtained stakeholder approvals, and a decision document collected stakeholders' feedback on a preferred strategy to implement minimum viable product requirements. However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.

Appendix IV: Assessment of the Bureau of
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Leading practices and subpractices	Rating	Description
Obtain commitment to requirements	Partially demonstrated	BLM took steps toward obtaining commitment to requirements from program staff responsible for developing AFMSS II and stakeholders. For example, the agency demonstrated stakeholders' agreement to the requirements to develop a minimally functional product in an AFMSS roadmap and to the requirements planned in program increment planning documents. However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.
Manage requirements changes	Partially demonstrated	BLM took steps to manage changes to requirements for the program. The agency's program increment planning documentation included requirements that the program office had identified a history of changes to requirements, and evaluations of impacts to stakeholders from changes in requirements. In addition, BLM demonstrated the log of changes to system requirements that it captured in its software development tool. However, as we have previously reported, BLM did not document change management procedures—its process for how change requests for AFMSS II were to be accepted, recorded, evaluated, prioritized, and communicated to stakeholders—for the program. Thus, it remains unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.
Maintain bidirectional traceability of requirements	Partially demonstrated	BLM took steps to maintain traceability from lower-level requirements to higher-level system features and documentation. Specifically, the program office demonstrated that it maintains traceability in its software development tool with user stories that define lower-level requirements and in sprint agreements that maintain traceability to higher-level work products and system functionality.[b] However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.
Ensure alignment between project work and requirements	Partially demonstrated	BLM took steps to ensure alignment between project documentation and changes in requirements. Specifically, BLM's incremental systems planning documentation demonstrated its alignment to requirements changes. Additionally, the program office demonstrated how its software development tool creates summary reports of activities to include changes to requirements and notifies members on their phones when updates or statuses change. However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.

Legend:

**Appendix IV: Assessment of the Bureau of
Land Management's Implementation of
Leading Practices for the Automated Fluid
Minerals Support System II**

● = Fully demonstrated implementation: the documents or software demonstrations supported all aspects of the subpractice.

◓ = Partially demonstrated implementation: the documents or software demonstrations supported some, but not all, aspects of the subpractice.

○ = Not demonstrated: the documents or software demonstrations did not support any aspect of the subpractice, or agency officials were not able to provide documentation or software demonstrations in support of the subpractice.

Source: GAO analysis of Department of the Interior documents and demonstrations and Capability Maturity Model® Integration (CMMI) for Development, Version 1.3. | GAO-21-209

[a]User stories are descriptions by users explaining what the system needs to do.

[b]Sprint agreements are commitments to produce working software within a defined time frame and are intended to provide distinct, consistent, and incremental progress of prioritized software features.

**Appendix V: Assessment of the Bureau of
Land Management's Implementation of
Leading Practices for the Mineral and Lands
Records System**

Appendix V: Assessment of the Bureau of Land Management's Implementation of Leading Practices for the Mineral and Lands Records System

This appendix includes detailed information on our assessment of the Bureau of Land Management's (BLM) implementation of leading practices for requirements for the Mineral and Land Records System (MLRS). We reviewed leading practices in four areas: (1) develop customer requirements, (2) develop product requirements, (3) analyze and validate requirements, and (4) manage requirements.[1] The practices in those four areas include 15 subpractices that should be met in order to fully implement specific practices.

We found that BLM partially implemented 10 subpractices. We did not rate its implementation of the remaining five subpractices because they were not assessed in the system's current state of development. Table 7 details our ratings of BLM's implementation of leading practices and subpractices for requirements for MLRS.

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[1]Carnegie Mellon University, Software Engineering Institute, *Capability Maturity Model® Integration* (CMMI®) *for Development,* Version 1.3 (Pittsburgh, PA: November 2010).

Appendix V: Assessment of the Bureau of
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Table 7: Detailed Assessment of the Bureau of Land Management's (BLM) Implementation of Leading Practices for Requirements for the Mineral and Land Records System (MLRS)

	Leading practices and subpractices	Rating	Description
Develop customer requirements	Elicit stakeholder needs	Partially demonstrated	BLM took steps to engage stakeholders and elicit their needs and constraints for the mining claim portion of MLRS during an October 2019 information session. For example, the program office engaged stakeholders to gain a better understanding of their behaviors, needs, and motivations through interviews with system users (**customers** and employees), design and data workshops, and the development of user stories, which are short descriptions of a feature in the system under development from the perspective of the end user.
			However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.
	Transform stakeholder needs into customer requirements	Partially demonstrated	BLM took steps to prioritize customer requirements in its software development tool through user stories that receive a priority ranking when established and agreements between program staff and stakeholders on the features that should be developed in future iterations. In addition, BLM defined system constraints in the MLRS System and Architecture Design Document from 2019 and a Requirements Management Plan from 2017.
			However, BLM revised its development approach in 2019 and did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.
Develop product requirements	Establish product and product component requirements	Partially demonstrated	BLM took steps to establish product and component requirements through various system architecture and design-related artifacts, such as the MLRS Technical Solution Architecture, Logical Solution Architecture, and System and Architecture Design Document.
			However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.

Appendix V: Assessment of the Bureau of
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	Leading practices and subpractices	Rating	Description
	Allocate product component requirements	Partially demonstrated	BLM took steps to allocate requirements for product components through details, test results, and incremental planning information surrounding user stories. In particular, the agency allocated user stories to functional components of the system, such as a virtual public room. In addition, BLM demonstrated that it documented the relationships and dependencies among its user stories in its software development tool.
			However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.
	Identify interface requirements	Partially demonstrated	BLM took steps to document requirements for product interfaces and other architectural requirements in the MLRS System and Architecture Design Document and within individual user stories in its software development tool. For example, BLM demonstrated a user story for MLRS that identified an interface with external system regarding bulk paper filing.
			However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.
Analyze and validate requirements	Establish operational concepts and scenarios	Partially demonstrated	BLM took steps to establish and maintain operational concepts and scenarios in the MLRS Concept of Operations and System and Architecture Design Document. According to BLM, the operational concepts of the system may be revised over time as user expectations and needs evolve and that such changes in expectations are to be captured in program increment planning meetings.
			However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.
	Establish a definition of required functionality and quality attributes	Partially demonstrated	BLM took steps to establish required functionality and quality for the system. For example, the program office established a backlog that stores user requests for the system and that includes basic information about desired attributes. The agency further refined and supplemented the information from the backlog into user stories that BLM captured and maintained in its software development tool. The user stories articulated specific functionality and quality as criteria for a requirement to be considered complete.
			However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.

**Appendix V: Assessment of the Bureau of
Land Management's Implementation of
Leading Practices for the Mineral and Lands
Records System**

Leading practices and subpractices	Rating	Description
Analyze requirements to ensure that they are necessary and sufficient	Partially demonstrated	BLM took steps to analyze requirements for the system to ensure that they are necessary and sufficient. Specifically, the agency conducted incremental reviews of requirements (referred to as "sprint reviews") every 3 weeks. During the reviews, a cross-functional team consisting of developers and stakeholders for the features being developed analyzed the requirements to ensure that they were accurate and prioritized according to user needs. Based on this analysis, the team reached agreement and obtained approval from a product owner on the requirements that were necessary and sufficient for the next iteration of development. However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.
Analyze requirements to achieve balance	Partially demonstrated	BLM took steps to analyze requirements to balance stakeholder needs and constraints. For example, BLM demonstrated user story descriptions and constraints that the program office captured in its software development tool. The agency conducted incremental reviews of requirements (referred to as "sprint reviews") every 3 weeks. During the reviews, developers and end user representatives discussed ways to adjust established requirements as necessary. BLM officials stated that cross-functional teams analyze and evaluate solutions and that sprint planning requires the development of work-arounds to address any constraints. However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders
Validate requirements	Partially demonstrated	BLM took steps to validate that MLRS would perform as intended in the end user's environment by conducting incremental reviews of completed functionality with stakeholders every 3 weeks. In these reviews, the product owner, state office representatives, and BLM information technology officials, among other stakeholders, analyzed documentation and obtained demonstrations of system features and functionality that had been developed for that increment. Based on this analysis, the product owner determined whether the development adequately met defined acceptance criteria for individual user stories, which represent user requirements. In addition, the performance work statement for the system's development contractor requires the contractor to provide BLM testing and analysis support for each software release, including user acceptance testing. The first software release for the mining module was scheduled to be completed in November 2020. However, BLM did not document plans or a process for how program staff were to implement the activities for this practice. Thus, it is unclear whether the steps that the program office has taken were adequate and consistent with expectations from Interior and BLM management and stakeholders.

Appendix V: Assessment of the Bureau of
Land Management's Implementation of
Leading Practices for the Mineral and Lands
Records System

	Leading practices and subpractices	Rating	Description
Manage requirements	Understand requirements	Not rated[a]	MLRS is still in development, and no components of the system are currently operational.
	Obtain commitment to requirements	Not rated[a]	
	Manage requirements changes	Not rated[a]	
	Maintain bidirectional traceability of requirements	Not rated[a]	
	Ensure alignment between project work and requirements	Not rated[a]	

Legend:

● = Fully demonstrated implementation: the documents or software demonstrations supported all aspects of the subpractice

◒ = Partially demonstrated implementation: the documents or software demonstrations supported some, but not all, aspects of the subpractice

○ = Not demonstrated: the documents or software demonstrations did not support any aspect of the subpractice, or agency officials were not able to provide documentation or software demonstrations in support of the subpractice

Source: GAO analysis of Department of the Interior documents and demonstrations and Capability Maturity Model® Integration (CMMI®) for Development, Version 1.3. | GAO-21-209

[a]Not rated: a system in development was not yet operational and was not assessed against the leading subpractices for requirements management.

Appendix VI: Comments from the Department of the Interior

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, DC 20240

Frank Rusco
Director, Natural Resources and Environment
Vijay A. D'Souza
Director, Information Technology and Cyber Security
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Director Rusco and Director D'Souza,

Thank you for providing the Department of the Interior (Department) an opportunity to review
and comment on the draft Government Accountability Office (GAO) report entitled, *Oil and
Gas, Interior Should Strengthen Management of Key Data Systems Used to Oversee
Development on Federal Lands* (GAO-21-209). We appreciate GAO's review of and feedback
related to the data systems used to oversee oil and gas development on leased federal lands.

The GAO issued six recommendations to the Department as part of its overall findings to
improve these processes. The Department concurs with the following recommendations issued
by GAO.

> **Recommendation 1:** "The Director of Bureau of Land Management (BLM) should
> consistently designate data stewards at relevant levels to ensure data are of known and
> sufficient quality."
>
> **Recommendation 2:** "The Secretary of the Interior should direct the Chief Information
> officer to develop a plan to address data sharing challenges in the course of updating and
> modernizing key oil and gas data systems, including automating data sharing and
> adopting common identifiers for leases and operators."
>
> **Recommendation 3:** "The Director of BLM should develop training plans for key data
> systems that identify users and how they will be trained."
>
> **Recommendation 4:** "The Secretary of the Interior should direct the Chief Information
> Officer to develop a process to ensure that program offices maintain requirements-related
> documentation supporting the development and management of requirements for future
> IT and data systems at BLM and ONRR."
>
> **Recommendation 5:** "The Director of BLM should define and document processes for

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developing and managing requirements for Automated Fluid Minerals Support System
(AFMSS) II and Mineral and Land Records System (MLRS) in a manner consistent with
existing or updated IT policies and guidance."

Recommendation 6: "The Secretary of the Interior should direct the Chief Information
Officer to update Interior's Solution Development Life Cycle Guide or other relevant IT
policies and guidance to address how program offices are to implement agile
methodologies for the development of software."

The Department looks forward to developing and reporting on planned actions in response to the
final report. If you have any questions or need additional information, please contact the Internal
Control and Audit Follow-up division of the Office of Financial Management at
DOI_PFM_ICAF@ios.doi.gov.

Sincerely,

RACHAEL
TAYLOR

Digitally signed by
RACHAEL TAYLOR
Date: 2021.05.10
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Rachael S. Taylor
Principal Deputy Assistant Secretary -
Policy Management and Budget

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Data table for Appendix VI: Comments from the Department of the Interior

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Frank Rusco

Director, Natural Resources and Environment Vijay A. D'Souza

Director, Information Technology and Cyber Security

U.S. Government Accountability Office 441 G Street, NW

Washington, DC 20548

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Financial Management at DOI_PFM_ICAF@ios.doi.gov.

Sincerely,

Rachael S. Taylor

Principal Deputy Assistant Secretary - Policy Management and Budget

Appendix VII: GAO Contacts and Staff Acknowledgments

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In addition to the contacts named above, Quindi Franco (Assistant Director), Josh Leiling (Assistant Director), Leah E. English (Analyst-in-Charge), Gerard V. Aflague, Andrea Harvey, Gwen Kirby, and Andrew Olson made significant contributions to this report. Contributions were also made by Marissa Dondoe, Eric Charles, Cindy Gilbert, Joe Maher, Rebecca Mendelsohn, Patricia Moye, and Dan Royer.

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