MOX Fuel Fabrication Facility

Briefings in Response to a Mandate in the National Defense Authorization Act for Fiscal Year 2017

September 6, 12, and 14, 2017

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Background: MOX Facility

In 1997, DOE established the Plutonium Disposition program—now managed by NNSA—to address the disposition of weapons-grade plutonium.

- As part of its Plutonium Disposition program, NNSA began constructing the Mixed Oxide Fuel Fabrication Facility (MOX facility) in 2007 at DOE's Savannah River Site in South Carolina (see fig. 1).

Background: MOX Facility

Figure 1: Aerial View of the Mixed Oxide Fuel Fabrication Facility Construction Project

Source: National Nuclear Security Administration. | GAO-18-122R

Background: MOX Facility

In 2007, DOE formally approved a cost estimate of $4.8 billion for construction of the MOX facility, with a scheduled completion date of September 2016.

- By 2012, NNSA had spent about $3.4 billion on the facility, and the contractor estimated that it needed approximately $4 billion more to complete construction by 2019.

In August 2016, in response to a provision in the National Defense Authorization Act for Fiscal Year 2016, DOE developed a revised cost estimate of approximately $17.2 billion to complete construction of the MOX facility by 2048.

- We recently found this estimate substantially met best practices and can be considered reliable.[1]

[1]GAO, *Plutonium Disposition: Proposed Dilute and Dispose Approach Highlights Need for More Work at the Waste Isolation Pilot Plant*, GAO-17-390 (Washington, D.C.: Sept. 5, 2017).

Background: MOX Facility

In April 2014, DOE completed an analysis of plutonium disposition options that identified an alternative dilute and dispose approach that DOE believes could significantly reduce the life-cycle cost of the Plutonium Disposition program.

- Starting with its fiscal year 2014 budget request—submitted in April 2013—DOE proposed slowing down work on the MOX facility while it assessed alternative strategies for plutonium disposition.

- DOE's fiscal year 2017 and 2018 budget requests proposed to terminate construction of the MOX facility and pursue the dilute and dispose approach for plutonium disposition. Under this approach, plutonium would be diluted with inert material to inhibit its future use in weapons. It would then be packaged and shipped to a repository for permanent disposal.

Background: DOE and Corps Reports

The National Defense Authorization Act for Fiscal Year 2017 required DOE to arrange with the U.S. Army Corps of Engineers (Corps) to prepare a report on the contract for the construction, management, and operations of the MOX facility, including:

- an assessment of the contractual, technical, and managerial risks for DOE and the contractor;
- an assessment of the elements of the contract that could be changed to fixed-price provisions; and
- recommendations on changes to the contract to reduce risk and cost to DOE while preserving a fair and reasonable contract.

DOE was to submit a report on the Corps report to the congressional defense committees.

The Corps submitted its report to DOE on February 22, 2017, and DOE submitted its report to the congressional defense committees on July 14, 2017.

Background: DOE and Corps Reports

The Corps recommended a two-phased approach to changing the contract.

- In the first phase, the Corps recommended determining the scope of the remaining work, which could include slowing down or stopping work on the construction of the facility, rebaselining the project, and negotiating changes to the contract.
- After agreement has been reached on the final design, the Corps recommended a second phase that would include changing the construction portion of the current contract, which is a cost-reimbursable line item, to a fixed-price incentive firm contract line item.
- The Corps estimated that it would take 31 to 43 months to convert the remaining construction work to a fixed-price incentive firm contract line item.

According to the Corps report, changing the contract type would reduce the level of government risk from that currently experienced under the existing contract.

However, if an agreement to convert the contract cannot be reached, the Corps recommended that DOE consider terminating the current contract.

Background: DOE and Corps Reports

According to DOE's report, the department continues to believe that terminating construction of the MOX facility is the best approach.

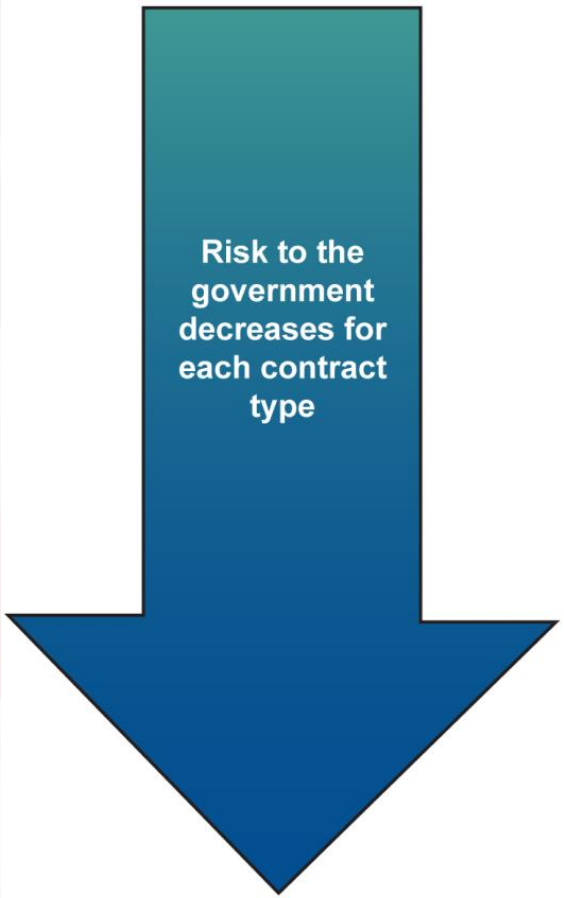
DOE's report further stated that if construction of the facility continues, the department recognizes the merits of the Corps' recommendations to

(1) convert the line item for construction to a fixed-price incentive firm line item so as to reduce cost and risk to the government and

(2) slow down or stop construction during the contract conversion period in order to complete design and determine how much work has been completed.

DOE's report also stated that the department is concerned that there may be significant challenges in reaching an agreement to convert the contract, which could further delay completion of the MOX facility.

Figure 2: Characteristics of Selected Contract Types



Contract type

Cost-Reimbursement Contracts

- The government pays allowable incurred costs to the extent specified in the contract and may include an additional fee (profit).
- The contractor must put forth its best efforts to perform the work within the estimated costs.
- However, the government must reimburse the contractor for its allowable costs regardless of whether the work is completed.

Fixed-Price Incentive

- The contract specifies several contract elements including a profit adjustment formula.
- The government and the contractor share responsibility for cost increases, or decreases, compared to the agreed upon target cost.
- The final negotiated cost is subject to a ceiling price, which is the maximum that may be paid to the contractor, except for any adjustment under other contract clauses.

Firm-Fixed Price

- Government agrees to a set price and the contractor is required to deliver regardless of their actual costs.
- The contractor bears the maximum risk and full responsibility for all costs and resulting profit or loss.

Source: GAO and analysis of the Federal Acquisition Regulation and Defense Acquisition University information. | GAO-18-122R

Objectives

The National Defense Authorization Act for Fiscal Year 2017 included a provision for us to review the actions taken by DOE related to the Corps' report on the MOX facility contract.

This briefing provides information on:

(1) The potential effects of converting the MOX facility contract to a fixed-priced incentive firm contract, as discussed in the DOE and Corps reports, on the cost for construction of the MOX facility.

(2) The potential effects of converting the MOX facility contract to a fixed-price incentive firm contract, as discussed in the DOE and Corps reports, on the life-cycle cost of the Plutonium Disposition program.

(3) Other observations on the Corps report and MOX facility.

Methodology

To answer these objectives, we:

- Reviewed the Corps and DOE reports and interviewed DOE, NNSA, and Corps officials responsible for developing those reports.
- Interviewed NNSA officials at the MOX Project Management Office at the Savannah River Site.
- Interviewed representatives from CB&I AREVA MOX Services, LLC (MOX Services), the contractor constructing the MOX facility, and reviewed the contractor's response to questions from NNSA included in the DOE report.
- Reviewed the contractor's data on 29 commodities used in constructing the MOX facility from its Quantity Tracking System.
  - We assessed the reliability of the data by interviewing knowledgeable contractor staff and conducting electronic testing of the data. We found the data to be sufficiently reliable to provide information on the contractor's assessment of the status of commodity installation.

Methodology

- Reviewed DOE's 2016 cost estimate for completing construction of the MOX facility.
  - In our September 2017 report (GAO-17-390), we found that the revised cost estimate substantially met best practices and can be considered reliable.
- Reviewed NNSA's revised 2016 life-cycle cost estimate for the Plutonium Disposition program, which includes the MOX facility.
  - The 2016 estimate is the only current NNSA life-cycle cost estimate available. This estimate is a revision of a draft estimate previously completed in 2013.
  - In our September 2017 report, we found that NNSA's revised 2016 life-cycle cost estimate did not follow best practices. We note this limitation when we discuss the estimate.

We received technical comments on the information in this briefing from DOE, NNSA, the Corps, and the contractor, which we incorporated as appropriate.

Objective 1: Potential Effects of Converting the Contract on the Cost for Construction of the MOX Facility

DOE's current cost estimate for the MOX facility construction is $17.2 billion. In our September 2017 report, we found this estimate substantially met best practices and can be considered reliable.

According to Corps and NNSA officials and MOX Services representatives, it is not certain that changing the contract type will reduce the total costs to the government of constructing the MOX facility.

Converting the current line item for MOX construction to a fixed-price incentive firm line item would limit government risk of potential cost increases for included items by shifting this risk to the contractor.

NNSA officials and MOX Services representatives also stated the continued uncertainty about the future of the facility is likely to lead to further cost increases.

Objective 1: Potential Effects of Converting the Contract on the Cost for Construction of the MOX Facility

The process of converting the MOX facility contract to a fixed-price incentive firm contract could present uncertainty about the costs of the project.

- According to representatives of MOX Services, the contractor will account for increased risks and other uncertainties when developing its proposal.
- NNSA officials and representatives of the contractor said that the time it takes to convert to a fixed-price incentive firm contract would increase the amount of time needed to complete construction. Any schedule delays could lead to increased costs, and during this time, the risk remains with the government.
- As discussed in the Corps report, leaving some items as cost-reimbursable would leave some risk for cost increases for the government.

However, according to the Corps report, once a fixed-price incentive firm contract is in place, the level of risk facing the government for cost increases would decrease from that currently experienced under the existing contract.

Objective 2: Potential Effects of Converting the Contract on the Life-Cycle Cost of the Plutonium Disposition Program

NNSA officials said they do not expect the change to a fixed-price incentive firm line item to significantly alter the life-cycle cost of the Plutonium Disposition program, which includes the MOX facility.

In 2016, NNSA estimated the life-cycle cost for the Plutonium Disposition program to be $56 billion. This includes costs for:

- constructing the MOX facility through 2048;
- operating the MOX facility from 2046 through 2063;
- preparing the feedstock, studying and modifying reactors to accept MOX fuel, and shipping pits—collectively referred to as MOX Irradiation, Feedstock, and Transportation;[2] and
- other program costs, such as program management costs.

[2]Some of these costs would occur regardless of whether the program uses the MOX facility or the dilute and dispose approach.

Objective 2: Potential Effects of Converting the Contract on the Life-Cycle Cost of the Plutonium Disposition Program

We found in September 2017 (GAO-17-390) that NNSA had not applied best practices when revising its 2016 life-cycle cost estimate for the Plutonium Disposition program, which includes the MOX facility.

- In February 2014, we recommended that NNSA revise its life-cycle cost estimate for the Plutonium Disposition program to incorporate best practices.[3]
  - In its response to that report, DOE stated that until a path forward for the Plutonium Disposition program is determined, it would not be cost effective to prepare a revised estimate.
  - We present these estimates because they are the only current estimates available to provide a sense of the potential costs of the Plutonium Disposition program.

[3]GAO, *Plutonium Disposition Program: DOE Needs to Analyze the Root Causes of Cost Increases and Develop Better Cost Estimates*, GAO-14-231 (Washington, D.C.: Feb. 13, 2014).

Objective 2: Potential Effects of Converting the Contract on the Life-Cycle Cost of the Plutonium Disposition Program

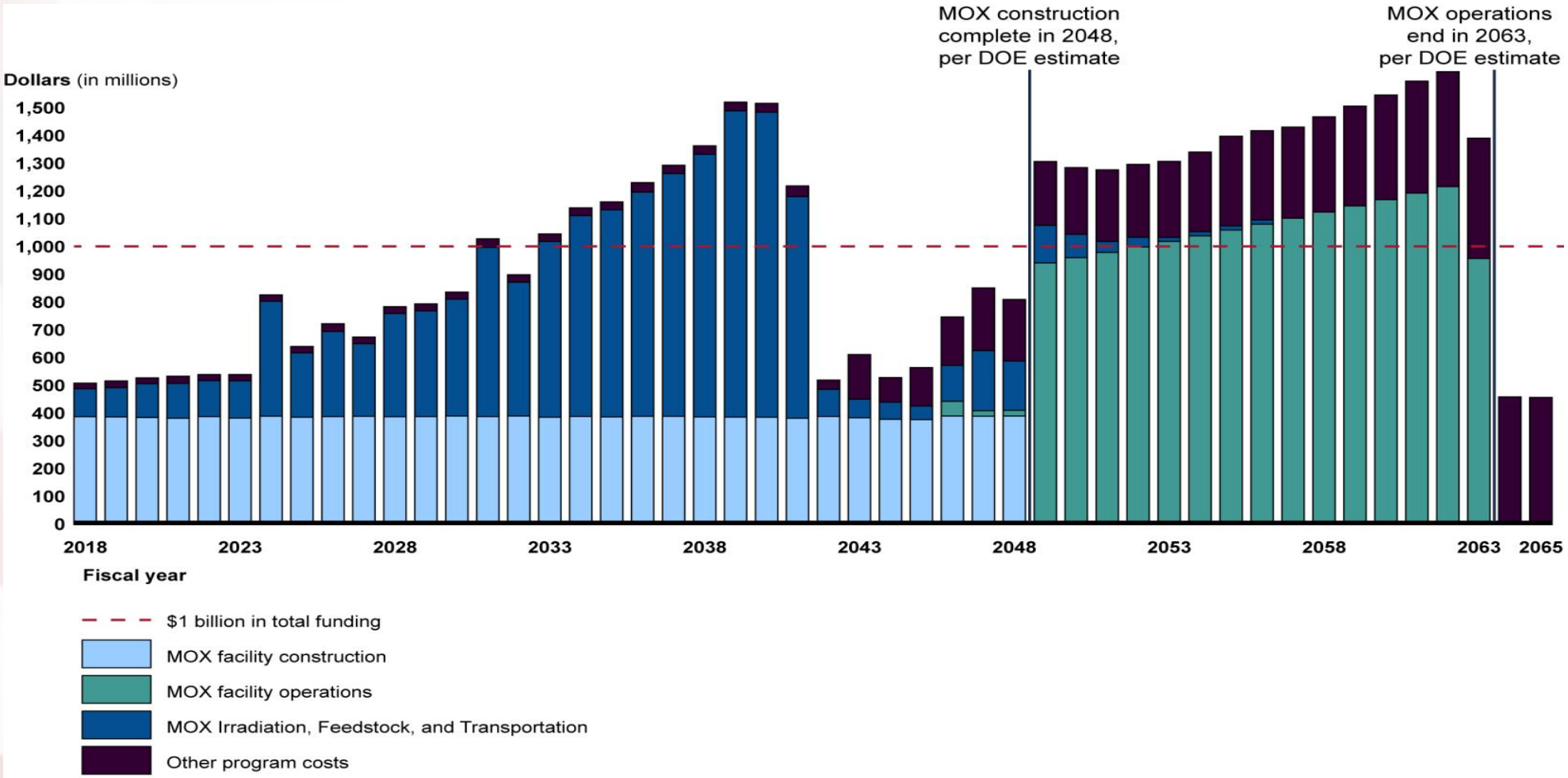
NNSA's 2016 life-cycle cost estimate calls for 6 years with annual funding at or above $1.5 billion, and an additional 19 years requiring annual funding greater than $1 billion (see fig. 3). These costs span:

- 10 years during the construction of the MOX facility and
- 15 years while the facility is in operation.

MOX Services representatives said that the costs to operate the MOX facility would be less than NNSA's estimate.

NNSA is developing a life-cycle cost estimate for the dilute and dispose approach. According to NNSA officials, this estimate could be completed by the end of calendar year 2018 and will be performed in accordance with best practices.

Figure 3: DOE's 2016 Life-Cycle Cost Estimate for the Plutonium Disposition Program, including the MOX Facility



Source: GAO analysis of Department of Energy (DOE) data. | GAO-18-122R

Note: We found in September 2017 (GAO-17-390) that NNSA had not applied best practices when revising its 2016 life-cycle cost estimate for the Plutonium Disposition program. We present these estimates as they are the only current estimates available to provide a sense of the potential costs of the program.

Objective 3: Other Observations

Estimates of Time to Convert to a Fixed-Price Incentive Firm Contract

The Corps estimated that it would take 31 to 43 months from the time a decision is made to convert the remaining work to a fixed-price incentive firm contract line item to the time the contract is modified. This estimated time frame includes:

- 12 to 18 months to determine the work that has been completed and the work remaining,
- 18 to 24 months for the preparation of the contractor's proposal and negotiations, and
- 1 month to modify the contract.

According to Corps officials, their estimate of the time to reach agreement on changes to the contract reflects the disagreement between NNSA and the contractor on the amount of work completed and the time needed to agree on a design and schedule for the MOX facility.

In its report, the Corps recommended slowing the pace of work while determining the work that remains and negotiating the changes to the contract.

Objective 3: Other Observations

Estimates of Percentage of Work Completed

Construction of the MOX facility is about 30 percent complete, based on the contractor's earned value data and DOE's 2016 construction estimate.

According to the GAO cost-estimating guide,[4] the percentage completed for a project is calculated as the budgeted cost for work performed—also known as earned value—divided by the budget at completion. The budget at completion is defined as the contract budget minus amounts for management reserve—money set aside in the project's budget for risks that were unknown at the project's start—and fees.

[4]GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C.: March 2009).

Objective 3: Other Observations

The contractor's estimate that the project is more than 70 percent complete is based on the contractor's 2012 proposed rebaseline estimate. The formula the contractor used to calculate the percentage completed was consistent with GAO's cost-estimating guide.

- In February 2014, we found that the contractor's 2012 proposed rebaseline estimate did not fully reflect the characteristics of a high-quality estimate and could not be considered reliable, in part because it was a proposal that was not reviewed and accepted by DOE.[5]
- In July 2016, the contractor estimated the costs of the project at completion as $9.99 billion based on annual funding of $350 million.

When we compared these estimates of percentage of the project completed, we found that the key difference between DOE's and the contractor's estimates is the estimated budget at completion used in their estimates, as shown in table 1.

[5]GAO-14-231.

Table 1: Comparison of DOE's and Contractor's Estimates of Percentage of Project Completion

Organization	Estimate of percentage completed	Cumulative earned value estimate, based on contractor data	Budget at completion estimate
DOE	about 30 percent	$4.9 billion	$16.7 billion Based on DOE's 2016 construction estimate of $17.2 billion, minus proposed fees. In September 2017, we found DOE's 2016 estimate substantially met best practices and can be considered reliable.
MOX Services (contractor)	74 percent[a]	$4.9 billion	$6.6 billion Based on the contractor's 2012 estimate of $7.7 billion minus management reserves, contingency, and fees. In February 2014, we found that the contractor's 2012 proposed rebaseline estimate for the facility did not fully reflect the characteristics of a high-quality estimate and could not be considered reliable.

[a]As noted in the table above, the 74 percent estimate of percentage completed is based on a 2012 estimate that we found to be unreliable in 2014, in part because it was a proposal that was not reviewed and accepted by DOE. Using MOX Services' July 2016 estimate at completion—minus estimated management reserves, contingency, and fees—of approximately $8.7 billion, the estimated percentage completed would be about 56 percent.

Source: GAO analysis of DOE and contractor (MOX Services) information. | GAO-18-122R

Objective 3: Other Observations

Indication of Work Completed Using Commodity Data

We reviewed data from the contractor's Quantity Tracking System to better understand the amount of the 29 commodities installed in the MOX facility.

- While not a traditional way to look at the percentage of the work that has been completed, this approach provides some information on construction progress without using a calculation based on total project cost.
- The contractor provided us with data for the 29 commodities on the amount (1) expected to be installed in the facility, (2) that has been completed and the work verified by the contractor, (3) that has been started but not completed, and (4) that has not been started.
- The contractor's data do not account for potential issues with work that may need to be redone, referred to as "rework." The Corps report stated that there is a substantial amount of rework that can be anticipated given issues with the current design and schedule, among other issues.

Objective 3: Other Observations

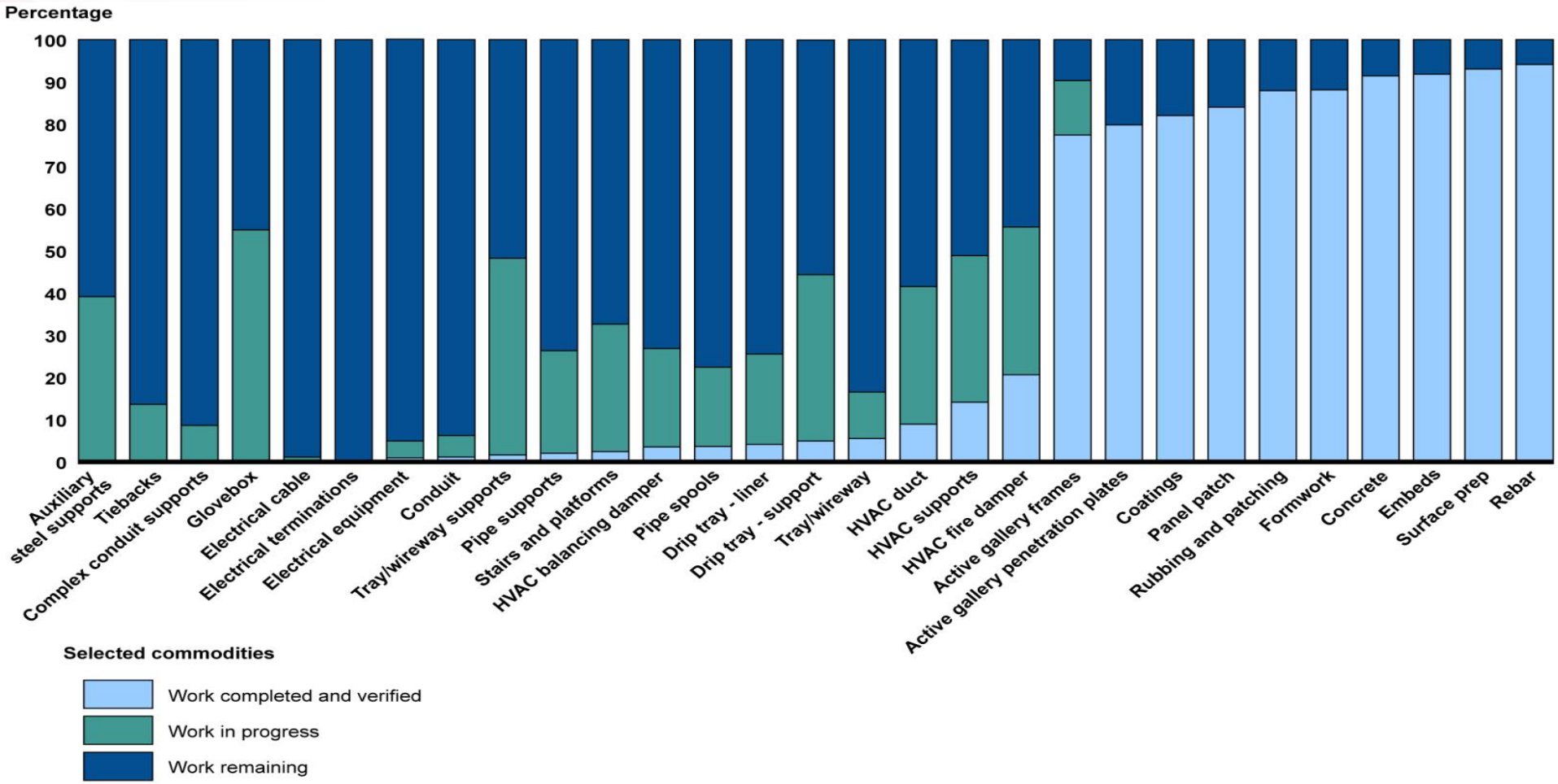
As shown in figure 4 and table 2:

- For 10 commodities, the contractor has completed and verified the work for at least 70 percent of the total expected quantities.
- For another 11 commodities, the contractor has not yet started the work for at least 70 percent of the total expected quantities.

There are limitations to this analysis. For example:

- The work that the contractor has completed generally reflects the typical progression of construction, with much of the concrete work completed first and other commodities, such as electrical wire, installed later.
- Our analysis of the data does not provide recognition of the amount of effort needed to complete the remaining work.

Figure 4: Status of Installation of 29 Commodities in the MOX Facility as a Percentage of the Total Forecast Quantity of the Commodity (as of July 30, 2017)



Source: GAO analysis of MOX facility contractor's Quantity Tracking System data. | GAO-18-122R

Note: The contractor's data do not account for potential issues with work that may need to be redone, referred to as "rework." The Corps report stated that there is a substantial amount of rework that can be anticipated given issues with the current design and schedule, among other issues.

Table 2: Status of Installation of 29 Commodities in the MOX Facility, as of July 30, 2017

Commodity	Unit of measure	Total forecast quantity	Work completed and verified	Work in progress	Work remaining
Auxiliary steel supports	pounds	594,591	0	232,662	361,929
Tiebacks	each	440	0	60	380
Complex conduit supports	each	841	0	72	769
Glovebox	each	417	0	229	188
Electrical cable	linear feet	6,867,153	0	75,107	6,792,047
Electrical terminations	each	364,965	0	284	364,681
Electrical equipment	each	4,498	39	178	4,281
Conduit	linear feet	728,927	7,992	37,350	683,585
Tray/wireway supports	each	4,438	69	2,069	2,300
Pipe supports	each	32,134	658	7,805	23,671
Stairs and platforms	pounds	1,240,457	30,390	374,166	835,901
HVAC balancing damper	each	1,751	62	408	1,281
Pipe spools	linear feet	444,796	15,959	83,616	345,221
Drip tray – liner	each	1,466	60	313	1,093
Drip tray - support	each	1,937	95	764	1,078

Source: GAO analysis of MOX facility contractor's Quantity Tracking System data. | GAO-18-122R

Table 2: Status of Installation of 29 Commodities in the MOX Facility, as of July 30, 2017 (continued)

Commodity	Unit of measure	Total forecast quantity	Work completed and verified	Work in progress	Work remaining
Tray/wireway	linear feet	83,797	4,608	9,180	70,009
HVAC duct	pounds	1,333,410	118,247	435,035	780,129
HVAC supports	each	9,560	1,351	3,322	4,887
HVAC fire damper	each	1,133	233	396	504
Active gallery frames	each	31	24	4	3
Active gallery penetration plates	each	342	273	0	69
Coatings	square feet	3,185,747	2,613,353	0	572,394
Panel patch	square feet	440,273	369,830	0	70,443
Rubbing and patching	square feet	1,994,537	1,752,950	0	241,587
Formwork	square feet	2,187,928	1,928,492	0	259,436
Concrete	cubic yards	177,549	162,256	0	15,293
Embeds	each	32,531	29,869	0	2,662
Surface prep	square feet	3,441,069	3,199,456	0	241,613
Rebar	ton	37,959	35,730	0	2,229

Source: GAO analysis of MOX facility contractor's Quantity Tracking System data. | GAO-18-122R