



March 2016

CRITICAL DEFENSE MATERIALS

Government Collected Data Are Sufficiently Reliable to Assess Tantalum Availability

Accessible Version

GAO Highlights

Highlights of [GAO-16-335](#), a report to congressional committees

Why GAO Did This Study

The United States relies on foreign mine production of tantalum, a corrosion-resistant metal that is used in commercial and defense applications. Having reliable information on the global supply of tantalum is important for defense planning, particularly in determining if it is necessary to stockpile in case of future shortages. The House Armed Services Committee Report on a bill for the National Defense Authorization Act for Fiscal Year 2016 included a provision for GAO to examine the global tantalum supply chain, with a focus on why data reported by the government and by industry vary.

This report addresses (1) how tantalum supply data reported by government sources differ from industry data, and (2) the extent to which DOD has assessed the availability of tantalum during emergency planning scenarios. GAO reviewed data compiled by the USGS—DOD’s primary source for tantalum production data—and by a tantalum industry organization that makes its information publicly available. GAO interviewed DOD and industry officials about the reporting and collection methods for the data; examined the data DOD uses to determine potential shortfalls of materials, including data for its biennial Strategic and Critical Materials Reports on Stockpile Requirements; and discussed with DOD officials steps they have taken to assess the reliability of the data used in the analyses.

What GAO Recommends

GAO is not making recommendations. Neither DOD nor the Department of the Interior provided written comments.

View [GAO-16-335](#). For more information, contact Marie A. Mak (202) 512-4841 or makm@gao.gov.

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Government Collected Data Are Sufficiently Reliable to Assess Tantalum Availability

What GAO Found

Data published by government and industry on the global supply of tantalum vary due to differences in forms of tantalum reported and data collection methods. For example, government data prepared by the United States Geological Survey (USGS) on tantalum production reports information on tantalum ore from mining. Industry data GAO obtained from the Tantalum-Niobium International Study Center includes additional forms of processed tantalum, such as synthetic concentrates and slags and recycled tantalum materials. In collecting data, the USGS employs specialists to estimate production data by country of origin for government agencies, including the Department of Defense (DOD), by conducting annual surveys of foreign governments on mine production and relying on country specialists. In contrast, industry data compiled by the Tantalum-Niobium International Study Center is based on aggregated data voluntarily reported by its member companies as a service to those members rather than in support of the federal government. The table below summarizes the differences in USGS and industry data.

| Comparison of Government and Industry Tantalum Data Reporting and Collection Methods | | | |
|--|---------------------------------|---------------------------------|---|
| | Category | United States Geological Survey | Tantalum-Niobium International Study Center |
| Data reporting | Mining | Yes | Yes |
| | Processed and secondary sources | No | Yes |
| | Data on processor purchases | No | Yes |
| Data collection methods | Validate data | Yes | No |
| | Collect data by country | Yes | No |
| | Reporting frequency | Annually | Quarterly |

Source: GAO analysis of United States Geological Survey and tantalum industry data and collection methods. | GAO-16-335

DOD assesses the availability of tantalum, among other materials, for selected planning scenarios for the National Defense Stockpile’s biennial assessment process. Further, DOD takes steps to help ensure that tantalum supply data used in its stockpile analyses are reliable. For example, USGS provides the Defense Logistics Agency-Strategic Materials (DLA-Strategic Materials)—the stockpile program manager—with the data it collects and validates. Consistent with internal control standards, DLA-Strategic Materials officials said they then verify sources and check calculations to ensure that data are reliable before conducting their stockpile analyses. Since 2013, DLA-Strategic Materials has identified potential shortfalls for tantalum and recommended stockpiling. Given DLA-Strategic Materials’ interest in using the most accurate information available, it is taking additional steps to review and analyze existing industry tantalum data sources to better inform its stockpile analyses.

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Abbreviations

| | |
|-------------------------|--|
| DLA-Strategic Materials | Defense Logistics Agency Strategic Materials |
| DOD | Department of Defense |
| TIC | Tantalum-Niobium International Study Center |
| USGS | United States Geological Survey |

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March 17, 2016

Congressional Committees

Tantalum is a material which is used in a variety of commercial and critical defense applications such as mobile phones and turbine engines for aircraft. The United States is entirely reliant on foreign sources for tantalum mine production. Substantial quantities of global tantalum production originate in high conflict zones such as the Democratic Republic of the Congo and other countries in Central Africa, raising concerns that proceeds from tantalum, a “conflict mineral,” may be financing conflict in the region.¹ In addition, large quantities of tantalum are processed outside the United States in countries such as the People’s Republic of China. Therefore, having reliable information on tantalum’s supply chain, such as the amount of supply available, is important for defense planning, particularly in determining if it might be necessary for the Department of Defense (DOD) to stockpile the material to provide for potential contingencies.

Congress has expressed concern about the reliability and transparency of the tantalum supply chain, particularly questioning why data reported by the government and by industry vary. The House Armed Services Committee Report on a bill for the National Defense Authorization Act for Fiscal Year 2016 included a provision for GAO to examine the global tantalum supply chain.² This report addresses (1) how data on tantalum supply

¹Citing the humanitarian situation and the need to take action, in July 2010, Congress included in the Dodd-Frank Wall Street Reform and Consumer Protection Act (hereafter referred to as the Dodd-Frank Act) provisions pertaining to trade involving conflict minerals. Pub. L. No. 111-203 § 1502. The Dodd-Frank Act defines conflict minerals as columbite-tantalite (coltan), cassiterite, gold, wolframite, or their derivatives, or any other mineral or its derivatives that are determined by the Secretary of State to be financing conflict in the Democratic Republic of the Congo or an adjoining country. Pub. L. No. 111-203 § 1502(e)(4). Columbite-tantalite (coltan), cassiterite, and wolframite are the ores from which tantalum, tin, and tungsten, respectively, are processed. Section 1502 of the Act directed several United States departments—the Securities and Exchange Commission, the Department of State, and the Department of Commerce—to take certain actions to implement the Act’s conflict minerals provisions, including provisions related to responsible sourcing of conflict minerals from the Democratic Republic of the Congo and the adjoining countries.

²H.R. Rep. No. 114-102, at 275 (2015).

reported by government sources differs from data reported by industry, and (2) the extent to which DOD has assessed the availability of tantalum during national defense emergency planning scenarios.

To compare the data available on tantalum supply reported by government sources and industry sources, we met with officials from the United States Geological Survey (USGS), Defense Logistics Agency Strategic Materials (DLA-Strategic Materials) and the Office of the Undersecretary of Defense for Acquisition, Technology and Logistics within DOD, as well as officials from the Tantalum-Niobium International Study Center (TIC) and other companies to identify tantalum data sources and collection methods and to discuss the available tantalum supply data. For the purposes of our review we focused on USGS tantalum production estimates, which are DOD's primary source for estimated tantalum production in the 2015 Strategic and Critical Materials Report on Stockpile Requirements (Stockpile Report). We also reviewed industry data collected by the TIC, an international, non-profit association founded in 1974 with about 90 member companies worldwide. Some of the TIC's data are publically available, and it is one of several industry data sources being considered by DOD to inform its analysis in the Stockpile Report. We obtained and analyzed the USGS tantalum data used by DOD, and assessed the reliability of USGS data by (1) reviewing existing information about the data and the system that produced them, and (2) interviewing agency officials knowledgeable about the data. We determined that the data were sufficiently reliable for the purpose of this report. We also examined industry data to identify similarities and differences between the data sources and the methods of compiling the data. Based on our review of industry data, we determined the data were not sufficiently reliable for the period of our review. As a result, we do not compare supply estimates from USGS and industry. We use the information obtained from industry to demonstrate differences between industry and USGS collection and reporting methods.

To assess the extent to which DOD has evaluated the availability of tantalum supply during national defense emergency planning scenarios, we examined DOD reports and data used in the stockpile analysis and met with officials from DLA-Strategic Materials to determine what steps were taken to assess the reliability of the data. In particular, we examined how DOD used the data to assess the availability of tantalum during specific national defense emergency scenarios as part of the National Defense Stockpile's biennial requirements assessment process, and we reviewed DOD's Stockpile Reports from 2011, 2013, and 2015 to understand DOD's analyses and efforts to identify risks related to the

availability of tantalum. Further, we met with officials from DOD and the Institute for Defense Analyses, the federally funded research center that assists with the stockpile analysis, to understand the Risk Assessment and Mitigation Framework for Strategic Materials model used to inform the Stockpile Report and the specific steps and challenges to determining tantalum availability. See Appendix I for additional details on the scope and methodology.

We conducted this performance audit from August 2015 to March 2016 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

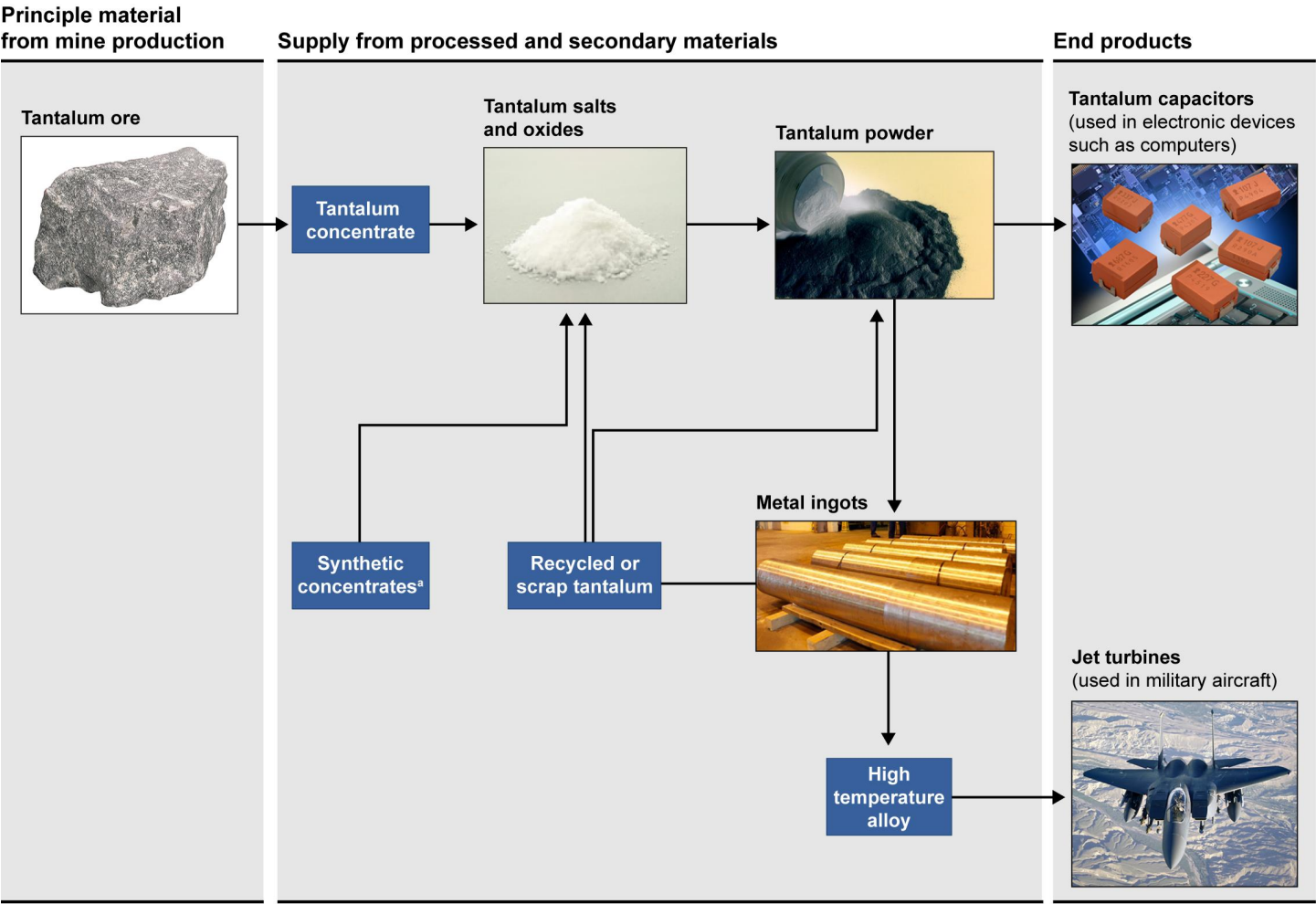
Tantalum is a hard, gray metal with a high melting point that is highly resistant to corrosion. It is a good conductor of heat and electricity. These attributes make it a valuable material for use in numerous military applications such as capacitors used in electronics equipment including computers, turbine engines for aircraft, and the linings of missile warheads. It is also used in numerous commercial consumer products such as mobile phones, personal computers, chemical processing equipment, heat exchangers, anti-lock brake systems, and airbag activation systems. It is possible to substitute other materials for tantalum, but substitutions usually result in a loss of performance.

Worldwide tantalum supply begins with mining tantalum ore—a concentration of tantalum-containing minerals, such as tantalite, microlite, and wodginite—that is economically feasible to mine. Ore is the principal raw material from which tantalum is derived, and can be mined through industrial operations which may be mechanized or through artisanal mining operations, which are characterized by a lack of mechanization. The ore is further processed into tantalum concentrate by physically removing unwanted materials. Tantalum is also derived from synthetic concentrates, where tantalum is extracted from slags, for example, from processing tin concentrates or other forms of industrial processing.³ These

³Slag is a byproduct of ore processing. Depending on the type of slag, it may contain economically recoverable amounts of a desirable material, such as tantalum.

concentrates can be chemically processed into tantalum salts, tantalum oxides, or other marketable tantalum materials such as tantalum powder, metal, and alloys, which are then further manufactured into end-products. Figure 1 shows details of the tantalum supply chain.

Figure 1: Example of a Tantalum Supply Chain



Source: GAO analysis of United States Geological Survey and industry data (data). Global Advanced Metals USA, Inc. (images: tantalum ore, tantalum salts and oxides, tantalum powder, and metal ingots); © AVX 2016 (image: tantalum capacitors); United States Air Force (image: jet turbines). | GAO-16-335

^aSynthetic concentrates include tantalum extracted from slags from processing tin concentrates, other slags, or other forms of industrial processing.

The USGS collects, monitors, and analyzes information about natural resource conditions, issues, and problems, including those related to tantalum, to provide information to various government agencies,

including DOD. Within USGS, the National Minerals Information Center develops and provides statistics and information on the worldwide production, consumption, and flow of minerals and materials essential to the United States economy and national security. To communicate this information, the USGS produces two publications that include information on tantalum, among other minerals.

- The Minerals Yearbook is an annual publication that provides statistical data on over 90 commodities over a 5-year period. It also includes data from over 175 countries on mineral production and trade, among other things.
- The Mineral Commodity Summaries is based on the data reported in the Yearbook and published each January. The annual summary includes similar historical data as reported in the Minerals Yearbook, as well as production estimates from the current reporting year.

According to the USGS' 2015 Mineral Commodity Summaries, the United States relies solely on imports to meet needs for tantalum; there has been no significant tantalum mined in the United States since 1959 because the tantalum cannot be economically mined at prevailing prices.⁴ Countries for which the USGS reported tantalum mine production in 2014 are Brazil, Burundi, China, Democratic Republic of the Congo, Ethiopia, Mozambique, Nigeria, and Rwanda. Although Australia has some of the largest reserves of tantalum, USGS reported no production for the country in 2014. The USGS estimated in its 2015 Mineral Commodity Summaries that the two largest producers of mined tantalum in 2014 were Rwanda and the Democratic Republic of the Congo, producing approximately 600 and 200 metric tons, respectively. This amount represented approximately two-thirds of USGS' total 2014 estimated global mine production.

The National Defense Stockpile maintains a domestically held inventory of strategic and critical materials.⁵ DOD uses USGS information on materials, in part, to help address its National Defense Stockpile program objectives. One objective of the National Defense Stockpile program is to decrease the risk of dependence on foreign suppliers or single suppliers for strategic and critical materials, such as tantalum, that are used in defense and essential civilian applications. Authority for stockpiling strategic and critical materials, which can include tantalum, is contained in the Strategic and

⁴United States Geological Survey, *Mineral Commodity Summaries 2015*, Reston, Virginia (2015).

⁵50 U.S.C. § 98, et seq.

Critical Materials Stockpiling Act (Stockpile Act) that lays out the purpose and responsibilities for the National Defense Stockpile.⁶

DOD generates national emergency scenarios for the Stockpile Act and related National Defense Stockpile Report. These scenarios cover four-year timeframes where the first year represents a period of conflict, and years two through four represent a period of recovery. The one-year period of conflict takes into consideration the following conditions: (1) a catastrophic attack on a United States city by a foreign terrorist organization or rogue state, (2) two near simultaneous major combat operations, (3) war damage from a highly capable enemy, and (4) ongoing military activities such as a military presence in a foreign country. On behalf of DOD, DLA-Strategic Materials serves as the National Defense Stockpile program manager, whose functions include:

- determining materials deemed strategic and critical,⁷
- precluding, when possible, a dangerous and costly dependence by the United States upon foreign sources for supplies of such materials in times of national emergency, and
- submitting a biennial report to Congress detailing stockpiling requirements and recommendations for the National Defense Stockpile based on certain national emergency planning assumptions.

USGS and DOD have an interagency support agreement to facilitate data sharing in support of DOD's biennial Stockpile Report. According to the agreement, USGS provides DOD with data on United States production, consumption, imports, exports, and world production by country for

⁶50 U.S.C. § 98, et seq., as added and amended. The Act provides Presidential authorities for the National Defense Stockpile, including determining which materials are strategic and critical. 50 U.S.C. § 98b. Under the Act, the President is to designate a National Defense Stockpile Manager and the President may delegate certain Presidential functions to the National Defense Stockpile Manager. 50 U.S.C. § 98h-7. The Secretary of Defense was designated as the National Defense Stockpile Manager and delegated certain Presidential functions. Exec. Order No. 12,626, 53 Fed. Reg. 6,114 (Feb. 29, 1988), reprinted in 50 U.S.C. § 98. The DLA Director is responsible for the management of the National Defense Stockpile program. DOD Directive 5105.22, "Defense Logistics Agency" (May 17, 2006) DOD submits biennial reports to Congress on recommendations with respect to stockpile requirements (50 USC 98h-5) and Congress authorizes funds for acquisition. 50 U.S.C. § 98d.

⁷For the purposes of the Stockpile Act, the term "strategic and critical materials" means materials that (a) would be needed to supply the military, industrial, and essential civilian needs of the United States during a national emergency, and (b) are not found or produced in the United States in sufficient quantities to meet such need.

materials in the National Defense Stockpile and other materials critical for defense applications. USGS data on worldwide tantalum production is the primary production data source used by DOD to support its stockpile analyses. As the program manager for the National Defense Stockpile, DLA-Strategic Materials is responsible for compiling the data it receives from a number of entities, including the USGS and Department of Commerce, and performing analyses to determine if shortfalls for materials will occur during potential conflict scenarios. Table 1 provides a list of the sources of data and examples of the data used by DLA-Strategic Materials.

Table 1: Select National Defense Stockpile Analysis Data Sources and Examples

| Data Source | Example(s) of data inputs |
|---------------------------------|---|
| Department of Defense | Office of the Secretary of Defense conflict scenario data |
| United States Geological Survey | United States material production, foreign material production, import and export data for materials, material prices, consumption, and percentage use by application |
| Department of Commerce | Domestic consumption for recent years and percentage use by application or industry, imports by industry and country |
| Council of Economic Advisors | Economic forecasting |
| Department of State | State sponsors of terrorism |
| Intelligence Community | Country reliability assessments |
| Census Bureau | Plant capacity for industry expansion and trade data, including imports by product and country |
| Industry sources | Consumption data for recent years and percentage use by application |

Source: GAO analysis of the 2015 Strategic and Critical Materials Report on Stockpile Requirements and Institute for Defense Analysis documents. | GAO-16-335

The analyses focus on the sources of materials and the likelihood these materials will be available in the conflict scenario based on forecasted demand for materials in critical defense and civilian uses. In the case of a material shortfall, the analyses also consider mitigation strategies such as increased production or substitutions that could be made for these materials. The results of these analyses are published biennially in DOD’s Stockpile Report and are the basis for DOD’s recommendations to stockpile certain materials.

Tantalum Data from Government and Industry Sources Vary Due to Differences in Forms of Tantalum Reported and Data Collection Methods

Government and industry tantalum information differ because the government reports on tantalum ore from mining operations, whereas industry data include not only mining but also data on additional forms of processed tantalum, such as synthetic concentrates and scrap. In addition, government and industry have different data collection methods to address their specific needs. Differences include which forms of tantalum are measured, the frequency of data collection, and data validation practices. Having reliable tantalum data is important because DOD uses the information to assess the availability of tantalum supply by country during specific planning scenarios, among other efforts.

Government and Industry Report Tantalum Data Differently

Government and industry data differ on the forms of tantalum reported. DOD's primary government source for mineral production data, the USGS, captures data on tantalum ore from mining operations but does not include or estimate synthetic concentrates such as tantalum derived from tin slags, other means of industrial processing, or secondary types of tantalum such as scrap or recycled tantalum. USGS officials told us that they have limited visibility into the supply from secondary types of tantalum, such as scrap or recycled materials, and thus for reliability reasons, only report mine production. However, USGS officials also said their data includes some artisanal mining reported from countries like Rwanda or the Democratic Republic of the Congo, although it is difficult to quantify how much of the tantalum production they report is from industrial versus artisanal mining.

Industry data, which, for the purpose of our review, are largely publically available data from the TIC, include tantalum supply from sources other than mined ore. For example, the TIC reports tantalum data that includes supply from mining as well as synthetic concentrates and slags from processing tin concentrates and other materials. Further, the TIC reports data on purchases of tantalum ore, synthetic concentrates, and some recycled material from member companies. These data may also include artisanal mined ore and processed materials of unknown origin. As a result, TIC data on tantalum purchased by processors—companies that modify the tantalum and change it into different forms for use—show higher supply figures than USGS reports on tantalum ore from mining operations.

Government and Industry Have Different Data Collection Methods

Our review also identified differences in data collection methods that affect USGS and industry tantalum reporting, including differences in how and when data are collected and validated. The USGS collects data on tantalum and other minerals to provide information to various government

agencies, including DOD. Table 2 summarizes a comparison of government and industry data reporting and collection practices.

Table 2: Comparison of United States Geological Survey (USGS) and Industry Tantalum Data Reporting and Collection Methods

| | Category | USGS | Tantalum-Niobium International Study Center |
|-------------------------|-------------------------------|----------|---|
| Data Reporting | Mining | Yes | Yes |
| | Processed and Secondary Forms | No | Yes |
| | Data on Processor Purchases | No | Yes |
| Data Collection Methods | Validates Data | Yes | No |
| | Collects Data by Country | Yes | No |
| | Reporting Frequency | Annually | Quarterly |

Source: GAO analysis of USGS and tantalum industry data and collection methods. | GAO-16-335

To facilitate its data collection, the USGS employs country and mineral commodity specialists to help estimate tantalum production by country of origin.⁸ USGS officials said they use the term commodity to refer to ore, minerals, and materials, and their mineral commodity specialists have expertise in mineral and material markets and industries. According to USGS and DLA-Strategic Materials officials, providing production information by specific country is important to DLA-Strategic Materials' ability to assess tantalum supply risks and how much tantalum the United States may be able to acquire during conflict scenarios. USGS country and mineral commodity specialists annually survey foreign governments on the production of tantalum from mining, gather data and information from in-country visits, and review mineral reporting provided by embassies and industry sources to estimate tantalum production. USGS officials told us that while the quality of the data provided by foreign governments can vary widely, its specialists use their expertise with a mineral commodity or country to estimate production even if the data are incomplete or questionable. For

⁸A USGS official provided us an inventory of employees' specialty and tenure for the National Mineral Information Center and commented on the need to manage workforce planning for these specialists to meet USGS' mission. GAO has reported on the importance of workforce planning. For example, see GAO, *Human Capital: Key Principles for Effective Strategic Workforce Planning*, [GAO-04-39](#), (Washington D.C.: Dec 11, 2003) and GAO, *High-Risk Series: An Update*, [GAO-15-290](#), (Washington, D.C.: Feb 11, 2015).

example, in cases where the amount of tantalum reported is significantly different than previous information, specialists can use mining permits, trade analysis, and mine capacities to confirm estimates.

In contrast, TIC data are provided as a service to its member companies rather than in support of the federal government, and are based on tantalum supply data voluntarily reported by those members. The TIC employs an independent company to compile surveys from its member mining and processing companies on a quarterly basis. Supply data are compiled and aggregated into categories such as raw material reported by mining, sales of tantalum products, and material purchased by companies that further process tantalum. These data are not reported by company or country of origin.

USGS and industry also vary in their procedures for validating tantalum data. USGS data are required to meet USGS Fundamental Science Practices, a set of consistent practices, philosophical premises, and operational principles that serve as the foundation for research and monitoring activities.⁹ These practices describe how USGS work is carried out and how the resulting information products, such as maps, imagery, and publications, are developed, reviewed, and approved. The USGS also examines the mineral commodity data it collects by using a set of 14 statistical standards, most recently revised in November 2014.¹⁰ These 14 standards include definitions of statistical terms, conversion factors, and guidelines for graphic display of statistical information, among other things. In addition, USGS mineral commodity or country specialists compile and review survey data. In cases where these experts have different estimates, USGS officials said that managers resolve the differences based on discussion with the analysts, their own expertise, and contacts within other governments or industry to arrive at a final USGS position. Further, USGS guidelines provide that at least 75 percent of surveys should be returned in order to report data in its publications.

In comparison, TIC officials stated that they do not have processes in place to validate the data received from their member companies, but

⁹United States Geological Survey, Circular 1367 *Fundamental Science Practices*, Reston, Virginia (2011).

¹⁰United States Geological Survey, National Mineral Information Center, *Statistical Standards*, (November 5, 2014).

they do have some guidelines for compiling the data. For example, the TIC guidelines request that member companies not report sales and purchases from other member companies to avoid double-counting of primary tantalum production. Further, the guidelines require that two-thirds of member companies, and certain major companies, provide data before the publications are released. However, industry officials we spoke with told us the TIC is not in a position to check or validate information provided by its members and that it is uncertain how much of the tantalum market the TIC's members encompass, making it difficult to ascertain how much of the worldwide tantalum market is reflected in its data.

DOD Has a Detailed Process in Place to Evaluate the Availability of Tantalum and Is Taking Steps to Mitigate Risk Posed by Existing Data

DOD has established a process for evaluating materials' availability, including tantalum, as part of the National Defense Stockpile's biennial requirements assessment process as required under the Stockpiling Act. To inform DOD's stockpile analysis, USGS provides DLA-Strategic Materials with the data it collects and validates, and DLA-Strategic Materials takes steps to ensure that the data are reliable. Further, as the program manager for the National Defense Stockpile, DLA-Strategic Materials assesses the availability of tantalum and other materials for national defense emergency planning scenarios as required under the Stockpiling Act. For example, in DOD's 2015 Strategic and Critical Materials Report on Stockpile Requirements, tantalum was among over 90 materials assessed for a potential shortfall. DLA-Strategic Materials is also taking additional steps to review and analyze industry data sources to address tantalum data challenges and better inform its stockpile analysis.

DOD Has a Detailed Process to Assess Tantalum Availability for National Emergency Planning Scenarios

DOD has a process for assessing the available supply of tantalum in selected planning scenarios as part of the National Defense Stockpile's biennial requirements assessment process, as required under the Stockpiling Act. Prior to evaluating tantalum and other materials' availability, DOD officials take steps to ensure that supply data used in its stockpile analysis are reliable. As discussed previously, USGS has documented procedures to validate its data and DLA-Strategic Materials officials identified additional steps they take to ensure that data are reliable, consistent with Standards for Internal Control in the Federal

Government and other guidelines.¹¹ For example, DLA-Strategic Materials officials said that their material specialists coordinate closely with USGS commodity and country specialists to verify data sources, such as whether production data are from USGS surveys or mining publications, and to determine how missing or incomplete data have been accounted for in its reports. Moreover, DLA-Strategic Materials officials told us they check USGS calculations and unit conversions to ensure accuracy prior to sending the data to the Institute for Defense Analyses, the federally funded research center responsible for the model used to perform the stockpile analysis. DLA-Strategic Materials officials also noted that they rely heavily on their own subject matter expertise, as well as interviews with knowledgeable industry and government officials and complementary data sources to inform their review of USGS production data and make decisions about whether to adjust tantalum figures. While DLA-Strategic Materials officials told us they are aware of limitations to USGS data, they told us they have generally relied on USGS mine data as the primary source for production data because its estimates are more conservative. Nevertheless, representatives stated that they believe the information USGS is able to collect and confirm is a basis for DOD's stockpile recommendations. Further, DLA-Strategic Materials officials told us that USGS has the knowledge-base and resources to effectively gather and validate reliable and unbiased mine production data as part of its stated mission and responsibilities.

The Stockpiling Act is intended to provide a process to mitigate dangerous and costly reliance on foreign sources of materials during national emergencies.¹² In accordance with the Stockpiling Act, DLA-Strategic Materials reports its findings of potential shortfalls of materials in the Stockpile Report every two years. In its 2015 report, tantalum was among over 90 materials assessed for a potential shortfall. Additionally, from 2011 through 2015 DLA-Strategic Materials identified potential shortfalls for tantalum. Since 2013, it has recommended stockpiling various amounts of tantalum. For example, in its 2013 Stockpile Report, DLA-Strategic Materials reported a shortfall for tantalum of 623,307 pounds,

¹¹GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#), (Washington, D.C.: September 10, 2014). These standards provide that federal agencies should use quality information to identify, analyze, and respond to risks related to achieving their defined objectives. Also, GAO, *Framework for Assessing the Acquisition Functions at Federal Agencies*, [GAO-05-218G](#), (Washington, D.C.: September 1, 2005).

¹²Stockpile Act, 50 U.S.C § 98 et seq.

and DLA-Strategic Materials subsequently recommended stockpiling 187,000 pounds of tantalum divided evenly over a four-year period along with other mitigation strategies to address the estimated shortfall. In May 2015, subsequent to issuing the 2015 Stockpile Report, DLA-Strategic Materials was provided with updated primary tantalum production data from USGS that revised the supply of tantalum upward, reducing the estimated shortfall.¹³ However, based on historical and consistent shortfalls as well as the United States’ reliance on foreign sources, DLA-Strategic Materials officials told us they plan to continue to seek legislative authority to stockpile tantalum. Table 3 identifies the reported tantalum shortfalls in DOD’s Stockpile Report from 2011 to 2015 and recommended stockpiling actions.

Table 3: Tantalum Shortfalls Identified in Stockpile Reports from 2011 through 2015 and Action Taken by the Defense Logistics Agency Strategic Materials

| Stockpile Report By Year | Shortfall Quantity ^a | Recommended Stockpiling Actions |
|--------------------------|---------------------------------|------------------------------------|
| 2011 | 7,832,446 pounds | No Recommended Action ^b |
| 2013 | 623,307 pounds | 187,000 pounds over 4 years |
| 2015 | 33,990 pounds | 33,990 pounds over 3 years |

Source: GAO analysis of Department of Defense data. | GAO-16-335

^aShortfall quantities represent gross shortfalls. According to DLA-Strategic Materials officials shortfalls are not comparable between report years due to changes in economic and national defense emergency planning scenario assumptions and ongoing model improvements.

^bFollowing the tantalum shortfall identified in the 2011 report, DLA-Strategic Materials officials told us they initiated additional analysis on the need to stockpile tantalum that culminated in their request to stockpile tantalum following the 2013 stockpile report.

DLA-Strategic Materials uses a repeatable three-step process to identify potential shortfalls for materials during national emergency scenarios.

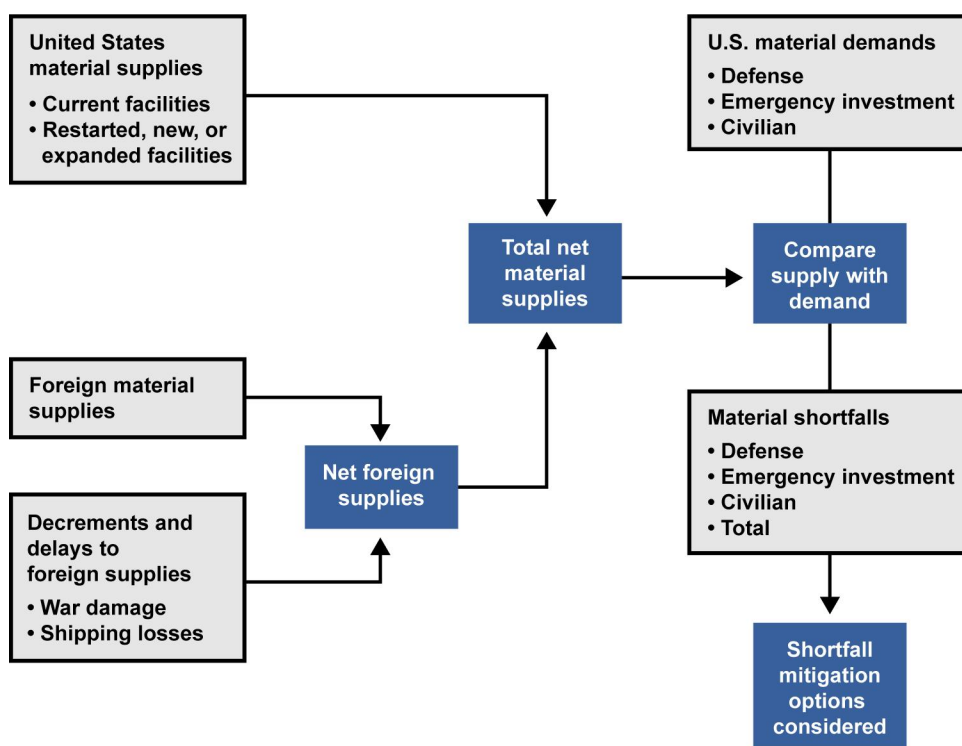
- In the first step, DLA-Strategic Materials identifies materials to assess and establishes data requirements needed for the shortfall assessments. DLA-Strategic Materials monitors a “watch list” of over 160 materials, which includes tantalum, that are of interest to the defense community. DLA-Strategic Materials then narrows the watch list to a smaller number of materials using an internal ranking system

¹³In May 2015, USGS revised its data on world mine production for the Democratic Republic of the Congo and for Rwanda based on additional information obtained by country and material experts.

where additional weight is given to risks associated with heavy reliance on foreign sources of supply and single points of failure along the supply chain, among others.

- In the second step, DLA-Strategic Materials determines whether material shortfalls exist in the context of national emergency scenarios. A component of this step is to estimate the global supply of tantalum available for United States civilian and defense needs. To estimate available supply, DLA-Strategic Materials and the Institute for Defense Analyses rely on country reliability assessments, as well as the specific assumptions of the national emergency scenarios, to decrement foreign production during a conflict. DLA-Strategic Materials receives inputs from the intelligence community for the country reliability assessments and officials told us they may “zero out” a country’s supply as part of their analyses if that country is deemed to be unreliable under the assumptions of the national emergency scenario. Because USGS production data is country-based, DLA-Strategic Materials can apply the assumptions of the national emergency scenario and country reliability assessments to decrement those amounts.
- In the third step of the process, DLA-Strategic Materials decides what mitigation strategies are appropriate to reduce any identified shortfalls, which may include recommendations to stockpile the material. For example, when a shortfall estimate is initially generated, DLA-Strategic Materials will determine whether mitigating options, such as substitution, reducing exports, or additional purchases of a material are sufficient to eliminate the shortfall. If mitigating options are not sufficient to eliminate the shortfall, the result is a net shortfall and DLA-Strategic Materials may decide to recommend a stockpiling action for that material. Figure 2 illustrates the shortfall analysis processes.

Figure 2: Defense Logistics Agency Strategic Materials' Tantalum Supply-Demand Analyses Leading to Shortfall Identification



Source: GAO analysis of Department of Defense data. | GAO-16-335

DOD is Taking Steps to Mitigate Risks from Existing Data

While DOD has a detailed process for evaluating the availability of tantalum and other materials, DOD, USGS, and industry officials identified several challenges that affect their ability to gather complete and reliable tantalum data. For example, the USGS reported that unlike other materials and precious metals, tantalum concentrates are not publicly traded through commodities exchanges. Rather the material is bought and sold through networks of dealers and on contract between producers and consumers, some of whom may not provide accurate statistical data.¹⁴ Further, according to industry officials, artisanal mining, which is difficult to quantify in USGS reporting, may account for a

¹⁴United States Geological Survey, *Shift in Global Tantalum Mine Production, 2000–2014*, December 2015.

significant portion of global tantalum production.¹⁵ In addition, industry officials commented that some artisanal mining production may enter the supply chain labeled as scrap to disguise its origin. While DLA-Strategic Materials officials told us that some of these concerns are not unique to tantalum, they said the lack of transparent tantalum supply data affects their ability to collect complete information to inform the stockpile analysis. Given the above challenges, officials from DOD, USGS, and industry acknowledged that tantalum has an “opaque” supply chain, making it difficult to collect more accurate data.

Recognizing these challenges, DLA-Strategic Materials is taking additional steps to inform its analysis of tantalum availability. For example, DLA-Strategic Materials has requested that the Institute for Defense Analyses perform additional work on materials of interest. In 2013, the Institute for Defense Analyses completed a review that identified weaknesses in the supply chain for processed tantalum used in some defense applications. Further the Stockpiling Act permits DOD to identify materials requiring further study.¹⁶ According to the 2015 Stockpile Report, significant reliance on foreign sources or a single point of failure is the main basis for additional study, but other reasons, such as a net shortfall or the potential for supply chain disruption can also result in additional research into a material. Under this authority, DLA-Strategic Materials said they are conducting research into whether certain materials, such as tantalum, could be recovered through recycling of manufactured materials.

Moreover, citing concerns about differences in tantalum data reported by USGS and industry sources, DOD’s 2015 Stockpile Report noted that DLA-Strategic Materials will be comparing data and performing additional analyses on these two sources in advance of their 2017 report. DOD’s efforts to review industry data were ongoing during our review, but officials noted several limitations to TIC data. For example, as discussed above, the TIC’s data is not reported by country, which limits its use in support of the National Defense Stockpile analyses. Further, DLA-

¹⁵Some industry officials we spoke with attribute about half of global tantalum supply to artisanal mining.

¹⁶Stockpile Act, 50 U.S.C § 98h(b)(2)(E) (funds authorized and appropriated for the National Defense Stockpile Transaction Fund are made available, subject to limitations as may be provided in appropriation acts, for studying future material requirements for the stockpile).

Strategic Materials officials told us they are uncertain about what portion of the industry is covered by TIC's reporting members, or how accurate the data are since there may be incentives for members to over- or under-report. Given these concerns, DLA-Strategic Materials officials identified several potential next steps they are considering upon completing their review of the TIC data. For example, officials said they could use the data as a complementary source to inform their review of USGS mine production data, similar to DLA-Strategic Materials' use of Roskill Information Services market report data.¹⁷ Additionally, officials told us that given the challenges of collecting accurate and reliable tantalum data, they may consider running two sets of analyses for tantalum in future stockpile reports—one using only USGS data and another that includes industry data estimates. In addition to their review of TIC's data, DLA-Strategic Materials is also in the process of compiling its own estimates for the supply of tantalum derived from slag, scrap, and recycled tantalum based on data and interviews with various sources, including USGS, Roskill Information Services, and tantalum processing companies. DLA-Strategic Materials officials told us that they plan to use these estimates to inform their 2017 analysis since the United States mostly imports these secondary types of tantalum, which are not included in USGS figures.

Agency Comments

We are not making recommendations in this report. DOD and the Department of the Interior were provided copies of the draft report. Neither DOD nor the Department of the Interior provided written comments. The Department of the Interior provided technical comments that were incorporated, as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Defense, the Under Secretary of Defense for Acquisition, Technology, and Logistics, the Secretary of the Interior, the Director of the United States Geological Survey, the Secretary of Commerce, the Chairman of the Securities and Exchange Commission, and other interested parties. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>.

¹⁷ Roskill Information Services, Ltd. is an industry source based in London, UK. Roskill provides market research to the minerals and metals industry and publishes materials on various metals including tantalum.

If you or your staff have any questions about this report, please contact me at (202) 512-4841 or at makm@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 II.

A handwritten signature in black ink, appearing to read 'Marie A. Mak', with a stylized, cursive script.

Marie A. Mak
Director, Acquisition and Sourcing Management

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Appendix I: Objectives, Scope and Methodology

The House Armed Services Committee Report on a bill for the National Defense Authorization Act for Fiscal Year 2016 included a provision for GAO to examine the global tantalum supply chain.¹ This report addresses (1) how data on tantalum supply reported by government sources differ from data reported by industry and (2) the extent to which the Department of Defense (DOD) has assessed the availability of tantalum during national defense emergency planning scenarios.

To compare available tantalum data reported by government sources to industry sources, we met with United States Geological Survey (USGS) officials, Defense Logistics Agency Strategic Materials (DLA-Strategic Materials) and other DOD officials, and tantalum industry officials from the Tantalum-Niobium International Study Center (TIC) to identify tantalum data sources and collection methods, and to discuss the availability of tantalum supply data. For the purpose of our review we focused on USGS tantalum production estimates, which are DOD's primary source for estimated tantalum production in the 2015 Strategic and Critical Materials Report on Stockpile Requirements (Stockpile Report). We also reviewed industry data collected by the TIC, an international, non-profit association founded in 1974 with about 90 member companies worldwide. Some of the TIC's data are publically available, and the TIC is one of several industry data sources used by DOD to inform their analysis in the Stockpile Report. We obtained and analyzed the USGS tantalum production data that DOD used in developing the 2015 Strategic and Critical Materials Report on Stockpile Requirements as well as industry data to identify similarities and differences between the data sources and the methods of compiling estimates. We assessed the reliability of USGS data by (1) reviewing existing information about the data and the system that produced them, and (2) interviewing agency officials knowledgeable about the data. USGS takes steps to collect and confirm production estimates for use in their publications such as the Mineral Commodity Summaries and the Minerals Yearbook. Based on our review of the data and interviews with USGS and DOD we determined that USGS data were sufficiently reliable for our purposes. To assess the processes used by USGS to ensure the reliability of its data, we obtained USGS Fundamental Science Practices and Statistical Standards and discussed how those practices are implemented in the reviews of data to be published in USGS publications. In addition, due to differences in data

¹H.R. Rep. No. 114-102 at 275 (2015).

collection and reporting methods, USGS and industry tantalum data are not directly comparable and, therefore, we do not compare supply estimates from these sources for the purpose of this report. We use the information to demonstrate differences between industry and USGS data and collection methods.

For industry, we met with officials from the TIC, Roskill Information Services Ltd., Commerce Resources Corporation, and Global Advanced Metals.² To the extent possible we confirmed types of information provided by the TIC by comparing it to published reports. We examined quarterly reports showing tantalum supply and discussed the types of data collected and reported and the processes used to assess reliability. However, based on our review of the process for collecting the data and assessing the reliability of the data provided by the members and on interviews with industry officials, we determined that the industry supply numbers were self-reported, but not verified, and, therefore, not sufficiently reliable for direct comparison to USGS data. Therefore, we did not compare USGS and industry figures for this report.

To assess the extent to which DOD has evaluated the availability of tantalum during national defense emergency planning scenarios, we obtained and analyzed information in reports prepared by DLA-Strategic Materials for DOD's Office of the Undersecretary of Defense for Acquisition, Technology, and Logistics including the Stockpile Reports from 2011 through 2015 and the Annual Industrial Capabilities Reports to Congress. We met with officials from DLA-Strategic Materials and the Institute for Defense Analyses, the federally funded research center that assists with the stockpile analysis, to determine what steps were taken to assess the reliability of data used in the assessment process and mitigate risk. We obtained and examined DLA-Strategic Materials' proposed Annual Materials Plans for fiscal years 2015 through 2017. We reviewed relevant legislation, regulations, and policy including:

- the Strategic and Critical Materials Stock Piling Act (50 U.S.C. § 98 et seq.);

²Roskill Information Services, Ltd. is an industry source based in London, UK. Roskill provides market research to the minerals and metals industry and publishes materials on various metals including tantalum. Commerce Resources Corporation is an exploration and development company with a focus on rare earth elements and rare metals such as tantalum. Global Advanced Metals is a supplier of tantalum products in all of its forms.

- provisions of the Dodd-Frank Wall Street Reform and Consumer Protection Act (Pub. L. No. 111-203 §1502;
- policy documents from the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics concerning determining potential shortfalls and the organizational structure for executing the provisions of the Stockpiling Act.

We reviewed DLA-Strategic Materials data used in the assessments and documentation of the steps they took to assure data reliability. To determine the extent to which DOD has assessed the availability of tantalum during specific national defense emergency scenarios as part of the National Defense Stockpile's biennial requirements assessment process, we reviewed the interagency support agreement between USGS and DLA-Strategic Materials. To understand the data and support USGS provides DLA-Strategic Materials, we reviewed the worldwide USGS production data provided to DLA-Strategic Materials for its assessment. We reviewed DOD reports to understand the analyses DOD had conducted to identify risks related to the availability of tantalum. Further, we met with officials from USGS, DLA-Strategic Materials, and with analysts from the Institute for Defense Analyses. We discussed sources of tantalum supply with industry representatives to determine what other sources of tantalum supply data are available and the general reliability of such data. We obtained documentation on the model DLA-Strategic Materials uses to conduct its stockpile analysis including the categories of information considered by the model to determine potential shortfalls and provide support for recommending stockpiling amounts.

In addition, we interviewed DOD officials from the Under Secretary of Defense for Acquisition, Technology, and Logistics and DLA-Strategic Materials about actions underway to increase the accuracy of the data reported in the Stockpile Report. We obtained and analyzed such documentation as was available about proposed and ongoing actions to improve the reliability and accuracy of tantalum data. We assessed DOD's policies, procedures, and practices against criteria in applicable statutes, Standards for Internal Control in the Federal Government, and GAO's Framework for Assessing the Acquisition Functions at Federal Agencies.³

³GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#), (Washington, D.C.: September, 2014) and GAO, *Framework for Assessing the Acquisition Functions at Federal Agencies*, [GAO-05-218G](#), (Washington, D.C.: September, 2005).

We determined whether or not documentation for the determination of reliability of the data used in the DLA-Strategic Materials model was provided but did not assess the adequacy of the information provided. We interviewed officials from USGS and DLA-Strategic Materials to clarify the issues. We concluded that the data had been collected and used in accordance with principles developed by USGS and DLA-Strategic Materials and were sufficiently reliable for the purpose of obtaining an understanding of the process used to collect the data, the model for determining potential shortfalls of material, and the reports produced by DLA-Strategic Materials.

We conducted this performance audit from August 2015 to March 2016 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.

Appendix II: GAO Contact and Staff Acknowledgments

GAO Contact

Marie A. Mak, (202) 512-4841, or makm@gao.gov

Staff Acknowledgments

In addition to the contact named above, Penny Berrier, Assistant Director; Marie Ahearn; Pedro Almoguera; John Beauchamp; Stephanie Gustafson; Jeffrey Harner; Mathew Jacobs; Carol Mebane; Jean McSween; Meghan Perez; Katrina Pekar-Carpenter; and Roxanna Sun made significant contributions to this review.

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