U.S. Government Accountability Office

Export Controls: Commerce Implemented Advanced Semiconductor Rules and Took Steps to Address Compliance Challenges

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Why This Matters

Semiconductors, or chips, are generally smaller than a postage stamp and are composed of billions of components that store, move, and process data. More advanced semiconductors have various applications, such as for artificial intelligence (AI), communications products, medical devices, and weapons.

Semiconductor shortages during the pandemic affected many industries and raised concerns about U.S. capacity to produce advanced semiconductors domestically. Congress enacted the CHIPS Act of 2022, appropriating more than $50 billion over 6 years to bolster domestic semiconductor research and development and manufacturing. The Department of Commerce's Bureau of Industry and Security (BIS) reported that this legislation promotes U.S. and allied country technology leadership in semiconductors. BIS also reported its export controls restrict the People's Republic of China (PRC) access to key technologies to address national security and foreign policy concerns. Together, these incentives and restrictions create the most comprehensive and effective policy for protecting national security and foreign policy interests while promoting U.S. leadership in semiconductors, according to BIS.

BIS took steps to help address these concerns, including by issuing three rules in October 2022 and October 2023 restricting the export of advanced semiconductors and their manufacturing equipment. We were asked to report on BIS's development and implementation of the three rules (BIS issued other rules, but throughout this report we will refer to these three rules as the three key rules), as well as what is known about private sector compliance efforts. We provide information in this report on the development and implementation steps BIS has taken and plans to take. We also provide information on compliance steps companies have taken regarding the rules and challenges they have reported encountering. Furthermore, we describe steps BIS has taken to address these challenges.

Key Takeaways

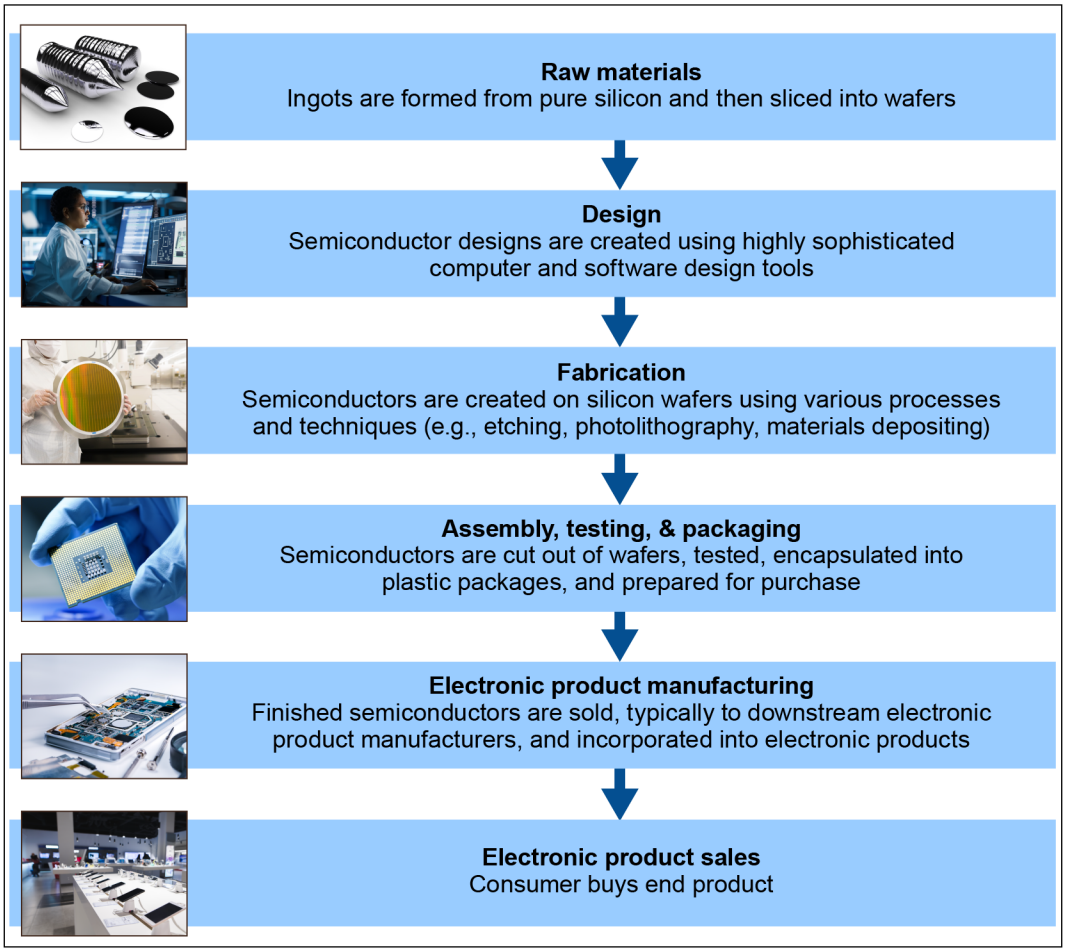
- BIS has issued three key rules. BIS published the first rule in 2022 on controlling exports of advanced semiconductors and semiconductor manufacturing equipment. BIS issued two additional rules in 2023 that revised the controls of the 2022 rule. In 2024, it updated the technical specifications of items the rules controlled.
- According to BIS, to avoid stockpiling of controlled items and for other national security or foreign policy concerns, BIS published these three rules as "interim final" rules, enabling it to enforce the rules before the end of a public comment period.

- BIS works with offices from six other U.S. agencies—the Departments of Defense (DOD), Energy (DOE), Homeland Security (DHS), Justice (DOJ), State, and the Treasury—to develop, implement, and enforce compliance with the rules as well as to engage with key foreign partners.
- The private sector has taken steps to comply with the new rules, such as by updating and maintaining compliance programs and self-reporting potential violations. Private sector interviews and comments on the rules also identified compliance challenges, including lack of clarity in the rules.
- BIS reported taking steps to address these challenges, including by soliciting feedback, refining definitions, and engaging with the private sector. BIS officials also told us BIS plans to publish periodic updates as needed, to match advancing technology and to improve the clarity of the rules, among other reasons.

How are semiconductors made and how have they evolved over time?

Semiconductors are made using materials and processes, such as silicon wafers, photolithographic chemicals, and etching machines that use ultraviolet light to form circuits in the chemically treated wafers. They are tiny electronic devices that are critical to nearly all industries (see fig. 1).[1]

Figure 1: Semiconductor Production Process



Source: Congressional Research Service, Semiconductors: U.S. Industry, Global Competition and Federal Policy, R46581 (Oct. 26, 2020) which was adapted from information provided by the Semiconductor Industry Association (information), GAO analysis (presentation), and stock.adobe.com/contributor/200571845/gorodenkoff (photos). | GAO-25-107386

Companies across the globe specialize in these specific steps of advanced semiconductor production, with some components crossing many international

borders before reaching the final consumer. U.S. firms play an important role in the supply chain such as through research, development, and design. In addition, advanced semiconductor production depends on a limited number of suppliers—including those in the Netherlands, Japan, South Korea, and Taiwan—for a single production step or for certain critical materials and equipment.

Semiconductors have evolved rapidly since their invention, becoming smaller, more efficient, and more effective. Over time, manufacturers have significantly decreased the size of the components in semiconductors, which increases the computing power and efficiency of the semiconductors. Historically, the smallest key features of semiconductors were measured in nanometers or 1 billionth of a meter (100,000 times thinner than the width of a human hair). Industry therefore has used the number of nanometers to represent semiconductor performance with smaller numbers implying more powerful semiconductors.[2] In 2005, the advanced semiconductor feature size was 65 nanometers. Nearly 20 years later, some manufacturers produced 3 nanometer features for the first time in 2022.

How can semiconductors be used for AI and military purposes?

Advanced semiconductors, and computers that perform at advanced speed (supercomputers), can be used for AI. AI can be used in a wide range of areas and its potential uses are still being explored.[3] AI enables machine learning, which can be used for many purposes, such as medical diagnosis or facial recognition.[4] AI also has military applications. For example, faster and more efficient chip operation enables superior processing and aggregation critical for managing the data volume and computational loads necessary for AI to model nuclear explosions.

BIS is responsible for controlling the export of "dual-use" items that may be used for military and non-military purposes. To carry out this function, BIS administers the Export Administration Regulations to regulate the export of goods and services for national security and foreign policy purposes.[5] These export controls restrict or require licenses for the transfer of controlled technologies. BIS has reported that the PRC could use advanced semiconductors for advanced computing to modernize its military, develop nuclear weapons, and conduct espionage. A senior BIS official also noted the PRC has set a goal to overtake the U.S. and its allies by, among other things, dominating the AI and semiconductor sectors.

What rules did BIS issue to control advanced semiconductor exports?

In October 2022 and October 2023, BIS published three key rules intended to control the export of advanced semiconductors and related manufacturing equipment that can be used for military as well as commercial purposes.[6] According to BIS, to avoid stockpiling of controlled items and for other national security or foreign policy concerns, BIS published these three rules as interim final rules, enabling it to enforce the rules before the end of a public comment period. In addition to the three key rules, BIS regularly updated the export control regulations starting shortly after the first rule and continuing through September 2024. These updates defined terms and provided information regarding public comment and briefings on relevant BIS rules, among other things.

One month prior to the first rule, in September 2022, the U.S. National Security Advisor outlined the four pillars of the administration's industrial and innovation strategy. One pillar focused on protecting U.S. technology advantages by preventing U.S. competitors from stealing U.S. intellectual property and from using U.S. technologies against the U.S. or their own people. The National Security Advisor noted the U.S. had a long-standing policy of using export controls to maintain relative advantages over competitors by staying a couple of

generations ahead of competitors in certain key technologies. The new strategy aims to use export controls to maintain as large of a lead as possible, given the nature of technologies such as advanced semiconductors. According to BIS, the comments of the National Security Advisor were a preview of the related rule it issued in October 2022.

On October 7, 2022, BIS released the first rule (later published in the Federal Register on October 13, 2022), which controlled the export of advanced semiconductors with the goal of addressing foreign policy and national security concerns related to the PRC.[7] The rule imposed new export controls on two categories of items and activities related to them: (1) advanced computing semiconductors and supercomputers and (2) advanced semiconductor manufacturing equipment. Among other things, the rule did the following:

Item-based controls. Established technical parameters for the items that require licenses (and assigned numbers to them in the Commerce Control List).[8]

End-use controls. Implemented end-use controls—meaning an export license is needed—for items intended for use in supercomputers located in or destined to be exported to the PRC and for the development and production of advanced semiconductors and their manufacturing equipment. Under the rule, Commerce reviews applications for licenses to export to countries subject to a U.S. arms embargo, which include the PRC, under a "presumption of denial." To obtain a license for export, applicants must provide sufficient justification and evidence to overcome this presumption on a case-by-case basis, according to agency officials.

U.S. persons activity. Established an export license requirement for U.S. persons activity. This requirement controls U.S. persons' activities related to items that could be used to produce advanced semiconductors for military programs.[9] The rule explained that this change was in response to policies of the PRC government that promote military advancement through partnerships with the PRC private sector. The rule also said these PRC government policies make it more difficult to tell whether exported items will be used in a manner that would be restricted under the Export Administration Regulations. For example, items would be restricted if intended for use in nuclear explosive devices and military intelligence services. As a result, according to the rule, U.S. persons may not have clear knowledge of whether their activities are contributing to prohibited end uses or end users. Therefore, the rule requires a license even when the U.S. person cannot determine the precise end use of such items.

Foreign direct product controls. Created two new foreign direct product controls. These controls place restrictions on foreign-produced items made by using either (1) certain technology or software subject to the Export Administration Regulations or (2) a plant or major component of a plant that was the direct product of certain U.S. technology or software. For example, this control would restrict the export of certain foreign-produced advanced semiconductors and other items destined for the PRC.

Entity List changes. Expanded the scope of licensing requirements for exports or shipments of items from one foreign country to another foreign country (reexports)—including of foreign direct products—to certain entities located in the PRC. For example, the rule added new advanced computing and supercomputer foreign direct product controls. These new foreign direct product controls required export licenses for a wide range of foreign produced semiconductors (or the development or production of such items) when the transaction involves certain entities on the Entity List.[10]

On October 17, 2023, BIS released two more rules (later published in the Federal Register on October 25, 2023) designed to refine the scope of the 2022 rule to

(1) achieve national security objectives more effectively and (2) respond to public comments about the 2022 rule. One rule focused on advanced computing semiconductors and supercomputers, and the other focused on advanced semiconductor manufacturing equipment.

In addition to the three rules issued in October 2022 and October 2023, BIS also updated regulations regarding the technical specifications of the items controlled by these three rules and provided information requested by public commenters, such as refined definitions and public briefings. Furthermore, BIS changed the entities and destinations for which export licenses are required. BIS announced these changes in the Federal Register.[11]

What steps did BIS take to develop the rules?

To develop the three key export control rules on advanced semiconductors and related manufacturing equipment, BIS incorporated input from experts, other agencies, and public comments, among other actions. According to BIS officials, BIS began developing the first of the three rules in spring 2022. They said their actions were informed by public comments BIS collected in 2018 on emerging and foundational technology and on information received in January 2022 from the National Security Council.

To draft the three key rules, BIS gathered information from several sources, according to BIS officials. For example, BIS coordinated with federal agencies to receive technical and scientific assistance, such as from DOE officials with expertise in advanced semiconductors. BIS also conducted research on minimizing market disruptions by consulting with BIS's Information Systems Technical Advisory Committee, which consists of representatives from industry and government. The Office of Management and Budget reviewed the proposed rules as part of the federal rulemaking process and solicited other agencies—DHS, DOD, DOE, DOJ, State, and Treasury—to review them, according to these agencies' officials. Finally, BIS gathered research on how best to set technical specifications for items on the Commerce Control List by talking to experts in federal agencies and companies.

BIS's three key rules included requests for public comments. BIS provided its responses to some of the public comments it received regarding the October 2022 rule in the two rules it published in October 2023. For example, BIS clarified the classification of semiconductor wafer processing equipment on the Commerce Control List based on feedback from public comments.[12] BIS then published its responses to some of the public comments it received regarding the two October 2023 rules in April 2024.[13]

The October 2023 rules also modified and updated the 2022 rule. BIS reported these updates were made to match the changing pace of the advanced semiconductor industry and to address issues raised by companies affected by the rules.

What exceptions did BIS create to the license requirements of the rules?

BIS established three new export license exceptions intended to minimize supply-chain disruptions and allow companies to export some of their advanced semiconductors and related manufacturing equipment more quickly, which Commerce determined was consistent with national security considerations.

First, companies trying to export or reexport certain advanced semiconductors and related items to Macau and countries for which the U.S. has imposed an arms embargo may apply for a license exception through the Notified Advanced Computing notification process, established in 2023. Through this process, BIS determines whether an export license is necessary and whether companies may export those items without a license. According to the regulations, it takes up to

25 days for BIS to notify companies of a result. This 25-day period begins once a company has submitted its notification in BIS's website for submitting and tracking applications for things such as export licenses and license exceptions.

Second, companies can use another license exception called Advanced Computing Authorized. This exception, established in 2024, grants exporters the right to export, reexport, or transfer (in-country) certain specified items, including certain advanced semiconductors, if they use the Advanced Computing Authorized label when doing so. Unlike the Notified Advanced Computing license exception, BIS does not require companies to submit a notification to BIS to export items under the Advanced Computing Authorized license exception, but misuse could lead to enforcement actions, according to agency officials.

According to the regulations, the Advanced Computing Authorized exception can be used to export specified items if those items will be exported to certain destinations that the U.S. government identified as raising national security, missile technology, or other concerns. Additionally, this license exception is available only if the item is not designed or marketed for use in data centers using advanced integrated circuits, and if the other terms of the license exception are met. BIS also specified those destinations for which the Advanced Computing Authorized exception cannot be used for exports, such as the PRC and Macau or companies headquartered in those countries.

Finally, companies may use a third license exception called Implemented Export Controls, also established in 2024. This license exception authorizes exports of items including certain advanced semiconductor manufacturing equipment to specified destinations whose governments have implemented equivalent controls on the same items as the U.S. government. According to BIS, the license exception supports technological collaboration and innovation for countries that have similar export controls.

BIS officials stated that export license exceptions have precedent. For example, they noted that BIS has used similar export license exceptions for the export of agricultural products to Cuba or of encryption products.

What steps has BIS taken to implement the rules?

To implement the three key export control rules on advanced semiconductors and related manufacturing equipment, BIS met with the End-User Review Committee to make changes to the Entity List, reviewed license applications, coordinated with other agencies, and engaged with private sector and foreign partners.[14]

Changed the Entity List. As chair, BIS met with the End-User Review Committee to make changes to the Entity List. The End-User Review Committee includes Commerce, DOD, DOE, and State, and, where appropriate, Treasury. The Entity List identifies foreign persons, including companies, that are subject to additional U.S. export license requirements. The End-User Review Committee may add foreign companies to the Entity List due to actions taken that the Committee judges as contrary to U.S. national security or foreign policy interests. On multiple occasions, in order to enforce the key rules, the agency added entities to the list. For example, BIS published in the Federal Register in 2023 an addition to the Entity List of 13 PRC companies that are involved in the advanced semiconductor industry.[15]

Reviewed license applications. According to BIS officials, after BIS issued the three key rules in October 2022 and October 2023, companies began submitting export license applications, which BIS has been reviewing. According to Executive Order 12981, BIS must issue decisions on license applications—or refer the matter to the President—no later than 90 days after BIS's registration of

the license application.[16] Additionally, BIS officials reported that BIS received 66 applications through the Notified Advanced Computing exception process since its inception in October 2023.

Coordinated with other agencies. BIS has coordinated with DOD, DOE, and State to review license applications, according to agency officials. If agencies disagree about license application decisions, applications may be escalated to an interagency Operating Committee, the Chair of the Advisory Committee on Export Policy, the Export Administration Review Board, and finally the President for further interagency discussion as needed over the application and proper determinations.[17]

Engaged with private sector. BIS officials said they conducted private sector outreach both domestically and internationally to enhance private sector understanding of and compliance with the three key rules. They conducted this outreach through seminars, the annual BIS Update Conference, and trainings, according to BIS officials. For example, in March 2024, BIS held a 2-day overseas seminar about the rules. Officials stated that they conducted more outreach than usual because the rules are so far reaching.

Engaged with foreign partners. BIS and other U.S. agencies engaged with foreign partners on export control policy and enforcement. BIS's international engagement included:

- Consulting with foreign governments through the Wassenaar Arrangement, a 42-member multilateral export control regime for conventional weapons and dual-use goods.[18]
- Conducting outreach to partner governments to further the goals of the rules, enhance understanding of the rules, and receive assistance from partner governments in enforcing the rules.[19] For example, in April 2024, BIS and DOJ established with Japan and the Republic of Korea the Disruptive Technology Protection Network to increase information sharing between the U.S. and the two countries and to prevent illicit technology transfer.

What roles do U.S. agencies have in developing, implementing, and enforcing the rules?

Commerce's BIS consults and collaborates with other U.S. agencies in developing, implementing, and enforcing the advanced semiconductor and related manufacturing equipment export control rules, according to agency officials and documents from the agencies.

Other agencies provide technical or scientific expertise to BIS, review proposed rules and export license applications, conduct outreach to private sector and foreign partner governments to improve compliance with the rules, enforce rules at sites of export (such as by seizing exports or verifying licenses), and investigate and prosecute possible violations of the rules, among other things (see table 1).[20]

Table 1: Agencies' Roles Related to Advanced Semiconductor Export Control Rules

Role in Rule Development	Commerce	Defense	Energy	Homeland Security	Justice	State	Treasury
Draft export control rules	✓						
Provide technical or scientific expertise to supplement Commerce's expertise		✓	✓			✓	

Review advanced semiconductor rules proposed by Commerce's Bureau of Industry and Security[a]	✓	✓	✓	✓	✓	✓

Role in Rule Implementation	Commerce	Defense	Energy	Homeland Security	Justice	State	Treasury
Review export license applications to determine whether applications should be approved	✓	✓	✓			✓	
Resolve interagency disagreements over export license application decisions	✓	✓	✓			✓	
Serve on the End-User Review Committee to update the Entity List[b]	✓	✓	✓			✓	✓
Conduct outreach with the private sector to improve compliance with and understanding of the rules[c]	✓	✓		✓	✓	✓	

Role in International Coordination	Commerce	Defense	Energy	Homeland Security	Justice	State	Treasury
Coordinate with foreign governments to improve compliance with and understanding of the rules and to share information	✓	✓	✓		✓	✓	
Serve on the U.S. Delegation at the Wassenaar Arrangement to encourage adoption of multilateral export controls[d]	✓	✓	✓			✓	

Role in Rule Enforcement	Commerce	Defense	Energy	Homeland Security	Justice	State	Treasury
Enforce rules at sites of export, such as by seizing exports or verifying licenses	✓			✓			
Investigate violations of the rules	✓	✓		✓	✓		
Prosecute criminal violations of rules					✓		
Share information and coordinate with agencies enforcing the rules	✓	✓	✓	✓	✓	✓	
Serve on the Disruptive Technology Strike Force[e]	✓	✓		✓	✓		
Monitor compliance with rules by conducting end-user checks and audits	✓						
Impose administrative penalties, such as fines or license revocations, when rules are violated	✓						

Source: GAO analysis of interviews with and documents from the Departments of Commerce, Defense, Energy, Homeland Security, Justice, State, and the Treasury. | GAO-25-107386

[a]When the Bureau of Industry and Security or another U.S. agency or office proposes new federal rules, the Office of Management and Budget reviews the rules.

[b]Commerce chairs the End-User Review Committee, which includes the Departments of Defense, Energy, and State, and, where appropriate, Treasury. While Treasury participates in conversations and provides information, it does not vote on committee decisions. The committee is tasked with updating the Entity List, which identifies foreign persons, including companies, that are subject to specific U.S. export license requirements.

[c]The Department of Justice's outreach aims to improve private sector understanding of various types of cases in general, including export control matters.

[d]The Wassenaar Arrangement is a 42-member multilateral export control regime for conventional weapons and dual-use goods.

[e]The Disruptive Technology Strike Force was established in February 2023 and is intended to protect advanced technology, such as advanced semiconductors, from being unlawfully acquired by foreign adversaries.

What efforts have companies reported taking to comply with the rules?

Companies reported taking several steps to comply with the new rules, according to our analysis of public comments, BIS documents, and our interviews with the private sector. Those steps included (1) updating and maintaining compliance programs to adhere to the rules; (2) self-reporting potential violations of the Export Administration Regulations by email to BIS's Office of Export Enforcement; (3) hiring outside counsel to ensure compliance with the rules, which interviewees said is sometimes necessary for complex rules; (4) stopping business with companies that interviewees thought BIS might be concerned about for foreign policy or national security reasons; (5) creating new business systems to ensure compliance; and (6) increasing due diligence screens to review end users of their products.[21]

Some companies, to maintain export revenue, also engineered their semiconductors to reduce their performance parameters so they would not meet the definition of advanced semiconductors subject to the rules, according to BIS and a private sector interview. For example, BIS and a semiconductor industry association told us companies designed new semiconductors in response to the rules. According to BIS, these redesigns reduced the performance of the semiconductors to a slightly lower capacity so they would not require a license under the new rules.

According to BIS officials, the private sector has generally been complying with the regulations by submitting license applications in line with the rules.

What challenges have companies reported encountering in complying with the rules?

Companies reported facing several challenges in complying with the rules, such as struggling with the complexity and the level of clarity of the rules, according to our analysis of public comments on the rules and our private sector interviews.

As discussed earlier, BIS solicited and responded to public comments on the rules in the Federal Register. Such commenting provides the public, including companies, an opportunity to voice concerns about the rules. We analyzed 145 public comments on the three key rules issued in October 2022 and October 2023, as summarized by BIS. We also interviewed representatives from four advanced semiconductor industry companies, one external counsel hired by companies, and two industry associations. We identified 10 reported categories of private sector compliance challenges (see table 2).[22]

Table 2: Private Sector's Reported Challenges in Complying with Bureau of Industry and Security's (BIS) October 2022 and October 2023 Advanced Semiconductor Export Control Rules

Compliance Challenge Category	Examples of What Commenters and Interviewees Said:
Breadth of rules	The rules controlled more technologies than necessary to achieve their national security objectives. BIS should be "surgical" in selecting the products it limits to achieve its goals. For example, commenters argued end-use controls established in the October 2022 rule were too broad and would have unintended consequences for producing older generations of technology, including semiconductors that would not be considered advanced.
Clarity of rules	Specific Export Control Classification Numbers and what they encompass are unclear, such as if an appliance would be considered a "computer" for the purposes of the export control rules.
Complexity of rules	The rules are so complex that two different engineers could interpret the same aspect of the rule in two completely different ways.

Compliance Challenge Category	Examples of What Commenters and Interviewees Said:
Cost of compliance	Companies have needed to hire new staff to address new due diligence requirements and have increased their use of external counsel to interpret the rules.
Inadequate industry coordination	BIS did not adequately consult with industry prior to the issuance of the October 2022 rule or respond to the private sector's questions on the rules in a timely manner.
Inadequate international coordination	Some foreign partners have adopted similar but not identical rules and others have not adopted any export rules controlling advanced semiconductors and related manufacturing equipment. As a result, some U.S. companies and industry associations reported an uneven playing field in international competition.
Inadequate time to implement rules	BIS used interim final rules to implement the 2022 and 2023 rules, enabling it to enforce the rules before the end of a public comment period. Unlike when BIS uses proposed rulemaking, which includes a public comment period prior to the effective date, the interim final approach did not allow the private sector time to understand the rules or provide feedback on potential unintended consequences before the rules were enforceable.
Loss of business	The export control rules have a large financial impact on companies, some of which ceased exports until they could clarify their understanding of the rules.
Loss of competitiveness	Non-U.S. competitors are not subject to the same export controls as U.S. companies. Thus, non-U.S. based companies have chosen to replace U.S.-origin products in the semiconductor supply chain with non-U.S.-origin alternatives. As U.S.-origin products are replaced, this may affect U.S. companies' capacity to fund research and development to ensure future competitiveness.
Supply chain challenges	Some companies have thousands of suppliers providing critical components, each with their own interpretations of the export control rules. For example, a company with a manufacturing plant in People's Republic of China struggled to make sure its suppliers understood what they were permitted to export, leading to supply chain disruptions.

Source: GAO analysis of public comments in the Federal Register on three BIS rules: 87 Fed. Reg. 62187 (Oct. 13, 2022), 88 Fed. Reg. 73424 (Oct. 25, 2023) and 88 Fed. Reg. 73458 (Oct. 25, 2023) and interviews with private sector representatives. | GAO-25-107386

Note: Compliance challenge categories are listed in alphabetical order.

No clear consensus existed among our interviewees about which challenges were the most significant. When asked to identify which of the 10 compliance challenges were the most significant, some private sector representatives we interviewed noted that many of the challenges are interrelated. Two companies also noted that a challenge may be more significant to one part of the semiconductor supply chain than another. Specifically, they said the inadequate international coordination created more challenges for companies that sell semiconductor manufacturing equipment than for companies that design advanced semiconductors. U.S.-based manufacturing equipment companies compete with similar companies worldwide that may not be subject to the same export controls, interviewees told us. In contrast, many chip designing companies are based in the U.S., according to the Congressional Research Service.

Despite these challenges, some public comments on the rules acknowledge the importance of the rules' national security objectives. Some commenters saw the implementation of the rules as the best option to address national security and regional stability concerns because the rules address the military use of supercomputers that have advanced semiconductors.

What actions has BIS taken to address the private sector's reported compliance challenges with the rules?

We identified six actions BIS has taken to address some private sector compliance challenges. To do so, we analyzed BIS's responses to public comments in the Federal Register, reviewed BIS documents, and interviewed BIS officials (see table 3).

Table 3: Bureau of Industry and Security (BIS) Actions in Response to Challenges Identified in Public Comments on Rules

BIS Action Category	Examples from BIS Responses to Public Comments and BIS Interviews:
Clarified rules	According to BIS, it received many public comments on the 2022 rule that suggested the number of items controlled due to regional stability reasons was too broad for compliance purposes. In response, BIS made some changes intended to narrow the scope. For example, BIS clarified in a subsequent rule that the 2022 export control rule was not intended to apply to telecommunications equipment, such as internet routers.[a]
Engaged with industry	Prior to publication of the rules, BIS consulted with the Information Systems Technical Advisory Committee, which consists of representatives from industry and government, to discuss information systems and emerging technologies. According to BIS's website, these committees advise BIS on the technical parameters for export controls applicable to dual-use commodities and technology and on the administration and potential impact of those controls. BIS also conducted industry outreach in the U.S. and overseas, offering industry briefings and seminars intended to increase public understanding and to collect industry feedback on ways to improve the rules' clarity.
Provided frequently asked questions or additional resources on website	BIS posted answers to frequently asked questions after the publication of each of the rules, including questions regarding specific aspects of the rules such as "U.S. Persons" controls.
Revised licensing processes	BIS revised licensing processes by creating three export license exceptions: the Notified Advanced Computing, Advanced Computing Authorized, and Implemented Export Controls. According to BIS, it created the first two exceptions to reduce potential supply chain disruptions to private sector companies. It created the third exception to support collaboration and innovation in those technologies for countries that have implemented technical parameters on items in their export controls that are equivalent to those in BIS's controls.
Revised text of rules	BIS revised the text of an Export Control Classification Number to simplify processing performance calculations for advanced semiconductors after commenters mentioned the complexity of calculations introduced by the 2022 rule.[a]
Solicited feedback	BIS requested comments prior to publication from the Information Systems Technical Advisory Committee and requested comments on rules through regulations.gov upon publishing each of the interim final rules.

Source: GAO analysis of Department of Commerce's BIS responses in Federal Register, documentary evidence, and interviews. | GAO-25-107386

Note: BIS action categories are listed in alphabetical order.

[a]88 Fed. Reg. 73458 (Oct. 25, 2023).

Some private sector representatives we interviewed noted that over time BIS has made improvements in how it has addressed compliance challenges. They suggested Commerce could take additional steps, such as returning to proposed rulemaking (rather than interim final rules), answering questions about interpretation of the rules in a timely manner, and increasing engagement with companies prior to the publishing of new rules.

What additional steps does BIS plan to take to develop and implement the rules?

BIS plans to continue developing updates to the rules and implementing them. It plans to publish periodic updates to address national security and foreign policy concerns as necessary to match advancing technology, address geopolitical changes, and to improve the clarity of the rules, among other reasons, according to officials.

To continue developing updates, BIS plans to take similar steps to those it took to develop the three key rules. For example, because of public comments on the two October 2023 rules, BIS issued an April 2024 update. In September 2024, BIS updated the Commerce Control List, among other changes. According to BIS officials, BIS may continue to publish updates as interim final rules, which will allow it to address national security concerns while still gathering public comments that may help to assess if additional updates are necessary. As of October 2024, BIS was still reviewing the rest of the public comments received in response to the two October 2023 rules and the April 2024 update. BIS plans to consult with agency officials and other technical and scientific experts, including the Information Systems Technical Advisory Committee, on updates to the rules and on the capabilities of technologies that may warrant controls due to national security concerns. BIS may also create new license exceptions, like the Notified Advanced Computing, or revise license processes as needed.

BIS plans to implement the rules by continuing to conduct private sector outreach to improve compliance with and understanding of the rules. Specifically, BIS may seek public comments on future rulemakings, respond to requests for guidance, and hold online seminars and informational briefings with industry. BIS also plans to continue to engage with foreign partners, such as through bilateral and multilateral outreach.

Agency Comments

We provided a draft of this report to Commerce, DHS, DOD, DOE, DOJ, State, and the Treasury for review and comment. Commerce and DOJ provided technical comments, which we incorporated as appropriate.

How GAO Did This Study

To describe advanced semiconductors and the BIS rules imposing controls on them, we reviewed BIS rules and documents, as well as our past reports, a 2023 U.S.-China Economic and Security Review Commission report, and Congressional Research Service reports.[23]

To describe the steps BIS has taken to develop and implement its three key 2022 and 2023 export control rules regarding advanced semiconductors and related manufacturing equipment, we reviewed the rules, BIS documents on rule development and implementation, and our past reports on export controls. We interviewed BIS officials on steps BIS has taken and plans to take to continue developing and implementing the rules. To describe how BIS works with other offices and U.S. agencies and what the roles of those agencies are, we reviewed documents and interviewed officials from the seven agencies—Commerce, DHS, DOD, DOE, DOJ, State, and Treasury—involved in reviewing proposed rules, adjudicating license applications, leading international coordination, conducting outreach with the private sector, and investigating possible violations, among other roles. We did not assess effectiveness of the rules in achieving their objectives.

To describe what is known about private sector compliance with the 2022 and 2023 rules, we reviewed and content-analyzed 145 public comments on the rules as summarized by BIS, industry reports, and agency documents on private sector challenges and compliance with the rules. To gather additional information about private sector compliance steps and challenges, as well as private sector

perspectives on BIS efforts to address compliance challenges, we conducted interviews with representatives from four advanced semiconductor industry companies, one external counsel hired by the companies, and two industry associations. We identified these private sector interviewees by conducting background research on the semiconductor industry and by selecting companies which fulfilled specific criteria, such as a developing, manufacturing, or selling a product targeted by the rules, or submitting a public comment to the rules. We selected external counsel and industry associations based on a number of criteria, such as whether they had submitted a public comment on the rules or represented multiple companies in the U.S. semiconductor industry. We also interviewed agency officials and reviewed agency documents to identify steps BIS has taken to address compliance challenges.

We conducted this performance audit from February 2024 to December 2024 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.

List of Addressees

The Honorable Charles E. Schumer
Majority Leader
United States Senate

The Honorable Margaret Wood Hassan
Chair
The Honorable Mitt Romney
Ranking Member
Subcommittee on Emerging Threats and Spending Oversight
Committee on Homeland Security and Governmental Affairs
United States Senate

We are sending copies of this report to the appropriate congressional committee, and the Secretaries of Commerce, Defense, Energy, Homeland Security, Justice, State, and the Treasury, as well as other interested parties. In addition, the report is available at no charge on the GAO website at https://www.gao.gov.

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Endnotes

[1]The term semiconductor refers to a material that has more electrical conductivity than an insulator but less than a conductor. In this report, we use a common definition of the term to refer to computer chips and integrated circuits. A monolithic integrated circuit is a complete circuit made into or on top of a single die or "chip" of semiconducting material (usually, but not always, silicon). Similarly, the export controls at issue often use the term "integrated circuit" rather than "semiconductors." For more information see: Intel, *Semiconductors and Intel: An Introduction*, https://www.intel.com/content/www/us/en/architecture-and-technology/semiconductors-primer.html; Congressional Research Service (CRS), *Semiconductors: U.S. Industry, Global Competition, and Federal Policy*, R46581 (Oct. 26, 2020).

[2]The key features on a semiconductor that industry historically measured in nanometers are called a node. Node no longer reflects the actual size of features in recent generations of semiconductors. However, the industry continues to use these labels to market new products. There is no industry standard on how recent node labels are assigned and which nodes are "mature" semiconductor technologies. For more information about different ways industry has measured and increased performance of advanced semiconductors over time, see CRS, *Semiconductors and the CHIPS Act: The Global Context*. R47558 (Washington, D.C.: Sept. 28, 2023).

[3]For more on this topic see our body of work in this area at https://www.gao.gov/artificial-intelligence, particularly GAO, *Artificial Intelligence: Generative AI Technologies and Their Commercial Applications,* GAO-24-106946 (Washington, D.C.: June 20, 2024).

[4]Artificial intelligence and machine learning is a set of technologies that includes automated systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, and decision-making.

[5]Specifically, the Export Administration Regulations regulate the export, reexport, and transfer (in-country) of items and certain U.S. person activities for national security and foreign policy purposes. These regulations are authorized by the Export Control Reform Act of 2018, Pub. L. No. 115-232, Title XVII, Subtitle B, 132 Stat. 1636, 2208-2092 (Aug. 2018).

[6]This report provides high-level summary information about the rules; to understand the full scope of the rules, readers are directed to the Federal Register. See 87 Fed. Reg. 62186 (Oct. 13, 2022), 88 Fed. Reg. 73424 (Oct. 25, 2023) and 88 Fed. Reg. 73458 (Oct. 25, 2023).

[7]After Russia invaded Ukraine in early 2022, BIS also noted Russia's invasion was supported by its illicit acquisition of semiconductors. The 2022 advanced semiconductor export rule mentions exports to Russia, among other U.S.-sanctioned countries, as a concern. Additionally, the rule imposes export controls on less sophisticated technology for anti-terrorism reasons. However, the primary focus of the rule is on the PRC and advanced semiconductors.

[8]Commerce lists items subject to its export controls on the Commerce Control List, which is available in Commerce's Export Administration Regulations at 15 C.F.R. Part 774 and shared on BIS's website at https://www.bis.gov/regulations. Available to the private sector as a resource, the list describes controlled items and indicates licensing requirements for each item by identifying each item with a specific number, known as the Export Control Classification Number.

[9]The Export Administration Regulations defines "U.S. person" as (1) any individual who is a citizen of the United States, a permanent resident alien of the United States, or a protected individual as defined by 8 U.S.C. 1324b(a)(3); (2) any juridical person organized under the laws of the United States or any jurisdiction within the United States, including foreign branches; and (3) any person in the United States. 15 C.F.R. § 772.1.

[10]See 15 C.F.R. § 734.9(h), (i).

[11]According to agency officials, between October 2022 and September 2024, BIS published nine rules BIS described as pertinent to the one October 2022 and two October 2023 key advanced semiconductor export control rules. The pertinent rules did the following:

- **Changed the Entity List rules.** 87 Fed. Reg. 61971 (Oct. 13, 2022), amended the Export Administration Regulations to provide that failure to cooperate with a bona fides check, including because of sustained lack of cooperation by the host government, could lead to placement on the Entity List.
- **Provided access to briefings about the three export control rules.** Two rules—87 Fed. Reg. 61970 (Oct. 13, 2022) and 88 Fed. Reg. 73783 (Oct. 27, 2023)—described how to access two public briefings about the three advanced semiconductor export control rules issued in 2022 and 2023.

- **Extended comment periods for the three export control rules.** Two rules—87 Fed. Reg. 74966 (Dec. 7, 2022) and 88 Fed. Reg. 86821 (Dec. 15, 2023) extended the period in which public comments were collected on the 2022 and 2023 rules, respectively.
- **Applied the export controls to Macau.** 88 Fed. Reg. 2821 (Jan. 18, 2023) expanded the export controls in the original October 7, 2022, rule to include Macau.
- **Expanded the Entity List.** 88 Fed. Reg. 71991 (Oct. 19, 2023) added 13 entities to the Entity List and designated those entities as footnote 4 entities for purposes of the foreign-produced direct product rule.
- **Corrected errors and provided updates.** 89 Fed. Reg. 23876 (Apr. 4, 2024) corrected inadvertent errors in the two October 25, 2023, rules and clarified information in those rules.
- **Added controls that are not PRC-specific.** 89 Fed. Reg. 72926 (Sept. 6, 2024) added export controls for quantum computing items, additional advanced semiconductor manufacturing equipment, technology (called gate all-around field-effect transistor technology) for producing or developing high-performance semiconductors, and additive manufacturing items.

BIS also issued 16 other rules that did not mention the three key rules but did mention emerging technology concerns related to PRC entities. These rules added or deleted PRC entities on the entity and unverified lists, which changed the entities that would require export licenses. See 87 Fed. Reg. 61970 (Oct. 13, 2022); 87 Fed. Reg. 76924 (Dec. 16, 2022); 87 Fed. Reg. 77505 (Dec. 16, 2022); 88 Fed. Reg. 9389 (Feb. 14, 2023); 88 Fed. Reg. 13673 (Mar. 6, 2023); 88 Fed. Reg. 17706 (Mar. 24, 2023); 88 Fed. Reg. 18983 (Mar. 30, 2023); 88 Fed. Reg. 38739 (Jun. 14, 2023); 88 Fed. Reg. 40084 (Jun. 21, 2023); 88 Fed. Reg. 57002 (Aug. 22, 2023); 88 Fed. Reg. 66271 (Sept. 27, 2023); 88 Fed. Reg. 80131 (Nov. 17, 2023); 88 Fed. Reg. 87668 (Dec. 19, 2023); 88 Fed. Reg. 87897 (Dec. 20, 2023); 89 Fed. Reg. 4187 (Jan. 23, 2024); and 89 Fed. Reg. 14403 (Feb. 27, 2024).

[12]See 88 Fed. Reg. 73424 (Oct. 25, 2023).

[13]See 88 Fed. Reg. 73424 (Oct. 25, 2023), 88 Fed. Reg. 73458 (Oct. 25, 2023), and 89 Fed. Reg. 23876 (Apr. 4, 2024).

[14]A forthcoming GAO report will examine the steps BIS has taken to enforce the export control rules on advanced semiconductors and related manufacturing equipment, as well as BIS efforts to coordinate with key foreign partners regarding the rules. For prior GAO reporting on the enforcement of Commerce's export control rules, see GAO, *Export Controls: Enforcement Agencies Should Better Leverage Information to Target Efforts Involving U.S. Universities*, GAO-22-105727 (Washington, D.C.: June 14, 2022). An additional forthcoming GAO report will examine BIS's processes and resources to control exports more broadly.

[15]88 Fed. Reg. 71991 (Oct. 19, 2023).

[16]Exec. Order No. 12,981, § 2 (1995). This timeframe is also set forth in the Export Administration Regulations. See 15 C.F.R. § 750.4(a)(1).

[17]Executive Order 12981 established an interagency review process for reaching a decision on Commerce license applications in which reviewing agencies disagree. An Operating Committee with representatives from Commerce, DOD, DOE, and State and non-voting representatives of the Joint Chiefs of Staff and the Nonproliferation Center of the Central Intelligence Agency reviews all such license applications. A dissenting department can escalate a license decision to Commerce's Advisory Committee on Export Policy at the Assistant Secretary level, followed by an Export Administration Review Board at the Commerce Secretary level and, ultimately, to the President for a final decision to approve or deny the license.

[18]According to a policy statement within the Export Control Reform Act of 2018, multilateral controls are the best way to control access to important technologies, because they ensure that allies are controlling the same technologies and further limit other countries' access to these technologies. The U.S. participates in four multilateral export control regimes: the Wassenaar Arrangement, the Nuclear Suppliers Group, the Australia Group, and the Missile Technology Control Regime. The control regime for dual-use items is the Wassenaar Arrangement. Wassenaar's 42 member states meet annually to discuss members' proposed revisions to the control lists. If members unanimously support a revision, the group updates the Wassenaar control list, and members commit to update their countries' export policies accordingly.

[19]For this report, allies and partners are nations that are not geopolitical competitors with the U.S. for key products.

[20]The agencies and offices with a role regarding the rules include: 1) Commerce's BIS; 2) DOD's Defense Criminal Investigative Services, Defense Technology Security Administration, and counter intelligence organizations; 3) DOE's National Nuclear Security Administration, Nonproliferation and Arms Control, Office of Nuclear Export Controls, Office of Science, and National Laboratory Complex; 4) DHS's Customs and Border Protection, Immigration and Customs Enforcement, Homeland Security Investigations, and Office of Strategy, Policy and Plans; 5) DOJ's Executive Office for the United States Attorneys, United States Attorneys' offices, Federal Bureau of Investigation, and National Security Division; 6) State's Bureau of International Security and Nonproliferation; and 7) Treasury's Office of International Affairs.

[21]BIS lists some entities of concern, such as individuals or semiconductor factories in the PRC, on the Entity List subject to licensing requirements and policies supplemental to those found elsewhere in the Export Administration Regulations. However, BIS noted there may be entities of concern that the end-use and U.S. persons controls apply to, and which are not on the Entity List. BIS further noted that since the Entity List is not exhaustive, exporters, reexporters, and transferors will still need to do their own due diligence to identify additional entities of concern when dealing with parties not specifically identified on the Entity List.

[22]Along with these 10 challenges, in our interviews some private sector representatives said the licensing process is also a challenge. Specifically, they said once they submitted export license applications, BIS did not provide clear and timely communications about the status of the application. Two interviewees told us BIS did not approve any of their applications for a Notified Advanced Computing license exception using the process BIS created in October 2023. The Notified Advanced Computing process can be used to determine whether an item can be exported to countries for which the U.S. has imposed an arms embargo. As a result, these companies had to then apply for licenses to export to countries for which BIS requires export licenses due to U.S. arms embargoes.

[23]U.S.-China Economic and Security Review Commission, *2023 Report to Congress,* (Washington, D.C.: Nov. 14, 2023.) In addition to the already cited reports (R46581, R47558, GAO-24-106946, https://www.gao.gov/artificial-intelligence, and GAO-22-105727), other examples of reports we reviewed included the following GAO reports: *Export Controls: System for Controlling Exports of High Performance Computing Is Ineffective,* GAO-01-10 (Washington, D.C.: Dec. 18, 2000); *Challenges With Commerce's Validated-End User Program May Limit Its Ability To Ensure That Semiconductor Equipment Exported To China Is Used As Intended*, GAO-08-1095 (Washington, D.C.: Sept. 25, 2008); *Semiconductor Supply Chain: Policy Considerations from Selected Experts for Reducing Risks and Mitigating Shortages*, GAO-22-105923 (Washington, D.C.: Jul. 26, 2022); and *Supply Chain Resilience: Agencies Are Taking Steps to Expand Diplomatic Engagement and Coordinate with International Partners*, GAO-23-105534 (Washington, D.C.: Feb. 2, 2023). We also reviewed the following CRS reports: *Semiconductors and the Semiconductor Industry*, R47508 (Apr. 19, 2023) and *Export Controls—International Coordination: Issues for Congress,* R47684 (Sept. 8, 2023).