

September 2008

EXPORT CONTROLS

Challenges with Commerce's Validated End-User Program May Limit Its Ability to Ensure That Semiconductor Equipment Exported to China Is Used as Intended



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Highlights

Highlights of [GAO-08-1095](#), a report to the Committee on Foreign Affairs, House of Representatives

Why GAO Did This Study

Semiconductors are key components in weapons systems and consumer electronics. Since semiconductors have both civilian and military applications, U.S. export control policy treats the equipment and materials used to manufacture semiconductors as “dual-use” items, and controls the export of these items through licensing requirements to sensitive destinations such as China.

You requested that we update our 2002 report on China’s semiconductor manufacturing capabilities to address the (1) evolution of China’s capabilities since 2002, (2) changes to U.S. export control policies over the sale of semiconductor manufacturing equipment and materials to China since 2002, and (3) the advantages and limitations of these changes.

What GAO Recommends

To enhance oversight, Commerce should suspend the VEU program to China until an amended or new agreement is reached to conduct onsite reviews and VEU-specific procedures for conducting on-site reviews are established.

Commerce disagreed with our recommendation, stating that it can use a classified 2004 agreement with China to conduct on-site reviews. However, use of the agreement imposes an additional burden on validated end-users. Commerce also maintains it has procedures for on-site reviews, but they are still in draft form and have not cleared the interagency review.

To view the full product, including the scope and methodology, click on [GAO-08-1095](#). For more information, contact Joseph A. Christoff at (202) 512-8979 or christoffj@gao.gov.

EXPORT CONTROLS

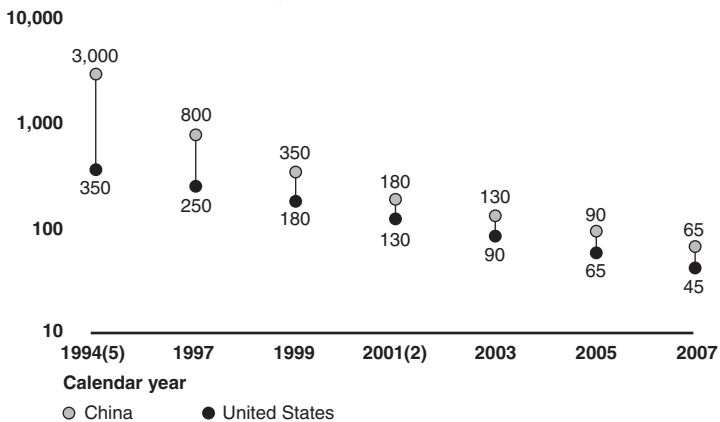
Challenges with Commerce’s Validated-End User Program May Limit Its Ability to Ensure That Semiconductor Equipment Exported to China Is Used as Intended

What GAO Found

The gap between U.S. and Chinese commercial semiconductor manufacturing capabilities, as measured by the feature size of the semiconductors produced, rapidly narrowed between 1994 and 2002. Since 2002, China’s semiconductor manufacturing capabilities have continued to advance but remain one generation behind state-of-the-art semiconductors produced in the United States. China’s most advanced semiconductor manufacturing companies continue to rely on equipment and materials from the United States, Europe, and Japan to improve their manufacturing capabilities. However, China has developed an indigenous capacity to build some types of advanced semiconductor manufacturing equipment, which may soon provide companies in China with a domestic source of equipment capable of producing semiconductors that are close to state of the art.

U.S. and Chinese Semiconductor Manufacturing Capability, 1994 through 2007

Feature size in nanometers (logarithmic scale)



A semiconductor’s feature size, or the size of the components on a semiconductor, is measured in nanometers and is used to define the current level of technology. Each reduction in feature size—for example, from 65 to 45 nanometers—is considered a move to a new generation of technology.

Source: GAO analysis of data provided by Semiconductor Manufacturing International Corporation and other semiconductor manufacturing facilities in China, Intel Corporation, and the International Technology Roadmap for Semiconductors.

Since 2002, U.S. export control policies over semiconductor equipment and materials to China have become more “end-user” focused, with the introduction of the Validated End-User (VEU) program, a parallel licensing framework that allows select pre-screened Chinese end-users to receive controlled items, including some semiconductor equipment and materials, without a license.

The Department of Commerce anticipated that the VEU program would facilitate trade to China and enhance U.S. security; however, challenges with program implementation may limit Commerce’s ability to ensure items are being used as intended. Specifically, Commerce has not reached a VEU-specific agreement with the Chinese government for conducting on-site reviews of validated end-users, a mechanism cited by Commerce as critical for ensuring program compliance. Instead, as a stopgap measure, Commerce is attempting to conduct VEU on-site reviews under a 2004 agreement. In addition, Commerce lacks procedures for conducting on-site reviews, though the validated end-user program was introduced in June 2007.

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Abbreviations

BIS	Bureau of Industry and Security
CIA	Central Intelligence Agency
Commerce	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
EAR	Export Administration Regulations
ERC	End-User Review Committee
IVL	Individual Validated License
OTE	Office of Technology Evaluation
PSV	postshipment verification
SCL	Special Comprehensive License
SEMI	Semiconductor Equipment and Materials International
SMIC	Semiconductor Manufacturing International Corporation
State	Department of State
VEU	Validated End-User (program)
EUVU	2004 End Use Visit Understanding

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United States Government Accountability Office
Washington, D.C. 20548

September 25, 2008

The Honorable Howard Berman
Chairman
Committee on Foreign Affairs
The Honorable Ileana Ros-Lehtinen
Ranking Member
Committee on Foreign Affairs
House of Representatives

For nearly five decades, the semiconductor industry has served as the foundation of the U.S. high-tech economy and, in turn, provided the United States with a strategic military advantage. However, as semiconductor production and its supporting industries move overseas to countries such as China, the ability of the United States to maintain this advantage may be threatened. Semiconductors, commonly known as integrated circuits or computer “chips,”¹ are often used in weapons systems as well as consumer electronics such as computers, cell phones, and televisions. The manufacture of semiconductors takes about 2 months, requires a complex process involving more than 250 steps, and uses hundreds of millions of dollars in sophisticated equipment and materials. Since semiconductors have both civilian and military applications, U.S. export control policy treats semiconductor equipment and materials as “dual-use” items, and controls the export of these items through licensing requirements to sensitive destinations such as China. According to the Department of Commerce, this policy is consistent with the objective of facilitating high-technology trade with civilian customers, while hedging against China’s rapid military modernization.

In 2002, we reported that China had narrowed the gap between the capabilities of its semiconductors and state-of-the-art U.S.-made semiconductors from 10 years to 2 years.² Moreover, we found that the growing sophistication of China’s semiconductor manufacturing facilities had improved its ability to develop more capable weapons systems and advanced consumer electronics. Since 2002, China has continued efforts to

¹For the purposes of this report, the terms semiconductor, integrated circuit, and computer chip are used interchangeably.

²GAO, *Export Controls: Rapid Advances in China’s Semiconductor Industry Underscore Need for Fundamental U.S. Policy Review*, [GAO-02-620](#) (Washington D.C.: Apr. 19, 2002).

develop its domestic semiconductor industry. Concurrently, the United States has made adjustments to its policies and procedures governing the sale and transfer of semiconductor equipment and materials to China.

In light of these developments, you requested that we update our 2002 report to address the (1) evolution of China's semiconductor manufacturing capabilities since 2002, (2) changes to U.S. export control policies over the sale of semiconductor manufacturing equipment and materials to China since 2002, and (3) advantages and limitations of these changes to U.S. export controls. In addition, this report describes progress the Departments of Commerce and Defense have made to address our prior recommendations.

To conduct this review, we analyzed the relevant statutes, regulations, and presidential directive pertaining to export controls for China; interviewed officials in Washington, D.C., from the U.S. Departments of Commerce (Commerce), Defense (DOD), Energy (DOE), and State (State); analyzed Commerce licensing data; and reviewed information provided by Commerce on end-use checks in China. We interviewed representatives and reviewed information from the U.S. and Chinese semiconductor and semiconductor equipment and materials industries, officials from the trade associations representing each industry, academics with expertise in China's semiconductor industry, and members of the intelligence community. We traveled to Beijing and Shanghai, China, and visited companies that have been approved to receive semiconductor equipment and materials under the Validated End-User program or have received these items under export licenses. We also attended SEMICON China—a semiconductor industry trade show with more than 900 U.S., Chinese, and other foreign companies represented—and met with three Chinese companies involved in semiconductor manufacturing. We determined that the data presented in this report are sufficiently reliable for the purpose for which they are presented.

We conducted this performance audit from October 2007 to September 2008, 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 I contains a more detailed description of our scope and methodology.

Results in Brief

Since 2002, China's ability to manufacture semiconductors has steadily advanced, but semiconductors produced commercially in China remain approximately one generation, or about 1 to 2 years, behind state-of-the-art semiconductors produced in the United States.³ As of July 2008, China's most advanced semiconductor manufacturing company can produce integrated circuits with a feature size of 65 nanometers,⁴ compared with U.S. companies that are producing semiconductors with 45-nanometer feature sizes.⁵ Nonetheless, according to Semiconductor Equipment and Materials International,⁶ most of China's semiconductor production is for integrated circuits that are four to seven generations old, and approximately 7 percent of integrated circuits produced in China are one generation or less behind current state of the art. China's most advanced semiconductor companies continue to rely on equipment from the United States, Europe, and Japan to enhance their manufacturing capabilities. China also has developed an indigenous capacity to build some types of advanced semiconductor manufacturing equipment, which soon may provide companies in China with a domestic source of equipment capable of producing chips that are close to state of the art.⁷ Despite these advances, significant gaps remain in China's ability to produce all the specialized equipment necessary for state-of-the-art production. In addition to advanced equipment available from foreign and domestic sources, China can obtain older equipment on the used market to increase its capacity to produce integrated circuits. The used equipment market potentially could enable production of integrated circuits for China's military, as weapons systems are generally designed around older technology.

³In 2002, GAO reported that semiconductors made in China were approximately one generation behind U.S.-made state-of-the-art semiconductors. Since 2002, the sophistication of Chinese and U.S. semiconductors has advanced at the same rate, and Chinese semiconductors therefore remain one generation behind the U.S.-made state of the art.

⁴A nanometer is one billionth of a meter, or 1/100,000 the width of a human hair. The feature size, or size of the transistors and other components, of semiconductors is measured in nanometers. Feature size also is used to define the current level of semiconductor technology.

⁵Each reduction in feature size—for example, from 65 to 45 nanometers—is considered a move to a new generation of technology, and each new generation represents a doubling of the number of transistors on a silicon wafer.

⁶Semiconductor Equipment and Materials International is the trade association serving the global semiconductor equipment, materials, and flat panel display industries.

⁷These companies also sell their equipment outside China.

Since 2002, U.S. export controls have become increasingly focused on the recipients or “end-users” of items, resulting in the introduction of the Validated End-User (VEU) program in June 2007. The VEU program is a parallel export licensing framework that allows select “trusted” Chinese end-users to receive controlled items, including some semiconductor equipment and materials, without a license. Most U.S. exports of semiconductor equipment and materials to China require an export license, which authorizes the sale or transfer of a specified item or items from a single U.S. entity to a specified end-user in China. Under this licensing system, an interagency panel reviews each application, scrutinizes the item and end-user, and if it approves the license, often attaches conditions to the license stipulating how the item may be used. Commerce may conduct a check after the item has been shipped to China, also known as a postshipment verification check, to ensure that items are being used in the correct location and for the purpose stated on the license. Under the new VEU program, Commerce allows U.S. exporters to ship eligible items to certain pre-screened end-users in China, including three companies authorized to receive semiconductor equipment and materials, without a license. Instead of requiring a postshipment verification check to ensure that the equipment is being used in accordance with the terms of the authorization, validated end-users must agree to periodic records reviews and discretionary “on-site reviews” by U.S. government personnel.

The introduction of the VEU program has yet to produce the advantages anticipated by Commerce, and challenges with program implementation may hinder Commerce’s ability to ensure that items are being used as intended. Commerce anticipated that the VEU authorization would facilitate trade in controlled items to China by reducing the number of exports requiring licenses. Commerce also expected that, through the reduction in the number of license applications requiring review, it could redirect resources to increase scrutiny over lesser-known end-users in China, thus enhancing U.S. security. However, as of June 2008, only one of three validated end-users authorized to receive semiconductor manufacturing equipment had received such items under the VEU program. In addition, problems with Commerce’s implementation of the VEU program limit its ability to ensure that semiconductor equipment and materials exported to China are used as intended. Specifically, although negotiations are ongoing, Commerce has not reached a VEU-specific agreement with the Chinese government for conducting on-site reviews of validated end-users, a mechanism cited by Commerce as critical for ensuring program compliance. In lieu of a VEU-specific agreement, Commerce is attempting to conduct on-site reviews under a 2004

agreement as a stopgap measure. Commerce also has not developed specific procedures for selecting and conducting on-site reviews of validated end-users.

The Departments of Commerce and Defense have not implemented the recommendations from our 2002 report to conduct both a formal foreign availability assessment⁸ for semiconductor equipment and materials and an assessment of the impact exports of these items have on U.S. economic and national security. However, Commerce has met the intent of our recommendation by using information on foreign availability to determine what items to control and to make licensing decisions. We believe these efforts sufficiently address our recommendation. For example, Commerce reduced the number of items controlled under its China Military End-Use rule⁹ from 47 to 31, in response to a variety of information, including foreign availability, it had sought from the public. Commerce also established an Office of Technology Evaluation in 2006, which conducts foreign availability studies. Finally, DOD has not conducted annual cumulative effects studies; however, the requirement was recently eliminated in a new DOD instruction.

To better promote the VEU program's objective of facilitating trade and to enhance oversight of semiconductor equipment and materials exported to China, we recommend that the Secretary of Commerce suspend the VEU program to China until Commerce negotiates a VEU-specific agreement with China or the 2004 End Use Visit Understanding (EUVU) is amended to include the VEU program, and develops operating procedures for selecting and conducting on-site reviews that are applicable to all validated end-users.

In commenting on a draft of this report, Commerce disagreed that no mechanism exists to provide oversight of exports of semiconductor equipment under the VEU program. Specifically, Commerce stated that (1) a classified 2004 EUVU with China provides a framework for all inspections

⁸According to the Export Administration Regulations, a foreign availability assessment includes a determination as to whether an item is available in fact, in sufficient quantity, of comparable quality, and from a non-U.S. source. *See* 15 C.F.R. §768.6.

⁹The China Military End-Use rule was published on June 19, 2007, and added a unilateral license requirement for military end-uses in China for items that previously did not require a license for export to China unless they were to be reexported to a terrorist supporting country. *See* 72 Fed. Reg. 33646 (June 19, 2007).

related to export controls in China, and (2) procedures for conducting end-use checks exist and will be used for on-site reviews as applicable. We amended the report to acknowledge that Commerce anticipates using the EUVU agreement to conduct on-site reviews under the VEU program until it is amended or a new agreement is concluded. However, the EUVU procedures, specifically the EUVU requirement to obtain End-User Statements for shipments, imposes an additional burden on validated end-users. Obtaining an End-User Statement is not a VEU program requirement, and runs counter to the trade facilitating objectives of the program. Therefore, an amended or new agreement is needed. Furthermore, Commerce asserts that it has procedures for selecting on-site reviews and conducting end-use checks. We disagree. First, as noted in this report, the procedures for selecting which validated end-users will receive on-site reviews are still in draft form and have not been cleared by the interagency process. Second, Commerce's general procedures for conducting end-use checks are not specific to the VEU program. Instead, they were designed for pre-license and postshipment verification checks of items shipped under individual licenses. End-use checks focus on ensuring that an item is being used for the purposes stated on the license, whereas on-site reviews are more comprehensive.¹⁰ Finally, we agree that Commerce needs additional case-by-case guidance for on-site reviews to ensure that the review is tailored to a particular validated end-user. However, the department also needs general procedures for VEU on-site reviews to ensure that they are conducted in a consistent manner.

The Departments of Commerce and Energy also provided technical comments, which are incorporated as appropriate throughout this report. The Departments of Defense and State did not have any comments on this report.

Background

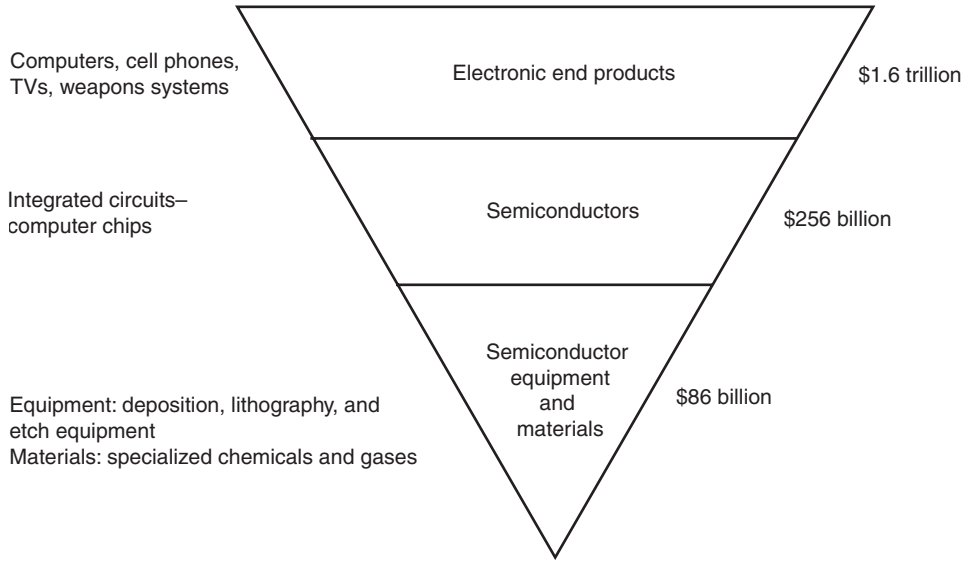
The semiconductor manufacturing equipment and materials industry produces a variety of equipment, chemicals, gases, films, and other materials critical to manufacturing integrated circuits. According to

¹⁰Advisory opinions, which are issued by Commerce and authorize entities as validated end-users, also specify activities that on-site reviews may include. Commerce has deemed advisory opinions to be protected under section 12(c) of the Export Administration Act, as amended. Consequently, the information contained in the advisory opinions is prohibited from disclosure absent a determination by appropriate authorities that release of the information is in the national interest. *See* 50 App. U.S.C. § 2411 (c).

Semiconductor Equipment and Materials International (SEMI), the \$86 billion global semiconductor manufacturing equipment and materials industry provides the equipment necessary for a \$256 billion semiconductor manufacturing industry (see fig. 1). This industry in turn produces the computer chips needed by many other industries, including a \$1.6 trillion electronics industry. Semiconductors are devices that enable computers and other products such as cell phones to process and store information. Producing semiconductors is a multistep sequence of photographic and chemical processes during which electronic circuits are gradually created on a wafer made of pure semiconducting material, most commonly silicon. For example, the equipment used to manufacture semiconductors performs tasks such as depositing a thin chemical film on wafers, and selectively removing the film by etching it away, creating microscopic transistors.¹¹

¹¹Manufacturing semiconductors involves four main processes: deposition, photolithography, etch, and implantation. Deposition equipment is used to lay a thin chemical film on a semiconducting material, such as silicon; photolithography equipment is used together with a “mask” to selectively expose film to a light source; etch equipment removes the material not protected by the light source; and implantation equipment is used to add conductivity to certain parts of the semiconductor.

Figure 1: End Markets for Semiconductor Equipment and Materials



Sources: Semiconductor Industry Association, Semiconductor Equipment and Materials International, and Henderson Ventures, March 2008.

The technological complexity of semiconductors is indicated by the feature size (the density of the etched lines) on the wafer. Smaller feature sizes measured in nanometers allow for more components to be integrated on a single semiconductor, thus creating more powerful semiconductors. Each reduction in feature size—for example, from 90 nanometers to 65 nanometers—is considered a move to a greater level of technological sophistication, or a move to the next “generation” of manufacturing technology.

Consistent with multilateral export controls, the U.S. government classifies semiconductor manufacturing equipment and materials as dual-use items because they have both commercial and military uses. Under the authority

granted in the Export Administration Act of 1979,¹² Commerce's Bureau of Industry and Security (BIS) administers export controls for dual-use items through the requirements contained in the Export Administration Regulations (EAR).¹³ Under these regulations, exporters are to either obtain prior government authorization from BIS in the form of a license, general authorization, or license exception, or determine that a license is not needed before exporting dual-use items.¹⁴ The EAR establishes a framework for regulating the export of dual-use items by identifying the characteristics and capabilities of items that may require export licenses. These characteristics and capabilities are contained in the Commerce Control List, which provides detailed specifications for about 2,400 dual-use items, divided into 10 categories (see app. II for a list of the 10 categories). Each category is subdivided into five groups designated by letters A through E (see app. II for a list of the five groups). For example, semiconductors and semiconductor manufacturing equipment and materials fall under Category 3 (electronics), with manufacturing equipment placed in Category 3B (test, inspections, and production equipment) and materials placed in Category 3C (materials).

Exports of semiconductor manufacturing equipment and materials to China are primarily controlled for national security and antiterrorism reasons.¹⁵ Appendix III describes the specific equipment and materials that require a license for export to China. For these items, the overall policy of the United States is to approve exports for civilian end uses but generally to deny exports that will make a direct and significant contribution to Chinese military capabilities.

Semiconductor manufacturing equipment and materials, as well as other sensitive dual-use items, also are controlled under the multilateral

¹²50 U.S.C. App. §§ 2401-2420. The Export Administration Act is not permanent legislation. Authority granted under the act lapsed in August 2001. However, Executive Order 13222, Continuation of Export Control Regulations, which was issued in August 2001, and extended most recently by Presidential Notice on July 23, 2008, under the authority provided by the International Emergency Economic Powers Act (50 U.S.C. §§1701 et seq.), continues the controls established under the act and the implementing EAR. *See* 73 Fed. Reg. 43603 (July 25, 2008).

¹³15 C.F.R. parts 730-774.

¹⁴BIS controls exports of dual-use and civilian commodities, which are collectively referred to as "items" in this report. *See* 15 C.F.R. § 730.3.

¹⁵*See* 15 C.F.R. Supplement No. 1 to Part 774 and 15 C.F.R. § 742.4.

Wassenaar Arrangement.¹⁶ Forty countries are signatories to the arrangement, including Germany, Japan, The Netherlands, and the United States. Formed in 1996, the Wassenaar Arrangement succeeded the Coordinating Committee for Multilateral Export Controls.¹⁷ Most advanced semiconductor equipment and materials are included on the Wassenaar Arrangement’s Basic List, which controls items that are “major or key elements for indigenous production, use, or enhancement of military capabilities.” One type of equipment, metal organic chemical vapor deposition (MOCVD) reactors, which may be used to produce radiation-hardened electronics for use in commercial and military applications, is included on the Wassenaar Arrangement’s Sensitive List.¹⁸ No semiconductor equipment or materials are included on Wassenaar’s Very Sensitive List. One of the arrangement’s principal goals is to prevent “destabilizing accumulations” of advanced dual-use items and technologies through the reporting of export information by its members. The Wassenaar Arrangement lacks a “no undercut” rule, under which a member would agree not to permit the export of any listed item or items that had been officially denied an export license by another member. Rather than having a no undercut rule, Wassenaar members exchange information on denied transactions as the sole means of trying to achieve its goals. Although the United States may not authorize a license for a specific piece of semiconductor manufacturing equipment to China, other Wassenaar members are not restricted from selling that same item themselves.

¹⁶The Wassenaar Arrangement is one of four principal multilateral export control regimes. The others are the Australia Group, which focuses on trade in chemical and biological items; the Missile Technology Control Regime; and the Nuclear Suppliers Group. The United States is a member of all four regimes.

¹⁷The Coordinating Committee for Multilateral Export Controls was established early in the Cold War and included all NATO countries except Iceland, plus Japan and Australia. Members agreed not to export specified, listed dual-use items and technologies to Soviet bloc countries and China and to obtain unanimous preapproval for any nonprohibited exports.

¹⁸The Wassenaar Arrangement controls dual-use items on one or more of three lists: the Dual-Use List (commonly referred to as the Wassenaar Basic List), Sensitive List, and Very Sensitive List. Wassenaar Arrangement Sensitive List items are items from the Basic List, which are key elements directly related to the indigenous development, production, use, or enhancement of advanced conventional military capabilities whose proliferation would significantly undermine the objectives of Wassenaar. The Very Sensitive List includes items from the Sensitive List that are key elements essential for the indigenous development, production, use, or enhancement of the most advanced conventional military capabilities whose proliferation would significantly undermine the objectives of the Wassenaar Arrangement.

China's Semiconductor Manufacturing Capability Has Steadily Advanced

Since 2002, China's ability to produce commercial semiconductors has steadily advanced but remains approximately one generation behind the United States. As of July 2008, China's most advanced semiconductor manufacturing company can produce integrated circuits with a feature size of 65 nanometers, compared with U.S. companies that are producing semiconductors with 45-nanometer feature sizes. China's ability to produce advanced integrated circuits continues to depend on whether it can obtain equipment, manufacturing technology, and materials from other countries. However, China has begun developing an indigenous capacity to build some types of advanced semiconductor manufacturing equipment, which may enable it to reduce its dependence on some foreign-sourced equipment. Lastly, China also can obtain semiconductor manufacturing equipment on the used market. Although this equipment cannot be used for state-of-the-art production, it nonetheless contributes to China's production capacity.

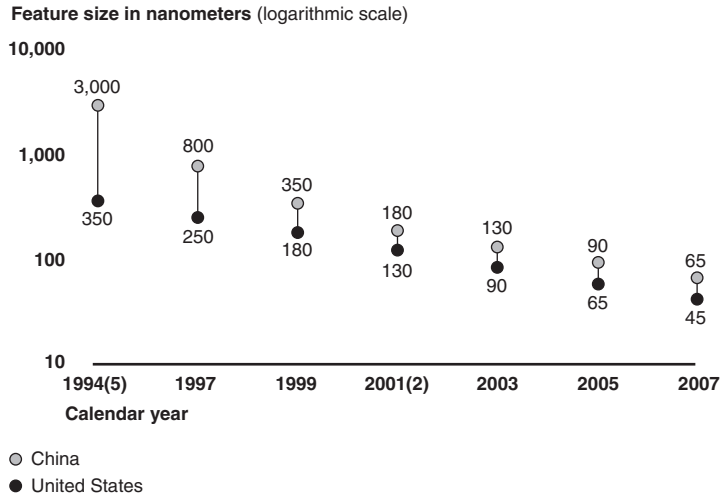
U.S. and Chinese Manufacturing Capabilities Continue to Advance

In 2002, we reported that, between 1986 and 2001, China had narrowed its technology gap from a span of five generations (or 10 years) behind U.S. commercial state-of-the-art production to approximately one generation (1 to 2 years).¹⁹ Since 2002, commercial state-of-the-art production has continued to advance. Companies in the United States now produce integrated circuits with a feature size of 45 nanometers, while the most advanced company in China is producing integrated circuits with a feature size of 65 nanometers—approximately one generation apart. Companies in China produce different types of integrated circuits, including microprocessors and various types of memory. Figure 2 shows the advances made by companies in the United States and China from 1994 through 2007.

¹⁹In 2001, U.S. commercial state-of-the-art production was considered 130 nanometers, whereas China produced semiconductors with a feature size of 180 nanometers.

Figure 2: U.S. and Chinese Semiconductor Manufacturing Capability, 1994 through 2007

A semiconductor's feature size, or the size of the components on a semiconductor, is measured in nanometers and is used to define the current level of technology. Each reduction in feature size—for example, from 65 to 45 nanometers—is considered a move to a new generation of technology.



Source: GAO analysis of data provided by Semiconductor Manufacturing International Corporation and other semiconductor manufacturing facilities in China, Intel Corporation, and the International Technology Roadmap for Semiconductors.

Note: We use a logarithmic scale on the y-axis to best illustrate changes in U.S. and Chinese semiconductor capabilities from 1994 through 2007.

Although companies in China are capable of producing near-state-of-the-art commercial integrated circuits, they mainly produce integrated circuits that are several generations old and are used for internal consumption in China's consumer electronics industry. These integrated circuits are used in products such as cell phones, TVs, DVD players, and personal computers. In 2006, SEMI estimated that 82 percent of China's production capacity produces integrated circuits that are four to seven generations (ranging from 500 to 180 nanometers) behind state-of-the-art manufacturing, and approximately 7 percent of integrated circuits produced are one or less generations (90 nanometers and below) behind current state-of-the-art capabilities.

China Still Relies on Imports of Foreign Equipment, Materials, and Partnerships with Foreign Entities to Fuel Technology Advances

Commercial Chinese semiconductor manufacturing companies are still largely dependent on foreign sources of equipment and materials to fuel technology advances. Currently, European, Japanese, and U.S. companies are the leading suppliers of semiconductor manufacturing equipment for facilities producing advanced integrated circuits. Additionally, to advance

its technological capacity, China has partnered with foreign companies or created incentives for foreign companies to locate to China.

China continues to rely on imports of semiconductor manufacturing equipment from Europe, Japan, and the United States for production of advanced integrated circuits. The demand is being driven by several advanced integrated circuit manufacturers, including Semiconductor Manufacturing International Corporation (SMIC), Hua Hong NEC, and Hynix-ST. In 2006, spending in China on semiconductor equipment from foreign sources was approximately \$1.6 billion, according to SEMI.²⁰ This accounted for nearly 97 percent of the value of all equipment purchases from foreign and domestic sources. China also relies on foreign material imports, including gases and chemicals, to manufacture semiconductors. Although China produces these items, according to industry experts, it does not produce them in sufficient quantity or quality to meet its domestic demand. As China increases its integrated circuit production capacity, its materials consumption also grows, increasing its reliance on imported materials.

China also relies on partnerships with foreign companies to fuel its technology developments. Through joint ventures or incentive programs to encourage international companies to locate to China, China has gained access to more advanced technology than it previously had or could produce on its own. In 2002, we reported that five of China's eight newest major integrated circuit manufacturing facilities were established through joint ventures and the other three were wholly owned foreign companies. One of the five facilities, a semiconductor manufacturing facility owned by Motorola, a wholly owned U.S. company, was sold to SMIC in 2003. The foreign-owned and publicly traded SMIC is the largest and most advanced integrated circuit company in China. China has continued to acquire advanced technology through partnerships. For example, SMIC obtained advanced manufacturing know-how on the production of integrated circuits specifically for memory through a cooperative arrangement with a German company, Infineon, in 2006. Moreover, in December 2007, SMIC obtained a license from IBM, a U.S.-based company, to use its 45-nanometer manufacturing technology in the production of integrated

²⁰This total includes only semiconductor equipment purchased for use in "front-end" manufacturing.

circuits for mobile applications such as cell phones.²¹ Likewise, HynixST, another new facility in China established in 2006, which is a joint venture between Korea's Hynix and Switzerland's STMicroelectronics, also provided China with advanced commercial integrated circuit memory technology.

China Is Developing Domestic Capacity to Build Some Types of Semiconductor Manufacturing Equipment

China is developing the domestic capability to build some types of semiconductor manufacturing equipment, which might eventually reduce its dependence on foreign-sourced equipment. Currently, China has more than 50 companies that produce equipment for semiconductor manufacturing, 2 of which, Advanced Micro-Fabrication Equipment and North Microelectronics, produce equipment to manufacture advanced integrated circuits, according to SEMI. Equipment made by these companies is found in some of China's most advanced fabrication facilities such as SMIC, although the equipment is being tested still and is not being used to manufacture integrated circuits for commercial purposes. Chinese-made equipment constitutes a small but growing share of domestic equipment purchases. In 2006, SEMI estimates that semiconductor manufacturers in China purchased \$56 million in domestically produced equipment, about 3 percent of all equipment purchases by Chinese manufacturers, but more than double the value of domestic equipment purchases made in 2003.

Despite recent advances, China cannot domestically produce all of the equipment needed to manufacture advanced semiconductors. For example, China lacks a domestic source of lithography equipment, which is used to imprint circuits on semiconductor materials and is necessary to advance reductions in feature size. The United States also lacks a domestic source of state-of-the-art lithography equipment. The last remaining competitive U.S. manufacturer, Silicon Valley Group, was sold to a Dutch company in 2001. Japan and The Netherlands are currently the global leaders in the manufacture of lithography equipment.

²¹Although SMIC obtained the manufacturing technology from IBM to produce at 45 nanometers, it is currently producing at 65 nanometers and does not expect to begin commercial production at 45 nanometers until 2009.

China's Purchases of Used Equipment Expand Its Production Capacity

China is able to expand its capacity for manufacturing integrated circuits through used semiconductor manufacturing equipment purchases. Although purchases of used equipment do not enhance China's ability to produce advanced integrated circuits, they do provide China with an ongoing source of equipment to expand its production capacity. Additionally, used equipment may enable the production of integrated circuits for China's military since military systems generally are designed around older technology, not state-of-the-art semiconductors. For instance, we reported in 2002 that China's most sophisticated production facilities, although about 2 years behind U.S. state of the art, were nonetheless capable of producing integrated circuits that were more advanced than those used in some of the most advanced U.S. weapons. Both U.S. and Chinese production capabilities have advanced since 2002, but the same paradigm—military systems generally are designed around older technology—still exists. Thus, China's ability to manufacture less sophisticated chips through purchases of used equipment potentially enhances its military capabilities.

Commerce's VEU Program in China Marks a Shift toward an End-User-Based System of Export Controls for Semiconductor Equipment and Materials

Before the introduction of the VEU program, export licenses provided the only mechanism by which U.S. companies could ship most advanced semiconductor manufacturing equipment and materials to China.²² Export licenses are assessed individually by an interagency team based on such factors as the item, its intended end use, and the end-user. A license also may contain conditions, including the requirement for postshipment verification, to ensure the item is used as intended. The VEU program, introduced in June 2007, marks a shift toward a more end-user-based system of export controls by allowing select, pre-screened Chinese entities to receive certain controlled items, including semiconductor manufacturing equipment and materials, without a license. The program established recordkeeping requirements to provide assurance that items exported under the VEU program are being used as intended, and recipients must agree to host *discretionary* on-site reviews by U.S. government personnel.²³

²²Export licenses cover all controlled items exported to China, not exclusively semiconductor manufacturing equipment and materials. See 15 C.F.R. Supplement No. 1 to Part 774 and Supplement No. 1 to Part 738.

²³15 C.F.R. § 748.15.

Export Licenses Provided the Only Means to Export Advanced Semiconductor Equipment and Materials to China before Introduction of the VEU Program

Before Commerce introduced the VEU program in 2007, export licenses provided the only means for U.S. companies to export most advanced semiconductor equipment and materials to China.²⁴ An export license authorizes the export, reexport, or transfer of a specific item or items to a specified recipient.²⁵ Commerce administers the export licensing system for dual-use exports, including semiconductor equipment and materials, with input from DOD, State, and DOE.²⁶ Each agency makes a recommendation to approve, deny, or return a license application without action.²⁷ Disagreements over the disposition of a license are resolved through a dispute resolution process.²⁸ The intelligence community can provide information to the interagency review team on prospective end-users, although they do not make licensing recommendations.

Interagency reviewers consider a number of factors in evaluating export license applications for semiconductor equipment and materials to China, including the type and quantity of items to be shipped, the end-user and stated end use, and foreign availability. To establish the identity and reliability of prospective recipients, reviewing agencies may request that Commerce check the “bona fides” of the recipient of the technology prior

²⁴Some lower-level semiconductor manufacturing equipment does not require a license to China because it is widely available from sources outside the Wassenaar Arrangement, including the used equipment market and several companies based in China. There also is a license exception for the export of some deposition equipment to China, provided that the equipment will be used for civilian end uses.

²⁵Licenses include both Individual Validated Licenses (IVL) and Special Comprehensive Licenses (SCL). IVLs are valid for a specific transaction between a U.S. exporter and a single entity. SCLs authorize a series of transactions between a U.S. exporter and one or more entities overseas.

²⁶An agency may delegate its reviewing authority to Commerce for licenses it chooses not to review.

²⁷Licenses may be returned without action if an applicant requests it, an export license is not required, BIS has not received adequate information about the transaction, or BIS is unable to contact the exporter to obtain additional information.

²⁸An Operating Committee (OC) of the Advisory Committee on Export Control Policy (ACEP) reviews any license for which the reviewing agencies are not in agreement, and the OC Chair makes a decision based on agency recommendations and statutory licensing standards. If an agency disagrees with the position of the OC Chair, it can request that the application be escalated to the ACEP. Decision making in the ACEP is by majority vote. If there is disagreement over the ACEP decision, an agency may further escalate the application to the Cabinet-level Export Administration Review Board. Decision making is again by majority vote. Further disagreements are escalated to the President.

to shipment, also known as a prelicense check. They also may condition approval of a license on the exporter or end-user meeting certain conditions. For instance, a license condition might specify how an item should be used or require that Commerce conduct a postshipment verification check on the recipient of the item.²⁹

The VEU Program Allows Export of Some Semiconductor Equipment and Materials to China without a License

The VEU program, announced by Commerce in June 2007, marks a shift to a more end-user-based system of export controls for semiconductor equipment and materials by allowing the export of some items to China without a license. The VEU program operates in parallel to the existing export control framework and is designed for “trusted” Chinese companies with a long licensing history and a record of using U.S.-controlled items for civilian end uses. Among the first five companies certified as validated end-users in October 2007, three are authorized to receive semiconductor equipment or materials.³⁰

Prospective validated end-users, or others applying on their behalf, must submit an application to Commerce that includes, among other things, a list of items they wish to receive under the VEU authorization, the locations where these items will be received, and a commitment to accept on-site visits by U.S. government personnel.³¹ In evaluating applications, Commerce conducts a four-part internal review that includes:

- *Compliance.* Verifies whether the applicant has met all the regulatory requirements specified in the EAR, confirms the applicant’s ownership and organizational structure, reviews the candidate’s licensing and compliance history, and assesses the candidate’s proposed compliance plan.
- *Enforcement.* Confirms whether information presented in the candidate’s application materials is consistent with its licensing and

²⁹Licensing officers may select from a number of standard license conditions, or they may create new, “customized” conditions within the limits of the EAR.

³⁰The three companies authorized to receive semiconductor equipment or materials include Applied Materials China, Ltd., Semiconductor Manufacturing International Corporation, and Shanghai Hua Hong NEC Electronics Company, Ltd. Two other companies, BHA Aerocomposite Parts Co., Ltd., and National Semiconductor Corporation, were authorized to receive other items. See 15 C.F.R. Supplement No. 7 to Part 748.

³¹See 15 C.F.R. § 748.15 and Supplement No. 8 to Part 748.

enforcement history and whether there is any adverse enforcement information on the applicant.

- *Item and end use.* Analyzes the items requested by the applicant and their appropriateness given the stated end use and the company's business activities.
- *Intelligence.* Vets parties to the application through the intelligence community.

Once Commerce's internal review has been completed, applications are reviewed by an End-User Review Committee (ERC), which is comprised of representatives from the Departments of Defense, Energy, and State (generally the same agencies that review export license applications), and other agencies as appropriate. In reviewing an end-user for eligibility, the ERC considers a range of factors, such as the entity's exclusive engagement in civil end-use activities, its record of compliance with U.S. export controls, its ability to meet the VEU program's recordkeeping requirements, its relationship with U.S. and foreign companies, and its willingness to host on-site reviews by U.S. government personnel to ensure program compliance. According to a Commerce official, applicants need to demonstrate that they either have or will have the requisite controls and data collection systems in place to ensure compliance with the terms of the VEU program. Such controls would provide Commerce with a high degree of confidence that on-site reviews will yield useful information. Validated end-users should also have systems in place to demonstrate that items imported under the VEU program are used for civilian purposes. For example, validated end-users may have systems in place that are capable of tracking customer orders so that Commerce can verify customer lists during on-site reviews. Commerce allows VEU applicants the flexibility to determine how they will demonstrate that they are capable of meeting these internal control and recordkeeping requirements.

If necessary, the ERC also may request a preapproval visit to assess an entity's suitability for validated end-user status. According to officials from Commerce, no preapproval visits were conducted for the first five Chinese entities approved for validated end-user status because members of the ERC were already familiar with the companies through their extensive licensing history. A unanimous vote is required by the ERC to approve

validated end-user status or add items to an existing authorization.³² Revocation of an authorization or removal of items from an existing authorization is by majority rule. Disagreements among agencies on the ERC are managed through a dispute resolution process similar to the procedures used for export license applications. For a comparison of the similarities and differences between a license and the VEU authorization, see appendix IV.

The Individual Licensing System and VEU Program Use Different Approaches to Ensure That Equipment Exported to China Is Used as Intended

The individual licensing system and VEU program employ different approaches to ensure that U.S. exports of semiconductor equipment and materials to China are used as intended. Under the individual licensing system, Commerce scrutinizes each individual application for the appropriateness of the item and the end-user, often attaches conditions to the license stipulating how an item may be used, and conducts postshipment verification (PSV) checks. Under the VEU program, Commerce ensures that items are used as intended by vetting validated end-users, stipulating conditions to approved entities, and confirming compliance with these conditions through periodic records checks and discretionary on-site reviews.

Under the individual licensing system, most licenses for semiconductor manufacturing equipment are issued with conditions that require the recipient to abide by certain requirements. For example, a license authorizing the export of semiconductor manufacturing equipment to a Chinese entity might restrict the equipment to civilian end-uses or prohibit the equipment from being used to produce integrated circuits with components smaller than a certain feature size. Because U.S. exporters are the licensees under this system, they are required to communicate the specific license conditions to Chinese recipients or other parties to whom the conditions may apply.

To verify compliance with license conditions and prevent the diversion of equipment and materials to unauthorized end-users, the United States also conducts PSV checks on a case-by-case basis in China. According to Commerce officials, several criteria are used to determine which entities will be subject to PSVs, including information on the exporter and end-user,

³²15 C.F.R. Supplement No. 9 to Part 748.

the sensitivity of the item, and the quantities in question.³³ During PSV checks, Commerce special agents or other U.S. government personnel visit importers or end-users to confirm the use and location of the items listed on the license. Commerce's PSV guidelines require that the agent physically inspect the items or the records that detail their disposition, verify that the items are located at the specified facility, and confirm that the equipment is being used for the purposes stated on the license. Agents also are instructed to document cases where there are indications of impropriety or whether the company's answers to questions are evasive.

Before 2004, the United States was able to conduct only a limited number of PSV checks on semiconductor equipment and materials in China because the Chinese government restricted the number and scope of PSV checks that it would allow. In 2004, the United States and China signed an EUVU that established protocols for PSV checks and expanded the number of checks that the United States would be allowed to conduct. Nevertheless, PSV checks on semiconductor equipment and materials in China remain limited. From fiscal years 2002 through 2007, Commerce approved 1,466 licenses for the export of semiconductor equipment and materials to China. Nine hundred-three, or about 62 percent, of these licenses contained a condition requiring Commerce to conduct a PSV check. Commerce restricted GAO from reporting the number of PSV checks conducted in China overall and for semiconductor equipment and materials in China, for the purposes of this report. Although this information has previously been available in public sources, Commerce asserted that publicly disclosing this data would give export violators or potential violators, both in the United States and abroad, sensitive information, including information revealing Commerce's focus within particular countries and on the kinds of items it checks most often.

In contrast, under the VEU program, Commerce intends to ensure that semiconductor equipment and materials are used as intended by requiring that validated end-users maintain a record of transactions, conducting periodic reviews of recorded exports under the VEU authorization, and undertaking *discretionary* on-site reviews to verify compliance with the terms of the program. Unlike individual export licenses, validated end-user

³³In fiscal year 2007, Commerce initiated a new process used to help select entities for PSV checks that scores export license applications according to several criteria, such as the parties to the transaction, the items, and the countries involved. However, Commerce officials noted that the result of this process is not the sole determinant of which entities it decides to inspect.

status is awarded directly to entities in China, and these entities are responsible for meeting the program's requirements. The EAR requires that all validated end-users legally certify that items obtained under the VEU program will be used only at approved facilities and exclusively for civilian end-uses.³⁴ Furthermore, the advisory opinions issued by Commerce to each validated end-user stipulate additional requirements that are similar to license conditions.³⁵ For example, advisory opinions may detail specific recordkeeping, reporting, and customer screening requirements, or restrict the type and technical parameters of semiconductors that can be manufactured using equipment or materials shipped under the authorization.

To ensure compliance with the terms of the VEU program as outlined in the EAR and individual advisory opinions, the Commerce official responsible for the VEU program stated that the department is already conducting or plans to conduct three layers of reviews. First, Commerce is conducting mandatory, semiannual reviews of each validated end-user. The information for the review is obtained from a variety of sources including public data, mandatory reporting by the validated end-user, and assessments provided by the intelligence community and BIS's enforcement unit. Second, Commerce is conducting an additional review of each validated end-user 6 months after it receives its first shipment under the VEU program and for every 6 months going forward. This review includes the same elements as the first review, but also includes an examination of data obtained from the Census Bureau's Automated Export System and U.S. exporters on transactions under the VEU authorization.³⁶ Third, based on the results of these two reviews, the ERC may decide to conduct an on-site review with the validated end-user. According to Commerce, the procedures for on-site reviews will be determined on a case-by-case basis, as dictated by the specific circumstances of the validated end-user.

³⁴15 C.F.R. Supplement No. 8 to Part 748.

³⁵Advisory opinions are the method by which Commerce communicates specific, unique requirements to the validated end-user.

³⁶The Automated Export System is the system administered by the U.S. Census Bureau that is used by U.S. exporters to electronically declare their international exports to U.S. Customs and Border Protection. BIS has a memorandum of understanding with the Census Bureau to receive regular data extracts from the Automated Export System that provide information on licensed exports and exports under the VEU program.

Challenges with VEU Program Implementation May Limit Commerce's Ability to Ensure That Semiconductor Equipment and Materials Are Used as Intended

The VEU program has yet to produce the advantages anticipated by Commerce, and challenges with program implementation may limit Commerce's ability to ensure that items shipped under the program are being used as intended. Commerce has yet to realize trade gains and enhanced national security because few U.S. exporters have taken advantage of the VEU program. Moreover, Commerce has not reached a VEU-specific agreement with the Chinese government for conducting on-site reviews of validated end-users, a key mechanism for ensuring program compliance. Instead, as a stopgap measure, Commerce is attempting to conduct VEU on-site reviews under a 2004 agreement. Commerce also lacks procedures for selecting and conducting on-site reviews, though it introduced the VEU program in June 2007.

Anticipated Advantages Have Not Yet Been Fully Realized Due to Limited Use of the VEU Program

Commerce anticipated that one of the advantages of the VEU program is that it would facilitate trade in controlled items to China by removing licensing requirements for the export of certain items to "trusted" Chinese customers with a history of using exports responsibly. According to Commerce, the program would foster trade by reducing the administrative burden associated with seeking an export license for U.S. exporters and enabling validated end-users to obtain items more easily than their domestic competitors. Two companies that received validated end-user authorization stated that the program facilitates long-term planning by eliminating some of the uncertainties associated with obtaining an export license from the U.S. government and other administrative requirements. Additionally, the program allows validated end-users to obtain certain equipment from U.S. companies without having to rely on the exporter to obtain a license, according to a validated end-user.

Commerce also anticipated that the VEU program would reduce the volume of licenses required for transactions involving known end-users. In turn, this would enable Commerce to dedicate more resources to transactions and end-users that are less well known, and thus enhance security. However, according to the Director of Commerce's Office of Technology Evaluation, the department has a finite amount of resources and an increasing number of export licenses to process from year to year. Thus, he noted that it is unclear whether a potential reduction in licensing volume resulting from increased shipments under the VEU program would allow Commerce to increase scrutiny over lesser-known end-users or merely enable Commerce to maintain current levels of oversight. In addition, although Commerce anticipated that one of the program's

benefits would be to increase scrutiny over lesser known end-users, according to the Chairperson of the ERC, it was unclear whether increased shipments under the VEU program would coincide with additional PSV checks for end-users that receive items under individual export licenses due to the multiple considerations involved in scheduling and carrying out PSV checks.

The advantages of the VEU program anticipated by Commerce have not yet been realized because few U.S. exporters have shipped items to China under the authorization. Commerce's ability to realize the anticipated benefits of the VEU program hinges on whether or not exporters choose to use the VEU authorization rather than an individual license. Recognizing the high volume and dollar value of U.S. exports to certain companies in China, Commerce designed the VEU program with the goal of reducing the number of licenses to these types of companies. For instance, according to Commerce, the first five companies designated as validated end-users accounted for 18 percent of the value of licensed trade with China in 2006. Commerce anticipates that approval of a second set of five companies could increase that number to 40 percent. However, as of June 2008, only one of the three validated end-users authorized to receive semiconductor equipment and materials had received any items under the program. Furthermore, according to Commerce, since the first validated end-users were authorized in October 2007, approximately 6 percent of the total exports of semiconductor manufacturing equipment to China have taken place under the VEU program, whereas 94 percent were conducted under an export license. In addition, according to the Chairperson of the ERC, since the VEU program was authorized, three licenses were issued for items that could have been shipped under the VEU program.

Company officials that received validated end-user status offered several reasons for not yet fully using the authorization. One company official stated that they were upgrading their administrative systems and planned to switch from their Special Comprehensive License to the VEU program in the fall of 2008. Another validated end-user cited a global economic slowdown in their industry as a reason for not taking advantage of the VEU program. Finally, another company official with validated end-user status noted that some of its suppliers have elected to use existing individual or special comprehensive licenses to avoid the administrative burden and time requirements associated with obtaining an additional End-User

Statement³⁷ from the Chinese government, as recently requested by Commerce. The EAR does not require that validated end-users obtain End-User Statements for shipments received under the authorization.³⁸ However, in April 2008, Commerce requested that the first five validated end-users seek End-User Statements from the Chinese government to facilitate on-site reviews.

Challenges with VEU Implementation May Limit Commerce's Ability to Conduct On-site Reviews

Commerce may not be able to ensure that semiconductor equipment and materials exported to China are used as intended because it has not negotiated a VEU-specific agreement with the Chinese government for conducting on-site reviews under the VEU program and lacks specific procedures for carrying out these reviews. On-site reviews are not a mandatory program requirement; rather, they are *discretionary* based on an assessment of each validated end-user by the ERC. Commerce has stated though that on-site reviews are a key mechanism for ensuring that validated end-users comply with the terms of the authorization and that the ability to conduct meaningful on-site reviews will be a critical factor in Commerce's long-term support of the program.

However, Commerce may be limited in its ability to conduct on-site reviews of validated end-users because it has not negotiated a VEU-specific agreement with the Chinese government for conducting these reviews. In October 2007, the Chinese Ministry of Commerce announced that Chinese entities were prohibited from hosting foreign governments, including the U.S. government, for interviews or investigations related to export controls without its permission. The Chinese government has also asked that Commerce refrain from approving any new, additional validated end-users until the two sides can agree on terms for conducting on-site reviews of validated end-users. A senior official from the Chinese Ministry of Commerce stated to us during a March 2008 meeting that the Ministry wants on-site reviews to be conducted either according to the terms of the 2004 EUVU, or under a newly negotiated U.S.-China agreement specific to the VEU program. In the absence of a new agreement specific to the VEU program, Commerce has requested to conduct one on-site review pursuant

³⁷The EAR requires exporters to obtain End-User Statements from the Chinese Ministry of Commerce for certain items requiring a license for export and valued above \$50,000 to facilitate U.S. government end-use checks. 15 C.F.R. § 748.10.

³⁸See 15 C.F.R. §748.10; 72 Fed. Reg. 33646, 33651.

to the terms of the 2004 EUVU as a stopgap measure. However, to conduct on-site reviews under the 2004 agreement, Commerce relies on the voluntary compliance of validated end-users to obtain End-User Statements from the Chinese Ministry of Commerce, as this requirement was not included in the regulations establishing the VEU program. According to Commerce, Chinese officials were receptive to its request for an on-site review, but MOFCOM and Commerce have agreed to postpone the check under the existing EUVU mechanism, as negotiations on the VEU-specific protocol are still in progress.

Commerce's ability to ensure that items shipped under the VEU program are being used as intended is further limited by a lack of procedures for selecting and conducting the on-site reviews. Commerce officials stated that criteria that could be considered for on-site review selection include the volume of items shipped, the geographic location of the validated end-user, the civil or military utility of the authorized items, foreign or U.S. company ownership, the facility's licensing history, and intelligence reporting. In April 2008, 10 months after Commerce approved the VEU program, draft procedures for selecting end-users for on-site reviews were disseminated to ERC members. However, as of September 2008, interagency agreement on these procedures had not been reached. Moreover, Commerce has not developed procedures for conducting on-site reviews. During our field work in March 2008 in China, Commerce's export control officer in Beijing noted that it was unclear how on-site reviews would be conducted because she was unaware of procedures governing them. Thus, even if the Chinese Ministry of Commerce grants permission to conduct an on-site review, it is unclear how the review would be conducted in the absence of any final procedures. Commerce asserted that it plans to develop on-site review procedures on a case-by-case basis to ensure that each on-site review is tailored to a particular validated end-user.

Agency Actions to Address Prior GAO Recommendations

We assessed progress that the Departments of Commerce and Defense have made to address the recommendations from our 2002 report. In 2002, we recommended that Commerce and DOD conduct a foreign availability assessment to determine if semiconductor equipment and materials of comparable quality are available in quantities that would render U.S. export controls on these items ineffective. We also recommended that Commerce and DOD assess the cumulative effects that exports of semiconductor equipment and materials to China have had on the U.S. economy and national security. Although Commerce and DOD have not formally assessed the foreign availability of semiconductor equipment and

materials, Commerce has taken some steps to meet the intent of our recommendation by using information on foreign availability to inform export controls and make licensing decisions for these items. Neither Commerce nor DOD has conducted assessments on the cumulative effect of U.S. semiconductor-related exports to China.

Commerce Evaluates Foreign Availability When Assessing Controls and Making Licensing Decisions

Commerce and DOD have not conducted a formal foreign availability assessment for semiconductor manufacturing equipment and materials, but Commerce does use the information on foreign availability that it obtains from other sources to inform export controls and licensing decisions for these items, and thus met the intent of our recommendation. Commerce stated that the key reason for not conducting a foreign availability assessment of semiconductor manufacturing equipment and materials is that semiconductor equipment manufacturers have not requested one. Commerce also noted that there is substantial public information on foreign availability of semiconductor manufacturing equipment and materials in China. In response to our prior recommendation, Commerce noted that, while the EAR allows the U.S. government to initiate a foreign availability assessment, this provision is intended primarily to be used by industry to challenge overly restrictive or ineffective export controls.

In recent years, semiconductor equipment manufacturers have not requested Commerce to conduct a foreign availability assessment because the assessments require a significant amount of effort, and previous efforts have not resulted in the decontrol of any equipment. For instance, SEMI indicated that it submitted, for the United States to discuss at Wassenaar, a number of proposals to decontrol items, which were unsuccessful. Furthermore, SEMI indicated that the scope of the issue regarding controls over semiconductor manufacturing equipment is too large for them to undertake without a serious commitment from the U.S. government.

Commerce has taken steps to address our 2002 recommendation, however, by evaluating foreign availability when assessing export controls and making licensing decisions related to semiconductor manufacturing equipment and materials. Information provided by a number of sources—

including technical advisory groups,³⁹ the public, and reviews of license applications—informs both export controls and licensing decisions. For example, Commerce receives information about foreign availability from its technical advisory committee and uses this information to develop proposals during multilateral discussions and for Commerce Control List reviews. The proposals could result in the addition or elimination of a control. For example, according to Commerce, a number of adjustments or liberalizations to controls for semiconductor manufacturing equipment and materials have occurred as a result of this input.

Commerce also seeks information regarding foreign availability from the public. For example, during the development of the China military end-use rule, Commerce originally planned to control 47 items. Commerce published a notice in the Federal Register seeking information, including whether or not the items they were seeking to control were available in foreign markets.⁴⁰ In response to the feedback it received and analysis it conducted, Commerce reduced the list of items controlled from 47 to 31.⁴¹ Included among the items were several types of lower-level semiconductor manufacturing equipment that Commerce determined were available from sources outside Wassenaar.

Commerce also noted that, as China has emerged as a significant semiconductor manufacturer over the past decade, U.S. export control officials have become knowledgeable about different “players” in China as well as the various sources of supply for controlled semiconductor manufacturing equipment. According to Commerce, officials incorporate this information into the licensing review process. Commerce also stated that a formal foreign availability study would reveal limited additional information that Commerce does not already have access to through existing sources.

³⁹Technical advisory committees are made up of industry representatives. Specifically, the Information Systems Technical Advisory Committee advises the Office of the Assistant Secretary for Export Administration on technical questions that affect the level of export controls applicable to information systems equipment and technology. Semiconductor manufacturing equipment is covered by this technical advisory committee.

⁴⁰See Revisions and Clarification of Export and Reexport Controls for the People’s Republic of China (PRC); New Authorization Validated End-User, 71 Fed. Reg. 38313 (July 6, 2006).

⁴¹The military end-use rule does not include restrictions on exports of semiconductor manufacturing equipment and materials that are only subject to unilateral U.S. controls. Exports of multilaterally controlled semiconductor manufacturing equipment and materials were not changed by the military end-use control.

We believe that Commerce's efforts are sufficient to address our 2002 recommendation. Although Commerce has not conducted a formal foreign availability study to determine whether there are comparable foreign sources of semiconductor equipment and materials, it has used other sources—including technical advisory committees, end-use visits, past licensing history, and the public—to obtain similar information. Provided that Commerce continues to be able to access this information, we do not believe that an additional foreign availability study is necessary at this time.

Commerce and DOD Have Not Conducted Studies on the Effects of Semiconductor Manufacturing Equipment Transfers to China

Neither Commerce nor DOD have addressed our recommendation to conduct assessments on the economic and security effects of U.S. semiconductor manufacturing equipment exports to China. In September 2006, Commerce established the Office of Technology Evaluation (OTE) to help gauge the effectiveness of U.S. export controls by conducting studies on the cumulative effects of transfer of certain key technologies, among other studies. In its Fiscal Year 2006 Annual Report, Commerce announced that it planned to conduct two studies related to the semiconductor and semiconductor manufacturing equipment industries. First, Commerce stated that it planned to conduct an industrial base assessment on U.S. integrated circuit design and manufacturing capability. According to the Director of OTE, Commerce has initiated this study, and it is nearing completion. Second, Commerce announced plans to conduct an evaluation of the health and competitiveness of U.S. industry engaged in developing critical semiconductor manufacturing equipment technology. However, OTE decided not to conduct the evaluation; according to the former Director of the Office of National Security and Technology Transfer Controls, BIS discussed the possible study with representatives from the semiconductor manufacturing equipment industry, and they collectively decided that it was not needed.

We also noted in 2002 that Directive 2040.2 required DOD to “assess annually the total effect of transfers of technology, goods, services, and munitions on U.S. security regardless of the transfer mechanisms involved.”⁴² However, the directive had not been updated since July 5, 1985, and no such studies had been completed since the issuance of the original directive. In July 2008, DOD released a revised “instruction” that addresses the need for cumulative effects studies but eliminates the specific

⁴²Department of Defense Directive Number 2040.2, sections 5.1.7 and 7.1.15, Jan. 17, 1984, reissued incorporating Change 1, July 5, 1985.

requirement to do a study and the annual requirement.⁴³ The instruction instead calls for the Director of the Defense Intelligence Agency to provide intelligence concerning the total effect of transfers of dual-use and defense-related technology, articles, and services on U.S. security. However, no such studies have been completed to date, and the impact of exports of semiconductor manufacturing equipment on U.S. national security thus remains unclear.

Conclusions

U.S. export control policy aims to balance two competing interests—promoting trade to civilian end-users and denying trade in sensitive technologies to end-users engaged in activities detrimental to national security interests. The migration of commercial semiconductor production to China and continued advances in China’s domestic manufacturing capabilities illustrate the challenges inherent in meeting these dual goals. Integrated circuits, for example, are not only inputs to consumer products but are often used in weapons systems. Although the VEU program is aimed at facilitating trade, Commerce built in various “safeguards” to ensure that items are used as intended and not to enhance military capabilities. Although the companies authorized under the VEU program have a long history of using exports responsibly, Commerce included a requirement for end-users to commit to accept on-site reviews to ensure that items are used as intended and indicated that the ability to conduct these reviews is a critical factor in its long-term support of the program.

Commerce, however, established the VEU program in June 2007 and authorized the first five companies in October 2007, without negotiating a VEU-specific agreement or amending the 2004 EUVU with China to conduct the reviews. Additionally, Commerce instituted the program without some basic mechanisms to ensure compliance with program requirements, including criteria for selecting on-site reviews and the procedures for conducting them. As a result, Commerce now relies on the EUVU procedures, which require an End-User Statement, burdening validated end-users and hindering trade facilitation. Additionally, if validated end-users do not voluntarily seek an End-User Statement, Commerce may not conduct on-site reviews and therefore will not be able to provide assurance that exported items are being used as intended.

⁴³Department of Defense Instruction Number 2040.02.

Recommendations

To better promote the Validated End-User program's objective of trade facilitation and enhanced oversight, the Secretary of Commerce should suspend the Validated End-User program to China until a VEU-specific agreement and procedures are established for on-site reviews. Specifically, Commerce should (1) negotiate a VEU-specific agreement with the Chinese government to conduct on-site reviews or amend the 2004 EUVU to include the Validated End-User program, and (2) develop procedures for conducting on-site reviews that are applicable to all validated end-users.

Agency Comments and Our Evaluation

We provided a draft of this report to the Departments of Commerce, Defense, Energy, and State for their review and comment. Commerce provided written comments, which are reprinted in appendix V. Defense and State did not provide comments. Commerce and Energy's National Nuclear Security Administration also provided technical comments, which we incorporated as appropriate throughout this report.

Commerce disagreed with our recommendations, stating that the report's premise—that the VEU program has no adequate mechanism to oversee exports of semiconductor equipment to China—is incorrect. Commerce stated that on-site reviews could be conducted under the 2004 EUVU or a VEU-specific addendum to the EUVU, which it is currently negotiating with the Chinese government.⁴⁴ Commerce also asserted that procedures for selecting on-site reviews exist, that general procedures for end-use checks are in place, and that specific guidance for on-site reviews must be developed on a case-by-case basis.

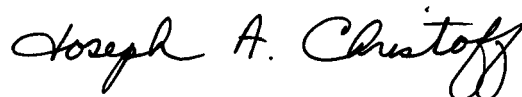
We have modified the report to acknowledge that Commerce intends to use a stopgap mechanism, the 2004 EUVU, which may enable it to conduct on-site reviews for items exported under the VEU program to China. However, this agreement requires companies to obtain an End-User Statement from the Chinese government. This statement is not required under the VEU program and thus imposes an additional burden on validated end-users, running counter to the trade-facilitating objectives of the program. To achieve the intended benefits of the VEU program, Commerce needs to negotiate a VEU-specific agreement or amend the 2004 EUVU to accommodate the distinct features of the VEU program. We disagree with Commerce's assertion that it has sufficient procedures for selecting on-site

⁴⁴The 2004 End Use Visit Understanding is a classified document.

reviews and conducting end-use checks. Commerce has consistently stated that on-site reviews for validated end-users and end-use checks for individual licenses are distinct activities serving different purposes. End-use checks focus on ensuring that an item is being used for the purposes stated in the license, whereas on-site reviews are more comprehensive. Additionally, the procedures for selecting validated end-users for on-site reviews are still in draft form as of September 2008, and have not been cleared by the interagency process as Commerce implied in its comments. Commerce would not provide us with a copy of these draft procedures. Finally, we agree that Commerce needs additional case-by-case guidance for on-site reviews to ensure that each review is tailored to the particular validated end-user. However, the department also needs general procedures to ensure that on-site reviews are conducted in a consistent manner.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no distribution until 30 days from the report date. At that time, we will send copies of this report to interested congressional committees. We will also make copies available to others upon request. In addition, this report will be available at no charge on the GAO Web site at <http://www.gao.gov>.

If you or your staffs have any questions about this report, please contact me at (202) 512-8979 or christoffj@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 major contributions to this report are listed in appendix VI.



Joseph A. Christoff
Director, International Affairs and Trade

Objectives, Scope, and Methodology

This report discusses the (1) evolution of China's semiconductor manufacturing capabilities since 2002, (2) changes to U.S. export control policies over the sale of semiconductor manufacturing equipment and materials to China since 2002, and (3) the advantages and limitations of these changes to U.S. export controls. In addition, this report describes progress the Departments of Commerce and Defense have made to address our prior recommendations.

To describe how China's semiconductor manufacturing capabilities have evolved since 2002, we reviewed available literature; interviewed government officials, industry representatives, and academics; and reviewed information from the U.S. and Chinese semiconductor and semiconductor equipment and materials industries. We also traveled to China and met with companies involved in manufacturing semiconductors. We met with officials from the U.S. Departments of Commerce (Commerce), Defense (DOD), Energy (DOE), and State (State), as well as members of the intelligence community. We also visited three DOE National Laboratories, including Lawrence Livermore in Livermore, California; Kansas City in Kansas City, Missouri; and Sandia in Albuquerque, New Mexico. We interviewed representatives from two U.S. semiconductor manufacturing companies—IBM and Intel. We met with officials from the Semiconductor Equipment and Materials International (SEMI) and Semiconductor Industry Association—the trade associations representing each industry—in San Jose, California; Washington, D.C.; and Shanghai, China. We also interviewed academics with expertise in China's semiconductor industry and semiconductor manufacturing at the University of Maryland's Center for Advanced Life Cycle Engineering and the University of California, Berkeley's Microfabrication Laboratory. We obtained trade reports on China's semiconductor and semiconductor manufacturing equipment industries from SEMI and met with the reports' authors in Shanghai, China, to discuss their methods and findings. We determined that the data collected and analyses conducted were sufficiently reliable for our use in this report. In addition, we visited three companies—Applied Materials China, Hua Hong NEC, and Semiconductor Manufacturing International Corporation—that are involved in manufacturing semiconductors in China and have received semiconductor manufacturing equipment and materials from U.S. exporters under export licenses and the Validated End-User authorization. We also attended SEMICON China—a semiconductor industry trade show with more than 900 U.S., Chinese, and other foreign companies represented. During SEMICON China, we met with an indigenous Chinese semiconductor equipment manufacturer, Advanced Micro-Fabrication Equipment, Inc.,

and obtained information from two other indigenous equipment manufacturers—Beijing Seven Star HuaChuang Electronics Company, Limited, and North Microelectronics Company, Limited.

To describe changes to U.S. policies and practices for the export of semiconductor equipment and materials to China since 2002, we reviewed the relevant statutes, regulations, Presidential and DOD Directives and DOD Instruction pertaining to export controls to China and interviewed officials from the Departments of Commerce, DOD, DOE, and State. We also interviewed representatives of semiconductor and semiconductor equipment companies—including Applied Materials, IBM and Intel in the United States, and Applied Materials China, Hua Hong NEC, and Semiconductor Manufacturing International Corporation in China—that received controlled items under U.S. export licenses and the Validated End-User authorization. We analyzed export licensing data provided by Commerce to describe the number of licenses approved for semiconductor equipment and materials to China, as well as the number of licenses containing the requirement to conduct postshipment verification (PSV) checks, from fiscal years 2002 through 2007. We determined that these data were sufficiently reliable for the purposes for which they are presented in this report. We also reviewed reports provided by Commerce on the number and outcomes of end-use checks, including prelicense and PSV checks in China. Although Commerce provided GAO with data on end-use checks, it restricted us from publicly reporting the number and outcomes of PSV checks conducted in China on shipments of semiconductor equipment and materials. According to Commerce, publicly disclosing this data would give export violators or potential violators, both in the United States and abroad, sensitive information, including information revealing Commerce’s Bureau of Information and Security’s (BIS) focus within particular countries and on the kinds of items the BIS checks most often.

To assess the advantages and limitations associated with changes to U.S. export control policies and practices, we reviewed the regulations, guidelines, and procedures governing export licenses and the VEU program. We also interviewed U.S. government officials in the United States and China, including Commerce’s export control officers in Beijing and Hong Kong responsible for conducting end-use checks. We interviewed representatives from Applied Materials China, Hua Hong NEC, and Semiconductor Manufacturing International Corporation, three of the five companies that received the validated end-user authorization and the only entities that are permitted to receive semiconductor equipment and

materials under the authorization. Additionally, we met with and interviewed officials from China's Ministry of Commerce in Beijing, China.

Finally, to determine whether or not DOD and Commerce addressed our 2002 recommendations to conduct assessments related to foreign availability and the cumulative effects of semiconductor manufacturing equipment exports on U.S. national security, we interviewed officials from both agencies, and reviewed regulations, directives, and an instruction, as well as documentation related to conducting these activities. We also discussed the topic of foreign availability with industry representatives including SEMI, Applied Materials, and Intel to ascertain if foreign availability continues to be a concern, as it was in 2002.

We conducted this performance audit from October 2007 to September 2008, 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.

Commerce Control List Categories and Groups

Table 1: Commerce Control List Categories

0	Nuclear materials, facilities, and equipment and miscellaneous
1	Materials, chemicals, "microorganisms," and toxins
2	Materials processing
3	Electronics
4	Computers
5	Telecommunications and information security
6	Lasers and sensors
7	Navigation and avionics
8	Marine
9	Propulsion systems, space vehicles, and related equipment

Source: 15 C.F.R. §738.2.

Table 2: Commerce Control List Groups

A	Equipment, assemblies, and components
B	Test, inspection, and production equipment
C	Materials
D	Software
E	Technology

Source: 15 C.F.R. §738.2.

Semiconductor Manufacturing Equipment and Materials Requiring an Export License to China

List number ^a	Description	National security significance	Primary supplier countries
<i>Semiconductor manufacturing equipment</i>			
3B001.a.1	Thin layer deposition equipment	Radiation-hardened electronics, space-qualified solar cells, high-power radio-frequency devices, infrared focal plane arrays	Japan, United States
3B001.a.2	MOCVD ^b	Radiation-hardened electronics, space-qualified solar cells, high-power radio-frequency devices, infrared focal plane arrays	Germany, United States
3B001.a.3	MBE ^c	Radiation-hardened electronics, space-qualified solar cells, high-power radio-frequency devices, infrared focal plane arrays	United Kingdom, United States
3B001.b	Ion implantation equipment	Used for radiation-hardened circuitry and state-of-the-art integrated circuits	Japan, United States
3B001.c	Plasma dry etching equipment	Needed for all state-of-the-art commercial and military electronics. Enables the production of controlled analog-to-digital converters (ADCs), field programmable logic devices (FPLDs), and application specific circuits (ASICs).	Japan, United States
3B001.d	Plasma enhanced chemical vapor deposition	Needed for all state-of-the-art commercial and military electronics. Enables the production of controlled analog-to-digital converters (ADCs), field programmable logic devices (FPLDs), and application specific circuits (ASICs).	Japan, United States
3B001.e	Cluster tool	Needed for all state-of-the-art commercial and military electronics. Enables the production of controlled analog-to-digital converters (ADCs), field programmable logic devices (FPLDs), and application specific circuits (ASICs).	Japan, United States
3B001.f.1	Photo-optical or X-ray lithography equipment	Needed for all state-of-the-art commercial and military electronics. Enables the production of controlled analog-to-digital converters (ADCs), field programmable logic devices (FPLDs), and application specific circuits (ASICs).	Japan, The Netherlands, United States
3B001.f.2	Imprint lithography systems	Needed for all state-of-the-art commercial and military electronics. Enables the production of controlled analog-to-digital converters (ADCs), field programmable logic devices (FPLDs), and application specific circuits (ASICs).	Japan, The Netherlands, United States
3B001.f.3	Mask lithography Equipment	Needed for all state-of-the-art commercial and military electronics. Enables the production of controlled analog-to-digital converters (ADCs), field programmable logic devices (FPLDs), and application specific circuits (ASICs).	Japan, Sweden, United States
3B001.g	Masks and reticles	Needed for all state-of-the-art commercial and military electronics. Enables the production of controlled analog-to-digital converters (ADCs), field programmable logic devices (FPLDs), and application specific circuits (ASICs).	Japan, United States
3B001.h	Multi-layer masks	Needed for all state-of-the-art commercial and military electronics. Enables the production of controlled analog-to-digital converters (ADCs), field programmable logic devices (FPLDs), and application specific circuits (ASICs).	Japan, United States

**Appendix III
Semiconductor Manufacturing Equipment
and Materials Requiring an Export License to
China**

(Continued From Previous Page)

List number^a	Description	National security significance	Primary supplier countries
3B001.i	Imprint lithography templates	Needed for all state-of-the-art commercial and military electronics. Enables the production of controlled analog-to-digital converters (ADCs), field programmable logic devices (FPLDs), and application specific circuits (ASICs).	Japan, United States
3B002.a	S-parameter testers	Needed for all state-of-the-art commercial and military electronics. Enables the production of controlled analog-to-digital converters (ADCs), field programmable logic devices (FPLDs), and application specific circuits (ASICs).	Japan, United States
3B002.c	Integrated circuit testers	Needed for all state-of-the-art commercial and military electronics. Enables the production of controlled analog-to-digital converters (ADCs), field programmable logic devices (FPLDs), and application specific circuits (ASICs).	Germany, Japan, United States
<i>Semiconductor manufacturing materials</i>			
3C001	Hetero-epitaxial materials	The products of MOCVD and MBE deposition used to make integrated circuits	Europe, Japan, Taiwan, United States
3C002	Resist materials	Needed for all state-of-the-art commercial and military electronics. Enable the production of controlled analog-to-digital converters (ADCs), field programmable logic devices (FPLDs), and application specific circuits (ASICs). These end items are controlled under the Export Administration Regulations in ECCN 3A001 and ECCN 3A101, or under the International Traffic in Arms Regulations Category XI.	Europe, Japan, United States
3C003	Organo-inorganic compounds	Gas sources for MOCVD	Europe, Japan, United States
3C004	Purified gases	Gas sources for MOCVD	Europe, Japan, United States
3C005	Silicon carbide wafers	High-power radio-frequency devices, power electronics	Europe, Japan, United States

Source: Department of Defense and the Commerce Control List.

^aCommerce Control List, Category Three – Electronics. 15 C.F.R. Supplement No. 1 to Part 774.

^bMOCVD - metal organic chemical vapor deposition reactors.

^cMBE – molecular beam epitaxy equipment.

Comparison of Individual and Special Comprehensive Licenses, and Validated End-User Authorization

	Individual Validated License (IVL)	Special Comprehensive License (SCL)	Validated End-User (VEU) Authorization
Recipient of license or authorization	Exporter	Exporter	End-User
Description	An export license authorizing a transaction or series of transactions between a single exporter and recipient.	An export license authorizing multiple exports and re-exports between a single exporter and recipient, without review and approval of each transaction.	An authorization that permits the export, re-export, and transfer to validated end-users of any eligible items that will be used in a specific, eligible destination.
Validity period	Generally 2 years.	4 years; may be extended for an additional 4 years.	VEU authorizations are valid in perpetuity unless revoked.
Review process	Representatives of the Departments of Commerce, Defense, State, and Energy review each license unless a reviewing agency has delegated its reviewing authority back to Commerce.	Same as IVL.	A committee of representatives from the Departments of State, Defense, Energy, Commerce, and other agencies, as appropriate, approves the VEU authorization.
Dispute resolution process	Yes, any agency that disagrees with a licensing decision may escalate a case.	Yes, any agency that disagrees with a licensing decision may escalate a case.	Yes, any agency that disagrees with a VEU authorization decision may escalate a case.
Factors considered in granting a license or validated end-user status ^a	For items controlled for national security reasons, type and quantity of the item; intended end-use of the item (military or civilian); foreign availability; and destination country.	Proposed end-use and end-users; past licensing history; evidence of continuous large volume of exports; and compliance with U.S. export controls.	Involvement only in civilian activities; previous compliance with U.S. export controls; agreement to "preapproval" visit and on-site reviews; and ability to comply with program requirements.
License conditions	Commerce may place conditions on the use of an IVL.	Commerce may place conditions on the use of an SCL.	Commerce may specify conditions on the use of VEU authorization.
Internal controls	Formal internal control program not required.	Internal control programs are required for the exporter and consignee.	Although a formal internal control plan is not required, the applicant must describe the system that is in place to ensure compliance with VEU requirements.

**Appendix IV
Comparison of Individual and Special
Comprehensive Licenses, and Validated End-
User Authorization**

(Continued From Previous Page)

	Individual Validated License (IVL)	Special Comprehensive License (SCL)	Validated End-User (VEU) Authorization
Recordkeeping and reporting requirements	<p>IVL holders generally are required to retain all records supporting their license applications for 5 years.</p> <p>IVL holders have no reporting requirements unless imposed by a particular license. However, the records of their exports are subject to inspection at Commerce's request.</p>	<p>SCLs include record-keeping requirements for SCL holders and consignees.</p> <p>SCL holders must report semi-annually exports of certain items controlled multilaterally under the Wassenaar Arrangement. In addition, the records of their exports are subject to inspection at Commerce's request.</p>	<p>Re-exporters are required to submit semi-annual reports to Commerce, and exports under the VEU program of certain items controlled multilaterally under the Wassenaar Arrangement must be reported semi-annually. Exporters and validated end-users are required to retain records but do not have reporting requirements unless otherwise specified by Commerce.</p>
End-use visits	<p>Yes, end-use visits may be conducted under a 2004 agreement between the United States and China.</p>	<p>Yes, end-use visits may be conducted under a 2004 agreement between the United States and China.</p>	<p>Validated end-users agree to host on-site reviews. Commerce plans to conduct these reviews under a 2004 agreement between the United States and China until an addendum to this agreement or a new, VEU-specific agreement is reached.</p>

Source: GAO analysis of information from the Export Administration Regulations.

^aNot all factors considered in granting a license or validated end-users are included here. Among the other factors considered in granting a license or VEU status are those included in 15 C.F.R. § 742.4(b)(3) (licenses for national security items), 15 C.F.R. § 758.2(d) (Special Comprehensive Licenses), and 15 C.F.R. § 748.15(a)(2) (Validated End-Users).

Comments from the Department of Commerce

Note: GAO comments supplementing those in the report text appear at the end of this appendix.



UNITED STATES DEPARTMENT OF COMMERCE
Assistant Secretary for Export Administration
Washington, D.C. 20230

September 5, 2008

Mr. Joseph Christoff
Director, International Affairs and Trade
Government Accountability Office
441 G Street, NW
Washington, D.C. 20548

Dear Mr. Christoff:

This is in response to your request for comments on the Government Accountability Office (GAO) report entitled Export Controls: Commerce Lacks the Ability to Ensure that Semiconductor Equipment Exported to China Is Used as Intended under the Validated End-User Program, GAO-08-1095. We appreciate the GAO's work in preparing the report and the opportunity to review this draft.

The fundamental premise of the report – that no adequate mechanism exists to provide oversight of exports of semiconductor equipment under the Validated End-User (VEU) Program – is incorrect. The report itself notes the Chinese view that reviews could be conducted under the existing 2004 End Use Visit Understanding (EUVU) or under a VEU-specific addendum to the EUVU being negotiated by the Bureau of Industry and Security (BIS) and China's Ministry of Commerce. In addition, the general procedures for selecting on-site reviews have been established, procedures for end-use checks have been in place, and guidance for specific on-site reviews must be developed on a case-by-case basis to ensure the review is tailored to each VEU.

BIS's specific comments on the draft report are enclosed.

Our point of contact on this report is Julissa Hurtado. Ms. Hurtado can be reached at (202) 482-8093. Please feel free to contact us if you would like to discuss any aspect of these comments.

Sincerely,

A handwritten signature in black ink, appearing to read "Chris R. Wall".

Christopher R. Wall

Enclosure



U.S. Department of Commerce
Comments on the Government Accountability Office Report:
Commerce Lacks the Ability to Ensure That Semiconductor Equipment Exported to
China Is Used As Intended Under the Validated End-User Program
GAO-08-1095

Recommendation: *In order to ensure that Department of Commerce has the necessary oversight mechanisms in place, the Secretary of Commerce should suspend the validated end-user program to China until it has taken the steps necessary to ensure that it will be able to carry out on-site reviews. These steps include (1) negotiating an agreement with the Chinese to conduct on-site reviews and (2) developing procedures for conducting on-site reviews.*

Response to Recommendation

See comment 1.

The fundamental premise of the report – that no adequate mechanism exists to provide oversight of exports of semiconductor equipment under the Validated End-User (VEU) program – is incorrect.

Inspections of items shipped under the VEU program can be made under the 2004 End Use Visit Understanding (EUVU). The report itself notes on page 23 that this is also the view of the Chinese government. While the specific details of the inspection mechanism are classified, the 2004 EUVU provides the framework for all export control-related inspections in China, including for shipments made under the VEU program. BIS has offered to make this classified EUVU available to GAO for its review and consideration.

See comment 2.

The report correctly notes that BIS is negotiating the terms of an agreement to conduct on-site reviews that is specific to the VEU program. These negotiations with China's Ministry of Commerce (MOFCOM) have been ongoing and are nearing completion. However, because the report's fundamental premise is incorrect, the report misunderstands the reason for pursuing a separate, VEU-specific addendum to the 2004 EUVU. It is not the case that BIS does not have adequate means to inspect shipments made under the VEU program. Rather, the EUVU procedures, specifically the EUVU requirement to obtain End-Use Statements for shipments, are cumbersome in light of the trade facilitating objective of the VEU program. BIS is pursuing a VEU-specific addendum to ensure that VEU on-site reviews are tailored to the VEU program so that U.S. exporters will be able to fully capture the trade-enhancing benefits of the program.

See comment 3.

The report also erroneously asserts that general procedures for selecting and conducting on-site reviews do not exist. General procedures for end-use checks exist and will be used for on-site reviews as applicable. However, specific guidance for conducting individual on-site reviews must be developed on a case-by-case basis to ensure the review is tailored to each VEU.

Overall Comments

In addition to the incorrect fundamental premise of the report, there are several other overall issues that need to be accurately addressed.

See comment 4.

First, the report asserts, without evidence, that semiconductors provide the United States with a strategic military advantage. While semiconductors are used in a variety of military applications, semiconductor manufacturing equipment is controlled only on the Wassenaar Arrangement's Basic List, which generally includes commercially applied materials and components. They are not on the Wassenaar Arrangement's Sensitive or Very Sensitive List. Moreover, general purpose microprocessors – the kind made by the equipment covered by the report – were significantly decontrolled in 2003.

See comment 5.

Second, the report should make clear that it describes capabilities of companies in China rather than those of the government. For example, in the Highlights section, the text should read "The gap between the semiconductor manufacturing capabilities of companies in the U.S. and China, as measured by . . ." Describing capabilities as China's capabilities implies that they are capabilities of the government, and, as such, could be used for military activities. However, the report does not provide a basis for this assertion. Licensing decisions are based on a determination that the exports involved will not support China's military activities but will be used only for civilian purposes.

See comment 6.

Third, the report implies that most, if not all, controlled semiconductor manufacturing equipment and materials are exported to China under the VEU program. This is not the case; in fact, it is the reverse. During the first nine months of the VEU program, approximately 94% of the total exports of semiconductor manufacturing equipment to China took place under individual and special comprehensive licenses and only about 6% took place under VEU authorization.

See comment 7.

Fourth, there should not be any references to "trusted" entities, as this implies that VEU relies on 'trust' as the reason for removing individual license requirements. This does not accurately reflect the rigorous application and screening process that companies are required to undergo before being approved for VEU. Companies approved for VEU status should be referred to as "pre-screened" or "authorized".

See comment 8.

Finally, there should not be any references to "Chinese companies" or "Chinese end-users." In principle, VEU is not limited to Chinese companies and, in fact, none of the five currently authorized VEUs is a "Chinese company." Two are Chinese subsidiaries of U.S. companies, two are joint ventures with partial Chinese ownership, and one is a public company traded on the New York and Hong Kong stock exchanges. These companies should be referred to as "companies in China," which more accurately reflects the international ownership of the companies that have already been approved and others that may eventually apply.

The following are GAO's comments on the Department of Commerce's letter dated September 5, 2008.

GAO Comments

1. We have modified our draft report to indicate that Commerce intends to use the 2004 End Use Visit Understanding (EUVU) as a stopgap measure to conduct on-site reviews under the VEU program. However, as we note in the following comment, this stopgap measure imposes an additional burden on VEU-authorized companies. Moreover, the Chinese government has not always agreed with this approach. In 2007, China's Ministry of Commerce issued a decree prohibiting Chinese entities from accepting on-site reviews conducted by foreign government personnel without its permission. The Chinese government also requested that the United States refrain from approving any new validated end-users until the two countries agreed on the terms for conducting these reviews.
2. We understand that the intent of the VEU program is to enhance and facilitate trade between the United States and China. Our report notes that the VEU program would foster trade by reducing the administrative burden associated with seeking an export license for U.S. exporters and enabling VEU-authorized entities to obtain items more easily than their domestic competitors. Commerce asserted that it can use the EUVU procedures for inspecting shipments made under the VEU program, but it can only do so by requesting validated end-users to voluntarily obtain End-User Statements from the Chinese government.¹ Such statements are required for all exports of controlled items to China under individual export licenses that exceed \$50,000. However, these statements were not required under the VEU program and impose an additional burden on VEU-authorized companies. Commerce notes that the procedures for obtaining these statements are cumbersome and conflict with the trade facilitating objective of the VEU program. Until VEU negotiations with the Chinese government are completed, the trade-enhancing benefits of the program may not be realized.

¹End-User Statements are issued by the Chinese Ministry of Commerce and include information on a particular shipment, including the names of the importer and exporter; end-user and end-use; a description of the item, quantity, and dollar value; and the signature of the importer and date.

3. We disagree with Commerce's assertion that general procedures for selecting and conducting on-site reviews do exist. First, as noted in this report, the procedures for selecting which validated end-users will receive on-site reviews are still in draft form as of September 2008 and have not been cleared by the interagency process. Commerce would not provide us with a copy of these draft procedures. Second, Commerce's general procedures for conducting end-use checks are not specific to the VEU program. Instead, they were designed for pre-license and postshipment verification checks of items shipped under individual export licenses. End-use checks focus on ensuring that an item is being used for the purposes stated in the license, whereas on-site reviews are more comprehensive. In the course of our work, Commerce repeatedly asserted that end-use checks for individual licenses and on-site reviews under the VEU program are distinct activities that serve different purposes. Finally, we agree that Commerce needs additional case-by-case guidance for on-site reviews to ensure that the review is tailored to a particular validated end-user. However, the department also needs general procedures to ensure that on-site reviews are conducted in a consistent manner.

4. Commerce's comment is perplexing since the department appears to be contending that semiconductors do not provide the United States with a strategic military advantage. As evidence, Commerce notes that semiconductors are included on the Wassenaar Arrangement Basic List, rather than its Sensitive or Very Sensitive List. However, Commerce understates the military significance of items on Wassenaar's Basic List. According to Wassenaar's Basic List criteria, items to be controlled are those which are "major or key elements for the indigenous production, use, or enhancement of military capabilities."² Furthermore, semiconductor manufacturing equipment is not only controlled on the Basic List. One of the first validated end-users was authorized to receive metal organic chemical vapor deposition reactors (MOCVD), an item included on Wassenaar's Sensitive List, under the VEU program in China. This equipment may be used to produce radiation-hardened electronics, for use in commercial and military applications.

5. Commerce noted that we needed to make clear that the report describes the capabilities of companies in China rather than those of

²Wassenaar Arrangement, Criteria for the Selection of Dual-Use Items (updated at the December 2005 plenary in Vienna Austria).

the government. We agree and have made changes to the report to reflect this distinction.

6. We have revised the report to clarify that, before the introduction of the VEU program in 2007, export licenses provided the only mechanism by which U.S. companies could ship most advanced semiconductor manufacturing equipment and materials to China. We also note that since the introduction of the VEU program, the majority of semiconductor manufacturing equipment exported to China continues to be made under individual export licenses. We added export data to the report showing that, according to Commerce, during the first 9 months of the VEU program, 94 percent of the total exports of semiconductor manufacturing equipment to China were approved under individual or special comprehensive licenses while 6 percent were authorized under the VEU program.
7. We used the term “trusted” entities because Commerce officials used the same language in discussions with us to describe companies that would be approved as validated end-users. Moreover, Commerce has used the “trusted” term in public statements describing the program, including as recently as April, 2008, in testimony before Congress.
8. We have revised our reference to Chinese companies and now refer to these companies as companies or entities in China.

GAO Contact and Staff Acknowledgments

GAO Contact

Joseph A. Christoff at (202) 512-8979 or christoffj@gao.gov

Staff Acknowledgments

In addition to the contact named above, Anthony Moran, Assistant Director; Nabajyoti Barkakati; Lynn Cothorn; Julie Hirshen; Drew Lindsey; Grace Lui; and Mark Speight made key contributions to this report. David Dornisch, Etana Finkler, and Minette Richardson also provided assistance.

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