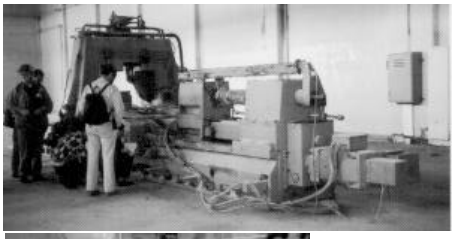
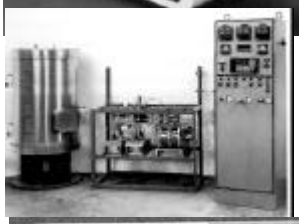
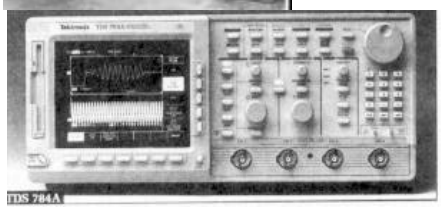






SECTION I
PART A

DUAL-USE AMERICAN EQUIPMENT LICENSED FOR EXPORT TO CHINA
1988 – 1998

The following tables, compiled from records at the Commerce Department's Bureau of Export Administration, show that China was licensed to receive more than $15 billion in sensitive "dual-use" equipment from 1988 to 1998. That is an average of $1.5 billion per year for the decade. Dual-use equipment has civilian applications but is uniquely capable of helping to make weapons of mass destruction or other military items.

The equipment, by definition, is of great strategic value. Only the highest performing machine tools, instruments, computers and other such items require a Commerce Department export license. This equipment has been placed on the U.S. export control list by U.S. experts who have judged that special care--and government review--is needed before releasing it to foreign countries.

More than half of the $15 billion was for computers. China was allowed to buy more than 11,000 controlled computers valued at $7.7 billion. China was, however, effectively denied access to high-performance computers until 1993. In that year, the Clinton Administration began to loosen computer export controls. By February 1994, it had drastically changed the definition of a "supercomputer," which is subject to the most stringent export controls. Before the change, a supercomputer was defined as a machine performing 195 million or more operations per second; machines above that level were strictly controlled. After the change, a supercomputer was defined as a machine performing 1.5 billion or more operations per second. The effect was a sevenfold relaxation in supercomputer export controls.

In early 1996, the administration cut computer controls even more deeply. American computers performing up to two billion operations per second were completely decontrolled to China, and if a Chinese buyer did not admit to being a nuclear, missile or military site, it could import computers performing up to seven billion operations per second.

The result of these successive decontrols was to give China access, for the first time, to high-performance computers. Such computers are used, among other things, to encode and decode secret messages, to design and test nuclear warheads and to simulate the performance of missiles from launch to impact.

According to data published by the U.S. General Accounting Office and the U.S. Department of Commerce, China imported a total of 286 high-performance American computers from January 1996 to November 1998. The machines were supposed to be imported for civilian purposes, but the United States has not been allowed to verify the whereabouts of more than three of them. Thus, it must be assumed that China's military scientists have access to the other 283. Since November 1998, more than 100 additional high-performance computers have been approved for export, bringing the total number sold to China to approximately 400. The great majority of these machines were sold without an export license.

China was also allowed to buy other American equipment especially useful for developing nuclear weapons, missiles and military equipment. The approvals include the following:

- **Equipment to manufacture and test semiconductors: 593 approvals worth $241.8 million**. Used to produce a wide variety of militarily critical components for avionics, missiles, torpedoes, smart munitions, fuses and secure communications equipment.

- **High-speed oscilloscopes: 1,653 approvals worth $131.3 million**. Used to record data from nuclear weapon tests, to design nuclear weapon firing circuits, and to develop missile guidance, control and tracking systems.

- **Equipment for controlling high-accuracy machine tools: 294 approvals worth $111.9 million**. Used to produce the precision parts needed for nuclear weapons and long-range missiles.

- **Vibration testing equipment: 14 approvals worth $5.4 million**. Used to test nuclear weapons, missiles, and a variety of military equipment to ensure combat reliability in situations of sudden shock, impact or rapid acceleration.

Viewed as a whole, American exports have provided the key equipment China needs to build a potent nuclear arsenal and a modern missile force to deliver it. China has bought American equipment used to design nuclear weapons, process and analyze nuclear material, machine high-accuracy nuclear weapon components, measure those components to make sure they work, and diagnose nuclear weapon tests. In addition, China's American imports can be used to simulate missile performance, improve missile design, manufacture missile components, improve missile guidance, transmit data from missile tests, and form missile bodies, nozzles and nose cones.

The following tables present only a sampling of the dual-use equipment approved for export to China. The value presented, however, is more than half the total approved. The tables, therefore, paint a fair picture of what China has received--and is still receiving. For each equipment category, the tables give a brief description of the export's strategic importance. The reader should note that licensing data for fiscal year 1995 was unavailable from the Department of Commerce.

Computers (ECCNs: 1565, 4A01-03, 4A001-003)

Computers are used in almost every weapon application, including the design and testing of nuclear warheads, estimation of nuclear yield, simulation of missile trajectories, and missile aerodynamics.

FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1996	FY 1997
2,721 approved	2,684 approved	2,055 approved	1,212 approved	845 approved	924 approved	617 approved	20 approved	16 approved
$1,503,286,287	$1,611,924,877	$1,603,944,830	$819,407,941	$655,640,106	$619,614,954	$925,612,981	$39,322,120	$8,283,859

Total approved: 11,094
Total value: $7,787,037,955

Dimensional inspection or measuring systems and equipment (ECCNs: 1093, 1099, 2B06, 2B46, 2B006)

Dimensional inspection machines are used for the inspection of gas centrifuge components such as rotor tubes, end caps, baffles, and scoops; the inspection of ion sources and product collectors for the electromagnetic isotope separation (EMIS) process; and the inspection of components for nuclear explosive devices. Highly accurate inspection machines can ensure the quality and reliability of parts used in nuclear explosive device assemblies.

FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1996	FY 1997
		6 approved	14 approved	16 approved	12 approved	17 approved	13 approved	3 approved
		$447,200	$427,631	$1,182,467	$1,606,143	$2,654,331	$3,197,784	$61,182

Total: 81 approved
Total value: $9,576,738

Fibrous and filamentary materials (ECCNs: 1763, 1C10, 1C50, 1C010, 1C210)

Carbon, glass, and aramid fibers (composite fibers) are extremely strong but lightweight, and are often used in missile bodies. Composite fibers can also form the high speed rotors of gas centrifuges used to enrich uranium and plutonium, and can be used in the bodies of nuclear warhead reentry vehicles.

FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1996	FY 1997
	2 approved	2 approved	2 approved	1 approved		3 approved	12 approved	4 approved
	$30,951	$17,461	$402,490	$2,240		$73,800	$8,627,490	$2,768,260

Total: approved: 26
Total value: $11,922,692

Gravity meters (gravimeters) and gravity gradiometers (ECCNs: 1595, 6A07)

Gravity meters measure variations in the earth's gravitational field. They are used in rocket and missile applications to determine changes in the force of gravity exerted on a missile or rocket while in flight. Gravity meter accuracy is essential for compensation of inertially guided long-range ballistic missiles, cruise missiles and aircraft.

FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1996	FY 1997
1 approved	4 approved	5 approved	2 approved	1 approved		1 approved	1 approved	
$276,240	$484,708	$1,534,303	$84,990	$47,633		$248,000	$285,000	

Total approved: 15
Total value: $2,960,874

Gyroscopes, compasses and accelerometers (ECCNs: 1485, 7A23)

This equipment is used in navigation systems for missiles, rockets, aircraft, and submarines. A navigation system is a self-contained unit that continuously measures position, velocity, acceleration, and attitude of a moving object. The more sophisticated the navigation equipment, the more accurate a weapon will be.

FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1996	FY 1997
64 approved	51 approved	43 approved	60 approved	31 approved	28 approved	7 approved	7 approved	7 approved
$6,596,262	$25,486,965	$9,678,375	$20,536,368	$10,207,731	$4,738,767	$1,507,235	$7,546,478	$2,118,632

Total approved: 298
Total value: $88,416,813

High-speed and high-definition cameras (ECCNs: 1585, 4585, 6A03, 6A43, 6A003, 6A203)

High-speed cameras are used extensively to develop high explosive components and initiation systems for nuclear explosive devices. Framing cameras provide useful qualitative information on the performance of nuclear explosive device components driven by high explosives.

FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1996	FY 1997
13 approved	7 approved	2 approved	2 approved	2 approved		12 approved	14 approved	7 approved
$67,018	$141,660	$28,392	$6,260	$138,000		$1,117,458	$982,460	$521,246

Total approved: 59
Total value: $3,002,494

Isostatic presses (ECCNs: 1312, 2B04, 2B24, 2B44, 2B004, 2B104, 2B204)

Isostatic presses are used to pressurize a closed cavity through various media (gas, liquid, and solid particles) to create equal pressure in all directions within the cavity. They are used to produce parts with controlled densities for nuclear explosive devices and for diffusion bonding of dissimilar materials used in such devices. The presses may be used for isostatic pressing of shaped plastic bonded explosives (PBX) for implosion devices. They can also be used to improve the density of structural composites used to make rocket nozzles and missile nose cones.

FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1996	FY 1997
			1 approved	2 approved	1 approved	4 approved	3 approved	
			$300,000	$683,850	$160,000	$1,158,423	$802,500	

Total approved: 11
Total value: $3,104,773

Mass spectrometers (ECCNs: 4530, 3A51, 3A233)

Mass spectrometers are used to determine the amount of uranium and plutonium present in a sample. Samples analyzed are usually nitrate compounds from plutonium reprocessing facilities, fluorine compounds in uranium enrichment facilities, and metallic forms in nuclear explosive device fabrication facilities.

FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1996	FY 1997
				45 approved	14 approved	1 approved	3 approved	3 approved
				$3,844,792	$2,423,265	$349,429	$785,000	$698,227

Total approved: 66
Total value: $8,100,713

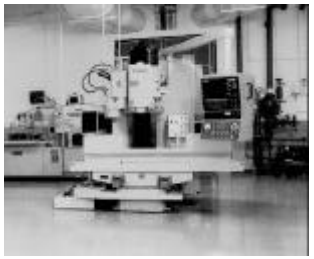
Neutron generators (ECCNs: 3261, 2A19, 3A231)

Neutron generators can be used to initiate the nuclear fission chain reaction in a nuclear explosive device.

FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1996	FY 1997
	4 approved	1 approved	1 approved		5 approved	1 approved	3 approved	1 approved
	$511,000	$45,000	$156,000		$3,199,000	$102,000	$233,750	$102,000

Total approved: 16
Total value: $4,348,750

Numerical control equipment (ECCNs: 1091, 2B01, 2B41, 2B001, 2B290)

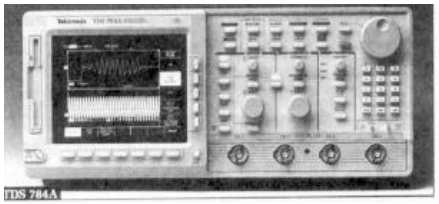


Numerical control equipment, including milling, grinding and turning machines, can be outfitted with electronic devices or computers for simultaneous "contouring control" in two or more axes (e.g., horizontal and vertical). The more accurate the machine, the more accurate the parts manufactured on the machine will be. These machines are useful for manufacturing nuclear explosive device components such as hemishells and for making uranium enrichment equipment components such as end caps for centrifuges and magnet components for electromagnetic isotope separation (EMIS) separators. They are also used to make molds and crucibles for casting uranium or plutonium, and components of plutonium production reactors such as fuel assemblies. These machines can also be used to precisely manufacture a variety of missile and rocket parts, all of which need to machined accurately.

FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1996	FY 1997
75 approved	82 approved	54 approved	33 approved	5 approved	2 approved	20 approved	19 approved	4 approved
$18,330,771	$21,506,260	$19,963,363	$9,919,754	$4,593,958	$311,992	$11,537,050	$19,438,064	$6,343,975

Total approved: 294
Total value: $111,945,187

Oscilloscopes (ECCNs: 1529, 1541, 1584, 3A52, 3A202)



Oscilloscopes are used for recording the results of hydrodynamic tests and full-scale nuclear tests (particularly with advanced designs). They also are used to develop very-high-speed diagnostic systems used in nuclear explosive device testing and are useful in developing fast hydrodiagnostic systems. In addition, they are used in designing and testing timing, firing, and safing circuits for nuclear explosive devices. Oscilloscopes are also used to develop missile guidance, control, and tracking systems. In August 1997, export controls on oscilloscopes were relaxed, making it possible for China to obtain more powerful oscilloscopes than before.

FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1996	FY 1997
495 approved	432 approved	351 approved	145 approved		1 approved	22 approved	93 approved	114 approved
$32,975,227	$57,457,951	$26,460,929	$3,128,131		$25,000	$1,137,550	$4,301,109	$5,772,198

Total approved: 1,653
Total value: $131,258,095

Pressure transducers (ECCNs: 4592, 1B51, 2B230)

Pressure transducers are used to measure the pressure of uranium hexafluoride (UF6) gas in facilities that separate uranium isotopes by the gas centrifuge process. Pressure measuring devices that are compatible with UF6 are also used in UF6 production plants and nuclear fuel fabrication plants.

FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1996	FY 1997
12 approved	19 approved	10 approved	13 approved	4 approved		7 approved	15 approved	14 approved
$79,166	$224,167	$49,743	$134,729	$22,904		$220,640	$710,164	$119,638

Total approved: 94
Total value: $1,561,151

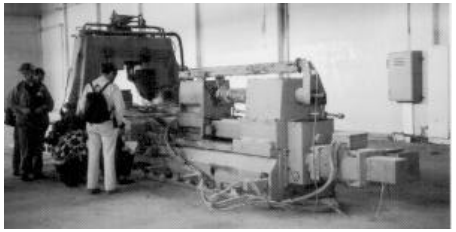
Semiconductor manufacturing and testing equipment (ECCNs: 1355, 3B01)

Semiconductor manufacturing is one of the most critical military technologies. Virtually all weapons in a modern military arsenal rely on electronics. More advanced electronic manufacturing capabilities mean higher performance and reliability at a smaller size. Semiconductor electronics are used in avionics, missiles, torpedoes, smart munitions, fuses, and secure communications equipment.

FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1996	FY 1997
228 approved	180 approved	95 approved	50 approved	7 approved	5 approved	5 approved	7 approved	16 approved
$44,012,989	$39,904,717	$29,841,209	$15,216,954	$1,510,027	$2,315,300	$10,300,000	$3,487,488	$95,165,785

Total approved: 593
Total value: $241,754,469

Spin-forming and flow-forming machines (ECCNs: 1075, 2B50, 2B115)



Spin-forming machines and flow-forming machines can be used to produce components for nuclear explosive devices. Rotor tubes and end caps for gas centrifuges may also be manufactured by flow-forming or spin-forming. These machines are also used to manufacture missile casings, rocket motor cases, rocket staging mechanisms, and liquid and slurry propellant control systems for missiles.

FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1996	FY 1997
1 approved				2 approved			1 approved	1 approved
$280,000				$1,777,000			$1,187,500	$601,240

Total approved: 5
Total value: $3,845,740

Telemetering and telecontrol equipment (ECCNs: 1518, 5A20)

This equipment is used to transmit measurements and instrument readings over long distances, usually by electromagnetic means. Missiles, rockets and unmanned aerial vehicles (UAVs) all use telemetry equipment to transmit flight and guidance information and measurements back to the launch site.

FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1996	FY 1997
2 approved	1 approved	3 approved		2 approved	3 approved	4 approved	3 approved	4 approved
$1,385,000	$239,763	$171,500		$23,225	$68,399	$16,787	$46,262	$14,256,873

Total approved: 22
Total value: $16,207,809

Vacuum induction furnaces (ECCNs: 1B50, 2B226)

Vacuum induction furnaces are used for casting uranium into key parts of nuclear explosive devices. They also are used for plutonium processing. These furnaces also may be used in the heat treatment of maraging steel for use in the rotor assemblies of gas centrifuges for uranium enrichment.

FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1996	FY 1997
			1 approved	5 approved	22 approved	8 approved	2 approved	3 approved
			$99,240	$1,778,579	$9,219,785	$3,673,188	$783,600	$13,142,000

Total approved: 41
Total value: $28,696,392

Vibration test systems, equipment and components (ECCNs: 1362, 9B06, 2B40, 9B26, 2B116)

Specialized equipment, such as digitally controlled centrifuges, are used to generate specific g profiles and vibrations for testing nuclear explosive device systems, including their arming and safing systems. Vibration testing equipment is also used to test a wide variety of military equipment and munitions to ensure combat reliability in situations of sudden shock, impact, or very rapid acceleration. It is used in the aerospace industry to test missiles.

FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1996	FY 1997
2 approved		2 approved	1 approved		1 approved	1 approved	5 approved	2 approved
$138,667		$1,423,443	$12,000		$14,500	$91,000	$3,222,828	$530,593

Total approved: 14
Total value: $5,433,031

Total number of licenses approved in Section I, Part A: 14,380
Total value of licenses approved in Section I, Part A: $8,459,173,676