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China's Space Program: A Brief Overview Including Commercial Launches of U.S.-Built Satellites

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ABSTRACT

China launched its first satellite in 1970 and has successfully placed 62 spacecraft into orbit since that time. Most are for communications, weather, remote sensing/reconnaissance, or scientific purposes. In 1990, China conducted its first commercial launch of a U.S.-built communications satellite. By September 3, 1998, 24 U.S.-built satellites had been launched, of which three suffered complete launch failures and a fourth did not reach its intended orbit. Several congressional committees are holding hearings into whether U.S. satellite manufacturers may have transferred technology to China that improved the reliability of Chinese nuclear missiles during a review of one of those launch failures. This report provides an overview of the Chinese space program since 1970, including commercial launches of U.S.-built spacecraft. The report may be updated if there are significant developments.

NOTE

This CRS study was initiated at the request of the Committee on Science of the U.S. House of Representatives and is adapted for general congressional use with permission of the Committee.

China's Space Program: A Brief Overview Including Commercial Launches of U.S.-Built Satellites

Summary

China launched its first satellite in 1970. Through September 3, 1998, it had conducted 62 launches, of which 50 were complete successes, 8 were complete failures, and 4 were partial failures, placing satellites into incorrect orbits. That total includes 5 failures between 1973 and 1979 that are not officially acknowledged by China, but which are counted by Western analysts.

China launches satellites for its own use, as well as for other customers primarily on a commercial basis. The satellites are for communications, weather, remote sensing/reconnaissance, or science. Its first commercial launch of a U.S.-manufactured satellite occurred in 1990. Through September 3, 1998, 24 U.S.-manufactured satellites had been launched by China, 20 successfully. One European-built satellite also was successfully launched. While launch failures are common in all the countries that launch satellites, two of China's raised particular concern because they resulted in fatalities on the ground. Following the second of these in 1996 — of the Loral-built Intelsat 708 spacecraft — Western insurance companies requested Loral to establish a team to review whether China accurately diagnosed and corrected the problem. Loral's review team included representatives of several Western aerospace companies, including Hughes, which had built several satellites for launch by China. Two of those failed to reach orbit (in 1992 and 1995). According to an April 4, 1998 *New York Times* article, the U.S. Department of Defense concluded in a classified 1997 report that as a result of that review, Loral and Hughes may have transferred technology to China that improved the reliability of Chinese nuclear missiles. Loral concedes that in violation of its own internal policies, it sent a copy of its report to China without first notifying the Department of State. The company asserts, however, that no technology was transferred. The Justice Department began a criminal investigation into the matter in 1997. Several congressional committees are holding hearings on the issues involved in this debate. The "Loral/Hughes" issue is discussed in more detail in CRS Issue Brief 93062, *Space Launch Vehicles: Government Requirements and Commercial Competition*, and in CRS Report 98-485, *China: Possible Missile Technology Transfers from U.S. Satellite Export Policy — Background and Chronology*.

Apart from commercial satellite launches, China has bold plans for the exploration and utilization of space, including its announced intention to launch humans into space in 1999. Two Chinese specialists have completed training at Russia's Star City cosmonaut training facility. China has cooperative agreements with several countries for joint space activities, including Brazil, Canada, Germany, Russia, and South Korea. No government-to-government level agreement for space cooperation exists between the United States and China, although China built magnets that were part of a scientific instrument (the Alpha Magnetic Spectrometer) flown on a 1998 U.S. space shuttle mission and is scheduled to fly again on the International Space Station. The National Aeronautics and Space Administration (NASA) drafted an agreement on cooperation in remote sensing activities prior to President Clinton's planned trip to China in June 1998, but the Loral/Hughes issue (see above) cooled the climate for signing such an accord.

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China's Space Program: A Brief Overview Including Commercial Launches of U.S.-Built Satellites*

Introduction

China launched its first satellite in 1970. By September 3, 1998, China had conducted 62 launches, of which 50 were successes, 8 were complete failures, and 4 were partial failures placing satellites into incorrect orbits (in one case, the launcher carried two satellites, one of which reached the correct orbit). That figure includes 5 launch failures between 1973 and 1979 that have not been officially acknowledged by China, but are counted by Western analysts. With those launches, China has successfully placed 62 spacecraft into orbit. China's first multiple launch (more than one satellite on a single launch vehicle) occurred in 1981. See table 1 below for a list of Chinese space launches.

The Chinese have not announced the missions for many of the satellites launched in the 1970s and early 1980s. Several were recovered on Earth after a few days in space, suggesting that they returned film images of the Earth (presumably for military reconnaissance purposes). Others were not recovered and their missions remain unclear. Since the mid-1980s, when more information has been made available, China has launched satellites for communications, weather, Earth remote sensing, or science both for itself and for other countries primarily on a commercial basis. China undoubtedly is interested in Earth remote sensing satellites both for their civilian scientific and military reconnaissance applications.

The Commission of Science, Technology & Industry for National Defense oversees space activities in China, with several organizations reporting to it. Among them are the China National Space Administration (CNSA) and the China Aerospace Corp. (operated as a private, profit-making company). China Great Wall Industries Corp. (CGWIC), part of China Aerospace Corp., markets commercial space launch services. The Chinese Academy of Space Technology develops spacecraft. The China Satellite Launch and TT&C General organization operates the launch sites and

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* This report is an update of a chapter published in CRS Report 94-873 SPR, *Space Activities of the United States, CIS, and Other Launching Countries/Organizations: 1957-1994.* Detailed citations are omitted from that report for brevity's sake, and consequently this report does not have them. In general the sources of information are Chinese articles translated and published by the Foreign Broadcast Information Service (FBIS); Western media sources such as *Aviation Week and Space Technology*, *Space News*, *Flight International*, *Jane's Intelligence Review*, and *Jane's Space Directory 1997-1998;* and information from Geoffrey Perry, M.B.E, of the Kettering Group in England.

provides tracking and telemetry services. Funding figures for Chinese space activities are extremely difficult to obtain. An October 14, 1996 article in the U.S. trade magazine *Aviation Week and Space Technology* reported that China's 1995 civilian space budget was $1.38 billion. A March 28, 1998 *Reuters* article states that the Import and Export Bank of China has provided $427.7 million in loans to CGWIC for commercial satellite launches.

China has three launch sites. The oldest is Shuang Cheng-tzu (41.2°N, 100.1°E) in the northern part of China (near Jiuquan). Versions of the Long March 2 (CZ 2) rocket are used at this site. In 1984, the Chinese introduced the Long March 3 (CZ 3) launch vehicle, which has a cryogenic (liquid oxygen/liquid hydrogen) upper stage. The vehicle inaugurated use of a new launch site at Xichang (28°N, 103°E) in southeastern China, also used for versions of the Long March 2. The site is used for satellites destined for geostationary orbit above the equator. In 1988, China initiated use of a third launch site, Taiyuan (38°N, 112°E), together with a new version of the Long March (CZ 4). This site is used for satellites requiring high inclination and polar orbits. To date those have been weather satellites or communications satellites for the Iridium program.

Development of the Chinese Space Program

The history of the Chinese space program is still shrouded in official secrecy, but occasionally information has been released by the government For example, the Chinese announced in 1984 that they had flown a puppy into space on a suborbital rocket in 1967. The puppy, named Xiao Bao (Little Leopard), was successfully recovered. They also reported that there had been a major explosion at one of their launch pads on January 28, 1978, which resulted in at least seven people being seriously injured, and a dozen or more people receiving burns to their hair, eyebrows, and faces. In addition, they honored as a martyr a young engineer who helped develop the first geostationary satellite, but died after 6 or 7 years of suffering the health effects of exposure to radiation during experiments related to that task.

An article in the May 1991 issue of *Space Policy* by Yanping Chen sheds some light on the development of the Chinese space program, concluding that despite a constantly changing political and economic climate, the space program has remained relatively stable. That article and other Western accounts credit Dr. Qian Xue-sen (also spelled Tsien Hsue-shen, Tsieh Hsueh-shen, or Chien Hsue-shen) as being the father of the Chinese space program. Born and educated in China, he came to the

United States for advanced education and worked for the Army's Jet Propulsion Laboratory (JPL). According to these accounts, in 1950 he was identified as a security risk and after a series of stays of the deportation order was expelled from the United States in 1955.

Dr. Chen divides the Chinese program into four distinct periods: 1956-1966, when the space program was first established despite a number of "traumatic political events" including the Great Leap Forward and the withdrawal of Soviet support for Chinese science and technology; 1966-76, during which the space program was able to maintain its course even though "virtually all sectors of Chinese society were torn apart" by the Cultural Revolution; 1976-1986, a period when the space program was put on the back burner, but survived, while the country recovered from the Cultural Revolution; and 1986 forward, which Dr. Chen describes as the "heyday" of the program as the government has made space a "cornerstone of the national science and technology development effort."

Significant Chinese Space Launch Failures

In the early and mid-1990s, China experienced mixed success with its launch vehicles, though its record has improved considerably since 1997 (see table 1). Launch failures are not uncommon in any of the launching countries, but two of China's captured worldwide attention because they caused deaths on the ground — a Long March 2E in January 1995 and a Long March 3B in February 1996.

The Long March 2E was developed to serve the commercial communications satellite market, initially for two Australian satellites AUSSAT-1 and -2 (later renamed Optus B-1 and B-2). The first flight of the Long March 2E, from Xichang, in 1990 was only a partial success, however. Its primary payload (a "dummy" AUSSAT satellite) did not achieve the proper orbit. A test satellite for Pakistan, Badr-1, aboard the same launch vehicle did achieve the correct orbit, however. In March 1992, the first of the two AUSSATs (renamed Optus-B1) was about to be launched, but an engine failure at the moment of ignition scrubbed the launch. It was successfully launched that August. Optus-B2 was launched in December 1992, but a malfunction caused an explosion enroute to orbit. Much of the satellite was found on the ground along the flight path, although some pieces and part of the rocket attained orbit. After a lengthy investigation by CGWIC and Hughes Space and Communications Co. (manufacturer of the satellite), officials concluded that the satellite, not the rocket, exploded, but neither side accepted responsibility for the failure.

In January 1995, a more tragic failure beset the Long March 2E program. Once again, the rocket exploded shortly after launch, but this time falling debris killed six people and injured 23 in a nearby rural area. Like the December 1992 launch, this carried a communications satellite (APStar 2) built by Hughes. In July 1995, CGWIC and Hughes released a joint statement that wind shear was the apparent cause of the failure, though they could not agree whether it was the rocket or the satellite that was at fault structurally. Hughes released a separate background paper explaining why it believed the rocket was at fault. Several successful launches of the CZ-2E have been achieved since, but the earlier failures raised not only technical questions, but issues about the openness of the Chinese investigatory process, and how well the rockets are instrumented to provide the requisite data to determine cause of failure.

The question of China's openness arose again following another significant launch failure in February 1996. A new version of the Long March 3, CZ-3B, was used for launch of the Intelsat 708 satellite. Seconds after liftoff, the rocket inverted itself and crashed to Earth in a village near the launch site. Officially, China reported that 6 died, 57 were injured, and 80 homes destroyed. Western observers who were present at the launch (and whose hotel also was severely damaged) insist that many more must have died. An Israeli attending the launch visited the village the next day and captured the ruin on videotape which was later shown in the West, buttressing the view that more devastation was incurred than China was ready to admit. In this case, Space Systems/Loral manufactured the satellite. The accident investigation board concluded that an inertial guidance system malfunctioned. A Loral-led team reviewed China's assessment of the launch failure, which has subsequently led to an investigation into whether Loral or Hughes, which also participated in the review panel, transferred missile-related technology to China (see **Commercial Launch Services**, below). Intelsat canceled two additional planned launches. The fatalities raised questions about range safety in China. China reportedly agreed to evacuate surrounding villages before future launches and revise launch destruct procedures.

Commercial Launch Services

Since 1986, the Chinese have been actively marketing launch services using the Long March family of vehicles through CGWIC (often referred to simply as "China Great Wall"). The first launches for paying customers were of materials processing experiments using the Long March 2, first for a French company (Matra) in 1987 and a German consortium (Intospace) in 1988.

The largest market for commercial space launch services is communications satellites, and China has focused great attention on attempting to get contracts for these launches. Virtually all commercial communications satellites are made by U.S. companies or contain U.S. components, so export licenses from the United States are required for the satellites to reach China for launch.

In 1988, the first such export license requests were made to the U.S. State Department for two Australian satellites, AUSSAT 1 and 2, built by Hughes Space & Communications Co., and one satellite named Asiasat-1 owned by Asiasat Ltd. that also was built by Hughes (Asiasat-1 is the refurbished Westar 6 satellite recovered by a 1984 space shuttle mission after it failed to achieve the proper orbit on its first launch attempt).

In September 1988, the Reagan Administration approved export of the three satellites to China on the condition that China sign three international treaties concerning, among other things, liability for damage from space launches; negotiate a fair trade agreement with the United States regarding launch services; and reach agreement on protecting technology from being transferred while each satellite is in China. All conditions were met by January 1989. Two of the conditions included in the agreement were that China would seek to launch no more than nine international satellites between 1989 and 1994, and that it would charge prices "on a par" with other launch services providers.

Approval for the export of the AUSSAT and Asiasat-1 satellites was granted by CoCom, the Coordinating Committee on Multilateral Export Controls, whose members were all the NATO countries (except Iceland), Japan and Australia (CoCom was disbanded after the collapse of the Soviet Union). Following the Tiananmen Square uprising in June 1989, however, the Bush Administration suspended all export licenses for items on the Munitions List, including the three satellites. Congress passed language in the FY1990 Commerce, Justice, State and Judiciary Appropriations Act (P.L. 101-162) and the 1990-91 Foreign Relations Authorization Act (P.L. 101-246, Section 902) prohibiting the export of U.S.-built satellites to China unless the President reported to Congress that (1) China had achieved certain political and human rights reforms, or (2) it was in the national interest of the United States. These notifications are often referred to as waivers. In December 1989, President Bush notified Congress that it was in the national interest to export the AUSSATs and Asiasat-1. Asiasat-1 was launched by China in April 1990, the two AUSSATs, renamed Optus B1 and B2, were launched in 1992 (the B2 launch was a failure as noted earlier).

The issue of whether China was adhering to its agreement with the United States to charge fair prices for launch services under the 1989 launch service agreement was raised by a 1990 contract between China and the Arabsat Consortium for launching an Arabsat satellite for $25 million, much less than what many consider "on a par" with Western companies. The main competitor for the launch was Europe's Arianespace, which turned to both the French and U.S. governments to prohibit export of the satellite (the prime contractor for the satellite is French, and it includes American components). The United States took no formal action and the issue became moot in the spring of 1991 when the Arabsat Consortium terminated the contract with the Chinese and signed an agreement with Arianespace. The reasons have not been fully explained by any of the parties, and the issue of what constitutes pricing services "on a par" remained, since it was not specified in the 1989 U.S.-Chinese agreement (it was further delineated in a 1995 agreement, see below). Language prohibiting the export of satellites to China unless the President certified that China was complying with the 1989 agreement was included in the Export Facilitation Act of 1990 (H.R. 4653). That bill was vetoed by President Bush on November 17, 1990. Another bill in the 102d Congress (H.R. 3489) included the same language, but did not clear Congress. China argued that because their costs are so low, they can offer lower prices and still adhere to international norms as to what costs are included in setting the price.

The AUSSAT export licenses expired in March 1991, and on April 30, 1991, the Bush Administration renewed them and approved the export of components for a Swedish satellite (Freja) to be launched by China, but simultaneously denied approval for exporting components China wanted for building a new communications satellite because of concerns about China exporting ballistic missiles to other countries. Two months later, on June 16, the White House announced that because of China's ballistic missile proliferation policies, it would be "inappropriate for the United States to approve any further export licenses for commercial satellite launches at this time." On July 17, the State Department identified CGWIC as one of two Chinese entities engaged in missile technology proliferation activities that require the imposition of trade sanctions in accordance with the Arms Export Control Act, including denial of license applications for export items covered by the Missile Technology Control Regime (MTCR). Although the MTCR does not cover satellites (only satellite launch vehicles, which are essentially interchangeable with ballistic missiles), the identification of CGWIC as a cause of concern to the U.S. Government complicated China's commercial space launch services marketing plans. China subsequently agreed to adhere to the MTCR, and the sanctions were lifted in March 1992.

China's fortunes improved. In May 1992, the International Telecommunications Satellite Organization (Intelsat) agreed to launch one of its Intelsat 7A satellites on a Chinese launch vehicle. On September 11, 1992, the State Department notified Congress that it was waiving legislative restrictions on U.S. exports for 6 satellite projects with China: APSAT, Asiasat-2, Intelsat 7A, STARSAT, AfriStar, and Dongfanghong 3. The first 5 are satellites China wanted to launch; the sixth is components (the same components President Bush refused to export in April 1991) for a new generation of satellites China itself is building (Dongfanghong 3, the first of which was launched in 1994 and failed shortly thereafter). Many observers saw the move as a conciliatory gesture in the wake of the U.S. decision to sell F-16s to Taiwan.

In 1993, the United States asserted that China was selling missiles to Pakistan and imposed sanctions, including the denial of satellite export licenses. This time, the issue became heated within the United States as Hughes and Martin Marietta (now Lockheed Martin, another satellite manufacturer) argued that the sanctions would hurt the American aerospace industry, not China. Noting that three of eight satellites at issue were not covered by the State Department's Munitions List, but by the Commerce Department's Commerce Control List since they did not contain technology of military concern, the companies and the Commerce Department succeeded in convincing the White House to overrule the State Department. The White House instructed Commerce to grant export licenses for those three satellites (APStar 2, Echostar and Asiasat). However, five others reportedly contained militarily-significant technology (such as encryption devices) and thus were governed by the Munitions List. Those licenses were not approved. Following extensive debate (including a House Science, Space and Technology hearing on September 29, 1994), in October 1996 the Clinton administration transferred primary responsibility for export of commercial communications satellites from the State Department to the Commerce Department.

In January 1995, the United States and China initialed a new 7-year agreement on commercial launch services. It was formally signed in March 1995. The agreement allows China up to 11 new launches for international customers to geostationary orbit in addition to 4 launch contracts already signed under the 1989 agreement. The number of geostationary launches is allowed to grow to 13 and then to 16 if certain market conditions develop. Including the existing 4 contracts, that could allow China a total of 20 launches. China agreed to price launches no less than 15 % below what Western companies charge or a U.S. review of the price would be triggered. For low Earth orbit (LEO) launches, it was agreed that as long as China, Russia, and Ukraine (the non market economies offering launch services) combined do not win contracts to launch more than 50 percent of any particular LEO satellite constellation (such as

Motorola's Iridium system), China will be assumed to be in compliance with the agreement. On October 27, 1997, the United States and China agreed to pricing provisions for LEO launches. Only general language had been included in the 1995 agreement. Under the agreement, China will price its LEO launches on a par with U.S. and European companies, allowing for adjustments for certain differences.

In May 1997, the Office of the U.S. Trade Representative stated that it believed China violated the pricing provisions of the 1995 agreement for launching a Loral-built satellite for the Philippines (Agila 2, formerly called Mabuhay). Chinese officials disagreed. On September 10, 1997, the *Washington Times* published a story that Chinese entities (including CGWIC) are selling missile technology to Iran. China denied the allegations. On February 18, 1998, the President notified Congress that it was in the national interest to export another satellite (Chinasat 8, built by Loral) to China.

In April 1998, issues publicly arose concerning the possible transfer of technology by two U.S. satellite manufacturing companies, Loral and Hughes. The multifaceted issue involves questions of whether Loral and Hughes transferred technology to China in the wake of the 1996 Intelsat 708 failure that improved the reliability of Chinese nuclear missiles, whether the Clinton Administration gave special treatment to Loral, and whether the Clinton Administration should have transferred responsibility for export of commercial communications satellites from the State Department to the Commerce Department in 1996. Table 2 below provides a list of U.S.-manufactured satellites launched by China through September 3, 1998, and the ownership of those satellites. The "Loral/Hughes" issue is discussed in more detail in CRS Issue Brief 93062, *Space Launch Vehicles: Government Requirements and Commercial Competition*, and in CRS Report 98-485, *China: Possible Missile Technology Transfers from U.S. Satellite Export Policy — Background and Chronology*. The latter contains a list of the waivers that have been granted to allow satellites to be exported to China.

Briefly, the questions center on actions taken by Loral following the 1996 Intelsat 708 failure. According to Loral, Western insurance companies asked it to review China's investigation of the launch. Loral formed a review committee composed of representatives from several aerospace companies, including Hughes. Loral concedes that, in violation of its own policies, it provided a copy of the committee's report to the Chinese before notifying the State Department to ensure there were no technology transfer concerns. The company asserts that as soon as it realized what had happened, it notified the State Department and that no transfer of information harmful to national security occurred. However, according to an April 4, 1998 *New York Times* story, a classified 1997 Defense Department report concluded that technical information had been transferred that improved the reliability of Chinese nuclear missiles. The Justice Department began a criminal investigation into the matter in 1997. As noted above, in February 1998, the Clinton Administration approved the export of another Loral satellite to China. Critics claim that the granting of that export license undermined the Justice Department's investigation. Media reports such as the April 4 *New York Times* article have alleged that contributions to the Democratic Party by Loral's Chairman, Bernard Schwartz, led the Clinton Administration to treat Loral favorably. Others argue that moving responsibility for deciding whether to export satellites to China from the State

Department and its Munitions List to the Commerce Department's Commerce Control List, was a mistake. A number of congressional committees are holding hearings on the matter.

Other Domestic and International Space Activities

As already noted, China has launched several communications satellites for its domestic needs. The first of a new generation of communications satellites, Dongfanghong 3, was launched in November 1994, but failed shortly after it attained orbit. A replacement was successfully launched in 1997. China also uses satellites in the Asiasat and APStar series. The companies that own those satellites — Asia Satellite Telecommunications Co. Ltd. and Asia Pacific Telecommunications Satellite Co. Ltd, respectively — are partially owned by Chinese entities. Both are based in Hong Kong, now part of China. In addition, China has purchased Western-made communications satellites for its own use. One of these, Chinasat 7, was placed into an incorrect orbit in 1996. Another, ChinaStar 1 (also called Zhongwei 1), was successfully orbited in May 1998. In July 1998, China launched its first European-built communications satellite, SinoSat-1, to service its domestic communications needs. The French company Aerospatiale was the prime contractor for SinoSat-1, built for the German-Chinese consortium EuraSpace. SinoSat-1 is managed by the Chinese company Sino Satellite Communications Company Ltd.

The Chinese also are interested in land remote sensing satellites. They inaugurated use of a Landsat receiving station purchased from the United States in 1986. It has been upgraded several times since to allow receipt of imagery from other satellites, including France's SPOT satellites, and European, Japanese and Canadian radar satellites (ERS, JERS, and Radarsat). As discussed earlier, several Chinese satellites reportedly have been related to development of a remote sensing capability. Presumably, these involve using a film system (rather than scanners such as those on Landsat and SPOT), hence the need for the payload to be recovered. As discussed below, China is also developing remote sensing satellites in cooperation with Brazil. China undoubtedly is interested in remote sensing both for military and civilian purposes. The term remote sensing broadly refers to any sensing of the Earth and its atmosphere, including weather satellites. Generally, the remote sensing data that have the greatest military utility are those that provide precise (high resolution) images of objects on the ground. Such data also are of use for civilian purposes such as land use monitoring, mineral exploration, and crop forecasting. The resolution of the recoverable Chinese satellites is not available. The planned Chinese-Brazilian system is designed to provide 20 meter resolution, which could be useful for both military and civilian purposes. Data with better resolution are available on the commercial market from several countries including France (10 meter), India (6 meter), and Russia (2 meter). The best publicly available U.S. data today are from Landsat (30 meters), but the U.S. government plans to launch a new Landsat spacecraft in 1999 with 15 meter resolution and several U.S. companies plan to launch commercial remote sensing satellites with as good as 1 meter resolution in the near future.

As noted, remote sensing also includes weather satellites. Following the 1988 failure of their first polar-orbit weather satellite, the Chinese launched a second in 1990, Fengyun 1-2, that apparently worked properly. Two balloons for making atmospheric measurements were launched along with it. A geostationary weather satellite, Fengyun 2, was planned for launch in 1994, but was destroyed in an April 1994 explosion at the facility at Xichang where it was being readied for launch. The explosion killed one worker and injured 31 according to China Great Wall Industry Corp. Details of the cause of the explosion were not released. A replacement was launched in 1997, becoming China's first geostationary weather satellite.

Some Chinese satellites have been for scientific purposes. In 1981, China launched three small satellites simultaneously for atmospheric physics studies. The two commercial launches that carried foreign materials processing experiments (in 1987 and 1988) also carried Chinese materials processing experiments. Other recoverable satellites have carried scientific experiments, including biological subjects. China 33 carried more than 60 plants and animals (guinea pigs). China 43 in 1994 carried flower and vegetable seeds as part of space seed-breeding experiments. China 50, launched in 1996, was primarily for remote sensing, but also included materials processing experiments performed cooperatively with Japan, and biological experiments.

China has been involved in a number of international space activities both as cooperative government-government agreements and as business joint-ventures. The countries involved include Australia, Brazil, Canada, Chile, France, Germany, Italy, Japan, Kazakstan, Pakistan, Russia, South Korea, and Sweden. Among the cooperative projects are the Chinese launch of an experimental Pakistani amateur radio satellite in 1990. The satellite, Badr-1, failed after one month in orbit. An agreement between the two countries for cooperation in peaceful applications of space technology was signed in December 1991. China launched a Swedish scientific satellite, Freja, in 1992. In 1993, China and South Korea signed an agreement to jointly build a small satellite for remote sensing and communications purposes. The four-year project was expected to cost $25 million, with launch in 1997, although the launch has not yet occurred. In 1994, China Aerospace Co. and Germany's Deutsche Aerospace (now DASA) formed a joint venture, EuraSpace, to build communications and remote sensing satellites. The first, a communications satellite called SinoSat, was launched in July 1998 (France's Aerospatiale built the spacecraft for EuraSpace). China and Germany also are cooperating on a solar telescope to be launched in 2003 to study the solar magnetic field. Another joint venture, Com Dev Xi'an, was created in 1996 between Canada's Com Dev International and China's Xi'an Institute of Space Radio Technology for building satellite electronics and ground facilities.

China also has a cooperative project with Brazil to jointly build two remote sensing satellites, CBERS-1 and -2 (China-Brazil Earth Resources Satellite). The satellites are designed to carry three imaging systems, including a CCD (charge-coupled device) camera with 20 meter resolution. Despite a number of problems in the program since its official initiation in 1988 (primarily lack of funding in Brazil), the two countries rejuvenated the program in 1993, signing a supplemental protocol that year and another in 1996. The first launch has been delayed many times and as of August 1998 was scheduled for July 1999, with the second launch anticipated three years later. Originally, the satellites would have been launched on Brazilian launch vehicles, developed with Chinese assistance, but instead they will be launched on Chinese Long March rockets. China is paying 70 percent of the project's cost ($150 million, including launch).

China and Russia held discussions for several years leading to the signing of a protocol in 1994 for broad space cooperation. Among the areas of interest are cooperation in robotic missions to Mars and human spaceflight, including Chinese purchase of Russian Soyuz spacecraft life support systems to assist China in its goal of putting astronauts in orbit by the year 2000 (see below). Russian President Boris Yeltsin signed a "joint understanding" on space cooperation with Chinese officials in April 1996 that apparently included training Chinese specialists at Russia's cosmonaut training center in Star City (see below). At the end of 1996, the Russian Space Agency reportedly was close to signing contracts with China regarding commercial spacecraft launches although the status of that agreement is unclear. In 1997, China reportedly was discussing with Israel the possibility of launching an Israeli student satellite. The French launch services company Arianespace has indicated that it is interested in possible joint development of a launch system with China. A framework agreement on space cooperation was signed between China and Kazakstan in 1998; details are not available.

For many years, China has sought government-to-government level cooperation with the United States, but no formal agreement has been signed. A draft agreement on cooperation in remote sensing satellites was prepared in advance of President Clinton's planned 1998 trip to China, but the Loral/Hughes controversy (discussed earlier) apparently has cooled interest in signing such an agreement now. Among other things, China has expressed interest in participating in the International Space Station program, and flying experiments on the U.S. space shuttle as "get away specials" (small, comparatively inexpensive experiments that require no crew interaction). China did provide magnets for a scientific instrument called AMS (Alpha Magnetic Spectrometer) that flew on a 1998 space shuttle mission (STS 91) and is scheduled to fly again on the International Space Station. AMS is designed to search for missing matter and cosmic sources of antimatter.

Future Plans

Chinese space officials have often expressed the intent to send humans into space. During 1979 and 1980, China had ambitious plans for utilization of space, and even had astronauts in training. In late 1980 and early 1981, however, they retreated from these expansive plans because of a reassessment of the Chinese economic situation, and announced that their human spaceflight program had been postponed for at least the remainder of the decade. In the 1990s, they resumed making statements about building space stations and a spaceplane. A plan released in March 1992 (*Outline for China's Long and Medium-Term Development of Science and Technology*) asserted that research into experimental spacecraft to carry crews into space would be completed by the year 2000. Chinese space officials have repeatedly stated since that time that they plan to launch a crew by the year 2000, to develop a space shuttle by the year 2010, and to build a space station. Reports in the Chinese press in 1998 repeated the oft-stated goal of launching humans into space in 1999. Two Chinese specialists have completed cosmonaut training at Russia's Star City facility.

At the October 1996 International Astronautical Federation (IAF) conference in Beijing, Chinese officials called for greater international cooperation in space. They also discussed their long term space strategy, which continues China's focus on communications and remote sensing (including weather and radar imaging) satellites, and on commercial space launches (including development of new launch vehicles). They also said they plan to send probes to the Moon or other planets.

Table 1. Chinese Space Launches*

Name	Launch Date	Launch Vehicle	Launch Site	Comments
China 1	04/24/70	CZ-1	S	Engineering test. "East is Red" song played until 05/20/70.
China 2	03/03/71	CZ-1	S	Housekeeping test and possible science.
__——__	***09/18/73***	***FB-1***	***S***	***This apparent launch failure is unacknowledged by the Chinese, but counted by Western analysts.***
__——__	***07/14/74***	***FB-1***	***S***	***This apparent launch failure is unacknowledged by the Chinese but counted by Western analysts.***
__——__	***11/05/74***	***CZ-2***	***S***	***This apparent launch failure is unacknowledged by the Chinese but counted by Western analysts.***
China 3	07/26/75	FB-1	S	Science? Reconnaissance? Not recovered.
China 4	11/26/75	CZ-2C	S	Possible reconnaissance test. Recovered. 1st CZ-2.
China 5	12/16/75	FB-1	S	Like China 3.
China 6	08/30/76	FB-1	S	Possible electronics intelligence gathering test and/or science. Not recovered.
__——__	***11/10/76***	***FB-1***	***S***	***This apparent launch failure is unacknowledged by the Chinese but counted by Western analysts.***
China 7	12/07/76	CZ-2C	S	Possible reconnaissance test. Recovered.
China 8	01/26/78	CZ-2C	S	Possible reconnaissance test. Recovered.
__——__	***07/27/79***	***FB-1***	***S***	***This apparent launch failure is unacknowledged by the Chinese but counted by Western analysts.***
China 9; China 10; China 11	09/19/81	FB-1	S	Three scientific satellites for space physics experiments.
China 12	09/09/82	CZ-2C	S	Possible reconnaissance test. Recovered.
China 13	08/19/83	CZ-2C	S	Possible reconnaissance test. Recovered.
China 14	*01/29/84*	*CZ-3*	*X*	*First Long March 3 launch; upper stage failed.*
China 15	04/08/84	CZ-3	X	First Chinese geostationary communications satellite.
China 16	09/12/84	CZ-2C	S	Reconnaissance? Remote sensing? Recovered.

Table 1. Chinese Space Launches*
(continued)

Name	Launch Date	Launch Vehicle	Launch Site	Comments
China 17	10/21/85	CZ-2C	S	Reconnaissance? Remote sensing? Recovered.
China 18	02/01/86	CZ-3	X	Communications.
China 19	10/06/86	CZ-2C	S	Possible reconnaissance. Recovered.
China 20	08/05/87	CZ-2C	S	Materials processing experiment for French company.
China 21	09/09/87	CZ-2C	S	Science. Recovered.
China 22	03/07/88	CZ-3	X	Communications.
China 23	08/05/88	CZ-2C	S	Materials processing for German company.
Fengyun 1-1	09/06/88	CZ-4	T	Weather. 1st CZ-4.
China 25	12/22/88	CZ-3	X	Communications.
China 26	02/04/90	CZ-3	X	Communications.
AsiaSat 1	04/07/90	CZ-3	X	Communications satellite for Asiasat Co. First Chinese commercial launch of U.S.-built satellite.
BADR-1; *China 29*	*07/16/90*	*CZ-2E*	*X*	Pakistani test communication satellite. *China 29 is "dummy" AUSSAT. Perigee kick motor failed, leaving satellite in wrong orbit.*
Fengyun 1-2; China 31; China 32	09/03/90	CZ-4	T	Weather satellite, plus two balloons for atmospheric studies.
China 33	10/05/90	CZ-2C	S	Remote sensing and biology. Recovered.
China 34	*12/28/91*	*CZ-3*	*X*	*Third stage failure placed communications satellite in wrong orbit.*
China 35	08/09/92	CZ-2D	S	Remote sensing and materials processing. Recovered.
Optus-B1	08/13/92	CZ-2E	X	Communications satellite for Australia.
Freja; China 38	10/06/92	CZ-2C	S	Freja is Swedish scientific satellite; China 38 is remote sensing (recovered).
Optus-B2	***12/21/92***	***CZ-2E***	***X***	***Launch vehicle broke up enroute to orbit.***
China 40	10/08/93	CZ-2C	S	Reentry module misfired.
Shijian 4; China 42	02/08/94	CZ-3A	X	Two test satellites for new CZ-3A variant.
China 43	07/03/94	CZ-2D	S	Science (plants, microgravity exp.)
APStar-1	07/21/94	CZ-3	X	Communications satellite for APT Satellite Co.
Optus-B3	08/28/94	CZ-2E	X	Australian communications satellite.

Table 1. Chinese Space Launches*
(continued)

Name	Launch Date	Launch Vehicle	Launch Site	Comments
Dongfanghong 3	11/29/94	CZ-3A	X	Communications satellite for China (satellite failed on-orbit).
APStar-2	***01/25/95***	***CZ-2E***	***X***	***Communications satellite for APT. Broke apart during launch; killed 6.***
AsiaSat-2	11/28/95	CZ-2E	X	Communications satellite for Asiasat.
EchoStar 1	12/28/95	CZ-2E	X	Communications satellite for Echostar.
Intelsat 708	***02/14/96***	CZ-3B	***X***	***Communications satellite for Intelsat. Launch failure; killed 6.***
APStar 1A	07/03/96	CZ-3	X	Communications satellite for APT.
Chinasat 7	*08/18/96*	*CZ-3*	*X*	*Communications satellite for China. 3rd stage failure left in wrong orbit.*
China 50	10/20/96	CZ-2D	S	Remote sensing.
Dongfanghong 3 F2	05/11/97	CZ-3A	X	Communications satellite for China.
Fengyun-2	06/10/97	CZ-3	X	1st Chinese geostationary weather satellite.
Agila 2	08/19/97	CZ-3B	X	Communications satellite for the Philippines.
Iridium MFS-1; Iridium MFS-2	09/01/97	CZ-2C/SD	T	2 test satellites for Iridium to test new launch vehicle variant (CZ-2C/SD).
APStar 2R	10/16/97	CZ-3B	X	Communications satellite for APT.
Iridium 42; Iridium 44	12/08/97	CZ-2C/SD	T	2 communications satellites for Iridium.
Iridium 51; Iridium 61	03/25/98	CZ-2C/SD	T	2 communications satellites for Iridium.
Iridium 69; Iridium 71	05/02/98	CZ-2C/SD	T	2 communications satellites for Iridium.
ChinaStar 1	05/30/98	CZ-3B	X	Communications satellite for China.
SinoSat-1	07/18/98	CZ-3B	X	Communications satellite for China (manufactured by France's Aero-spatiale).
Iridium 03; Iridium 76	08/19/98	CZ-2C/SD	T	2 communications satellites for Iridium.

* Prepared by CRS based on data from Chinese news bulletins and other media sources; *World-Wide Space Activities* (House Science and Technology Committee, 1977); *Jane's Space Directory 1997-1998*; and information from Geoffrey Perry, M.B.E., of the Kettering Group in England.

Chinese launch sites are designated herein as follows: S = Shuang Cheng-tzu (also known as Jiuquan); X = Xichang; and T = Taiyuan. Launch dates are in Greenwich Mean Time, which may differ by a day from local time. *Satellites that reached orbit, but not the intended orbit, are shown in italics*. ***Launch failures where the satellite did not reach orbit are shown in bold italics.*** Launch vehicles are designated "CZ" for Chang Zheng (Long March) or "FB" for Feng Bao (Storm).

Table 2. Owners of Satellites Manufactured by U.S. Companies and Launched by the People's Republic of China

Satellite*	Launch Date*	Manufacturer**	Owner**
AsiaSat-1	04/07/90	Hughes	Asiasat (Asia Satellite Telecommunications Co. Ltd.), of Hong Kong. In 1996, Asiasat's holding company went public. Asiasat now is owned 31% by the public, with the remaining shares equally owned by Cable and Wireless PLC, China International Trust and Investment Corp., and Hutchinson Whampoa.
Optus B1	08/13/92	Hughes	Optus Communications PTY Ltd. of Australia.
Optus B2	Launch failure 12/21/92	Hughes	Optus (Australia)
APStar-1	07/21/94	Hughes	APT (Asia Pacific Telecommunications Satellite Co. Ltd), of Hong Kong. APT is 75% owned by Chinese government-backed companies.
Optus B3	08/28/94	Hughes	Optus (Australia)
APStar-2	Launch failure 01/25/95	Hughes	APT (Hong Kong)
AsiaSat-2	11/28/95	Lockheed Martin	Asiasat (Hong Kong)
EchoStar 1	12/28/95	Lockheed Martin	Echostar Inc. (U.S.)
Intelsat 708	Launch failure 02/14/96	Loral	International Telecommunications Satellite Organization (Intelsat, a consortium of 142 countries)
APStar 1A	07/03/96	Hughes	APT (Hong Kong)
Chinasat 7	Failed to reach intended orbit 08/18/96	Hughes	China Telecommunications Broadcast Satellite Co. of China. Satellite reached orbit, but not intended orbit due to third stage failure.
Agila 2 (formerly Mabuhay)	08/19/97	Loral	Mabuhay Philippines Satellite Corp. (Philippines)
Iridium MFS Iridium MFS	09/01/97	Motorola	China Aerospace Corp. Two test satellites (Iridium Mass Frequency Simulators) used to test a new version of the Long March that is used for Iridium launches.
APStar 2R	10/16/97	Loral	APT (Hong Kong)

Table 2. Owners of Satellites Manufactured by U.S. Companies and Launched by the People's Republic of China (continued)

Satellite*	Launch Date*	Manufacturer**	Owner**
Iridium 42 Iridium 44	12/08/97	Lockheed Martin and Motorola	Iridium (U.S.)
Iridium 51 Iridium 61	03/25/98	Lockheed Martin and Motorola	Iridium (U.S.)
Iridium 69 Iridium 71	05/02/98	Lockheed Martin and Motorola	Iridium (U.S.)
ChinaStar 1 (or Zhongwei 1)	05/30/98	Lockheed Martin	China Oriental Telecom Satellite Co. Ltd. of China.
Iridium 03 Iridium 76	08/19/98	Lockheed Martin and Motorola	Iridium (U.S.)

* Satellite name and launch date from CRS data. Launch dates are in Greenwich Mean Time, which may differ by a day from local time.

** Manufacturer and owner from *Jane's Space Directory 1997-1998*, media sources, or *Jonathan's Space Report*. Some satellites designated as built by Lockheed Martin were built by Martin Marietta before its merger with Lockheed.