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China's nuclear weapons programme

Elin Enger

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Summary

China has been a nuclear weapons power since it conducted its first nuclear test explosion in 1964. This means that China is one of the five states that are allowed to keep a nuclear weapons arsenal under the Treaty of the Non-Proliferation of Nuclear Weapons (NPT) from 1968. China has always maintained that it follows a policy of minimal credible deterrence, and will adhere to a strict none first use policy under all circumstances. Chine has avoided building up a very large arsenal, but has instead relied on a policy of quantitative and geographic ambiguity, keeping all information about the number of weapons and their location strictly secret.

Over the years, China's nuclear programme has gone through a substantial development, in spite of economic restrictions, especially in the early years, and relatively few, 47 recorded, test explosions. Although the total number of weapons probably is kept low, most analysts estimate around 240 warheads. China has several nuclear capable missile types, including intercontinental ballistic missiles, submarine launched missiles and possible cruise missiles, and is currently believed to be in the process of developing a multiple independently targetable re-entry vehicles (MIRV) technology. China today seems to have a small, but technically advanced nuclear weapons arsenal.

Sammendrag

Kina har vært en kjernevåpenmakt siden de utførte sin første kjernefysiske prøvesprengning i 1964. Dette medfører at Kina er en av de fem statene som har rett til å beholde et kjernevåpenarsenal under Ikke spredningsavtalen for kjernevåpen (NPT) fra 1968. Kina har alltid uttrykt at deres politikk følger et prinsipp om minimal troverdig avskrekning, og vil forholde seg til en streng ikke-førstebrukspolitikk under alle omstendigheter. Kina har unngått å bygge opp et veldig stort arsenal, men har i stedet bygget på kvantitativ og geografisk uklarhet, det vil si at all informasjon om antall våpen og deres plassering holdes strengt hemmelig.

I årenes løp har Kinas kjernefysiske våpenprogram utviklet seg kraftig, til tross for trange økonomiske rammer, spesielt i de tidlige årene, og relativt få, 47 registrerte, prøvesprengninger. Selv om det totale antallet våpen holdes lavt, de fleste analyser anslår rundt 240 våpen, har Kina flere missiltyper med kjernefysisk kapasitet, inkludert interkontinentale ballistiske missiler, ubåtbaserte missiler og muligens kryssermissiler. De antas også å være i ferd med å utvikle missiler med flere uavhengig styrbare stridshoder, såkalt MIRV teknologi. Det ser i dag ut til at Kina har et lite, men teknologisk avansert kjernevåpenarsenal.

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Preface

This report was written as part of the project *Atomkappløp i Asia? Teknologisk bistand og atomopprustning i India og Kina* (*Nuclear arms race in Asia? Technological assistance and nuclear armament in India and China*), financed by the Norwegian Ministry of Foreign Affairs. The project is a cooperation between the Norwegian Defence Research Establishment (FFI) and the Norwegian Institute for Defence Studies (IFS).

This report aims to give a general review of the Chinese nuclear weapons programme, from the beginning to the present, based on open sources, to be used as background information for a future comparison of the developments in China and in India.

1 Introduction

The atom bomb is a paper tiger which the U.S. reactionaries use to scare people. It looks terrible, but in fact it isn't. Of course, the atom bomb is a weapon of mass slaughter, but the outcome of a war is decided by the people, not by one or two new types of weapon. [1]. Mao Zedong's famous statement about nuclear weapons being "paper tigers" originates from an interview given to the American journalist Anna Louise Strong in 1946:

Despite this, Mao and other Chinese high officials decided early that China itself needed nuclear weapons. The rationale behind the decision, based on official statements given at the time and later, seems to be that not only could China use the weapons to deter attacks from "imperialists", i.e. the United States and its western allies, but also that by constructing such weapons, China could gain further international respect [2]. Later, when the relationship between China and the Soviet Union deteriorated, the nuclear weapons were probably also meant to function as a deterrent against attacks from that side.

It is difficult to obtain information about Chinese nuclear facilities with military connections. There is little technical information in open sources, and the information that is available, is often based on guess-work. In this report, the information presented is based on several widely quoted sources, most importantly the book *China builds the bomb*, published by Stanford University Press in 1988 [3]. The book was written by social scientists John Wilson Lewis and Xue Litai, and is to a large extent based on declassified Chinese documents and interviews with Chinese officials and others involved in the early nuclear programme. Newer sources do rarely differ from the information in this book, and are often quoting it. The book only covers in depth the period up to 1967.

The first Chinese nuclear test explosion was recorded on16 October 1964 [4]. The test gave an explosive yield of about 22 kilotons (kt), and was conducted at the Lop Nor test site in north eastern China. Up to 1996, when China joined the Comprehensive Nuclear-Test-Ban Treaty (CTBT), a total of 47 tests had been conducted at this site.

The Chinese nuclear programme started in all likelihood shortly after the Chinese revolution in 1949, when the new government gave the Chinese physicist Qian Sanqiang the task of buying nuclear equipment in Europe. In 1955, after receiving a briefing from the same Qian Sanqiang, the Chinese government, led by Mao Zedong, officially made the decision to pursue nuclear weapons [3]. In this period, China had a close relationship with the Soviet Union, and there was considerable cooperation in the nuclear field.

However, in 1960, the Soviet Union broke off the nuclear cooperation deal after the political climate between the two countries had begun to turn sour. This left China with several half-built nuclear facilities which they would either have to finish on their own or abandon. Lewis and Xue [3] describes how the technicians and scientists developed successful production methods for various materials and components by theoretical work, but also by long series of trial-and-error type experiments until the desired result was achieved.

No single person has been appointed “father of the Chinese bomb”. The first weapons were apparently the result of the work of a large group of scientists and engineers who were given considerable resources. Several of the scientists involved in the Chinese nuclear programme had studied or worked at universities in the United States or other western countries before returning to China. Even though none of them had been involved in the American nuclear weapons programme, this suggests that a lot of the general nuclear physics and high explosive information used in the programme had its origin in the United States and the West rather than the Soviet Union. Much important information could also be found in unclassified publications. Finally, it cannot be overestimated how much hard work and effort must have been put into the programme in the 1950s and 1960s, despite all the political and economic turmoil that characterized this period in Chinese history.

2 Political background and organization of the early programme

2.1 Cooperation with the Soviet Union

In January 1955, the Soviet Union declared that it would help China develop peaceful nuclear energy, and a bilateral agreement confirming this was signed later the same year. The deal, and the later agreements, resulted in a nuclear reactor and a cyclotron being supplied from the Soviet Union to China. Between 1954 and 1959, there was also considerable assistance from the Soviet Union to the Chinese incipient nuclear weapons programme, including about 260 Chinese scientists receiving training in the Soviet Union and a similar number of Soviet scientists working in the Chinese nuclear weapons programme. However, in 1959, the Soviet Communist Party Central Committee formally notified its Chinese counterpart that it would not provide China with technical detail or working bomb designs, and in 1960, the Soviet Union cancelled all nuclear agreements with China. [3]

Although the break with the Soviet Union made further development of the Chinese nuclear programme more difficult, it in all likelihood also increased the Chinese incentive to invest in their programme. After the break, China did not only have to worry about the nuclear weapons of the “imperialistic” western powers[1], but also the potential threat posed by the nuclear capabilities of its close neighbour, the Soviet Union.

2.2 Research institutions

Two institutions stood for most of the nuclear weapons research in China, The Beijing Nuclear Weapons Research Institute and the Ninth Academy.

[1] Before 1960 the western nuclear powers were the United States and Great Britain; France conducted its first test explosion in February that year.

The Beijing Nuclear Weapons Research Institute was founded in 1960, and conducted theoretical research on nuclear issues, as well as research in explosives and metallurgy. The organisation in charge of nuclear research in the new nuclear weapons related sites was named the Ninth Academy. (Other military development organisations were also named in this way in this period, for example, the Fifth Academy was a missile development organisation.)

In addition to these initiatives, the Institute for Atomic Energy (codenamed *Plant 401*) in Beijing was also involved in the early nuclear weapons programme. A lot of the theoretical work and basic experiments were conducted here. [2;3].

3 People involved

Several of the physicists and engineers involved in the early Chinese Nuclear Weapons programme had studied or worked abroad. The most important of these seem to be Deng Jiaxian, Guo Yonghuai and Chen Nengkuan.

Deng Jiaxian was a nuclear physicist who had started his career in China, but studied for a PhD at Purdue University in the United States between 1948 and 1950. Deng led basic research at the Beijing Nuclear Weapons Research Institute, before transferring to the Ninth Academy in 1964. He made contributions to theoretical design of nuclear weapons, such as detonation physics, fluid mechanics, neutron transport and equations of state, and also directed nuclear tests. Together with Peng Huanwu, he led the team that designed the first Chinese nuclear weapon and also the team that designed the first Chinese thermonuclear weapon.

Peng Huanwu was a physicist who after initial physics studies in China, went on to study for a PhD at Edinburgh University in 1938. In 1947, he returned to China, and he became deputy director of the Beijing Institute in 1961.

Guo Yonghuai, a specialist in Mechanics who after studying physics at the University of Beijing in the 1930s, studied for a master's degree in applied mathematics at the University of Toronto, Canada, and a PhD in fluid dynamics at California Institute of Technology in 1945. He then worked at Cornell University in the United States until he returned to China in 1956. He became a deputy director of the Beijing Nuclear Weapons Research Institute in 1960 and made major contributions to the development of the first nuclear and hydrogen bombs, as well as to rocket and missile research.

Chen Nengkuan was a physicist who after studying at the Department of Mining and Metallurgy at Jiaotong University in China, went to the United States in 1947 and received a PhD from Yale in 1950. He then worked at Johns Hopkins Institute and the Westinghouse Corporation (an important institution for research and development in the field of nuclear technology) until he returned to China in 1958. Chen Nengkuan contributed to and supervised much of the work on explosives and headed the team which created and tested the first explosive lenses.

In addition to the above, important figures in the early programme were *Nie Rongzhen*, who held many positions in the People's Liberation Army (PLA) and the central government related to the nuclear programme and *Qian Sanqiang*, a nuclear physicist with background from the Curie Institute in France and the University of Paris, who gave a brief to Mao and other officials on the prospect of a nuclear bomb in 1955. Qian also served as Director of the Chinese Institute of Atomic Energy. Nie Rongzhen oversaw the nuclear weapons programme from his various positions and protected it against a lot of the fallout from the Cultural Revolution. This made it possible to continue almost unhindered through a very chaotic time. [2;3]

4 Nuclear infrastructure

The Chinese nuclear programme began with a few key facilities in the 1950s. While the cooperation deal between China and the Soviet Union was still in force, China was developing infrastructure for the production of both highly enriched uranium (HEU) and plutonium. After the break, to save resources, the Chinese government decided to focus on uranium. The construction of the plutonium production facilities was then halted, but most of them were reopened again later.

From the mid-1960s, China started to construct a second set of nuclear and other important defence production facilities in remote areas to reduce vulnerability in case of attack. This policy was called *Third Line Construction*, and these facilities are often referred to as *Third line facilities*. Not all of these facilities were in use for long.

Fissile materials are materials that can sustain a nuclear chain reaction. An uncontrolled nuclear chain reaction leads to a nuclear explosion, and this is why fissile materials can be used to make nuclear weapons. Two fissile nuclides are commonly used, **Uranium 235** (U-235) and **Plutonium 239** (Pu-239).

Natural uranium found in nature contains only about 0.7 % U-235, but the amount of U-235 in the material may be increased in a process called uranium enrichment. Uranium containing more than 90 % U-235 is often referred to as **weapons grade uranium**.

Plutonium does not exist in nature, but is produced from uranium in nuclear reactors. Plutonium is separated from spent reactor fuel in reprocessing plants, but the fraction of Pu-239 in the resulting plutonium will depend on the type of reactor it comes from and the time that the fuel spent in the reactor. Plutonium containing more than 94 % Pu-239 is generally referred to as **weapons grade plutonium**.

4.1 Uranium mining

Lewis and Xue, in an article published in China Quarterly in 1987 [5], state that under the cooperation agreement with the Soviet Union, the Chinese had expected to receive pre-processed natural uranium in the form of uranium hexafluoride (UF_6) gas from the Soviet Union, ready to be enriched at an enrichment facility that was being built in China, also with Soviet assistance. When the deal was broken in 1960, China therefore had to start from scratch with everything from uranium mining to processing of the ore and manufacturing of the UF_6 needed for the enrichment plant.

In 1955, when the Chinese started its nationwide uranium prospecting programme, no sizable uranium deposits had yet been discovered in China, even though uranium prospecting had been going on in an unsystematic fashion since the 1930s. A new entity, the *Third Bureau*, was established under the Ministry of Mining to lead the programme. By the end of 1956, more than

20 000 people were involved in the prospecting, many of them geologists who had received training from Soviet or Eastern European experts.

The largest deposits were initially found in two mountain ranges in south-eastern China, along the borders of the provinces Jiangxi and Hunan, and on the border of Jiangxi and the Zhejiang province (see Figure 4.1). The construction of the first mine, in Chenxian in the Hunan Province in south east China, was started in 1958.

Several of the largest Chinese uranium mines were developed close to the city of Hengyang, in the Hunan Province, where there already were some nuclear facilities. This city was therefore chosen as a centre for natural uranium processing, with a national uranium mining institute and various other research facilities.

Figure 4.1 The provinces of China today. (Source: Wikimedia commons.)

4.2 Fuel processing and component manufacturing

The first production of uranium oxide for enrichment was done by the *Uranium Mining and Metallurgical Processing Institute*, located in Tongxian near Beijing. This institute was established in 1958, and produced at first pure uranium oxide from yellowcake, a product of uranium mining containing a mixture of uranium oxides and impurities. This was subsequently converted to uranium tetrafluoride (UF_4), also known as *green salt*, and further to UF_6 gas. UF_6 is typically used during enrichment in U-235 and as a basis for subsequent production of uranium metal, either in the form of low-enriched uranium (LEU) for nuclear reactor fuel elements or highly enriched uranium (HEU) for weapons purposes.

After the first batches were made, a larger plant for mass production of UF_6 was constructed in 1960 at a site in Juiquan in the Gansu Province. At the same site the first Chinese nuclear reactor for plutonium production was also built (see Section 4.4). In addition to the reactor, the Juiquan site had a conversion plant to produce UF_6 from yellowcake, a plant for producing uranium metal from UF_6 via UF_4, a nuclear component manufacturing plant, and plants for reprocessing spent nuclear fuel and producing plutonium by separating it from other components of the fuel [3]. It can therefore be assumed that much of the development of weapon parts also took place here.

Another fuel fabrication site, *Baotou Nuclear Material Plant* in Baotou in Inner Mongolia (Plant 202) [6], was built with Soviet support in the early period, beginning in 1956. At first, facilities at this site were used to produce UF_4, and later for both UF_6 production and for production of natural (un-enriched) uranium fuel for the plutonium producing reactor in Juiquan. It is not clear how much of this work was done in Baotou and how much was done on the Juiquan site itself, but [3] states that the first nuclear weapons did not use materials from Baotou, which was not yet producing materials of high enough quality, but from Tongxian and the Institute for Atomic Energy.

Later, Baotou was also used for production of lithium-6 deuteride, and other special materials which can be used in thermonuclear weapons (see also section 6.2). Today, this site is still used for fuel fabrication, both for civilian reactors and for nuclear submarines[2]. [6]

Norris, Burrows and Fieldhouse [2] state that the Juiquan site was also where weapon components of both uranium and plutonium were fabricated and that the final weapons assembly took place in a workshop on the same site.

In the late 1960s, a third line nuclear component production plant was built in Yibin in the Sichuan province, the *Yibin Nuclear Fuel Component Plant* (Plant 812) [6]. A new production facility for fuel for nuclear power plants was constructed in 1982 in connection with this site. This plant has later been modernized and the capacity increased several times. It is still in use today.

4.3 Enrichment of uranium

4.3.1 Gaseous diffusion enrichment plants

China is known to have constructed gaseous diffusion plants at two sites, the first in Lanzhou in the Gansu Province (Plant 504) and then a second one, as a third line facility, in Heping in Sichuan (Plant 814). [6]

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[2] Highly enriched uranium is often used in fuel for submarine reactors.

According to [3], the construction of the first Chinese uranium enrichment plant started in 1957 outside of Lanzhou in the Gansu province, near The Yellow River (Huang He). The plant was a gaseous diffusion enrichment plant, and since the construction began with Soviet assistance, it is often assumed to be based on the same type of technology as “D-1”, the first gaseous diffusion plant in the Soviet Union.

The town of Lanzhou is situated in the Gansu province, but is not quite as remote as the site in Juiquan where the uranium processing plants and the first plutonium producing reactor was built. In the 1950s, Lanzhou was a quickly-growing industrial city with both metallurgical and chemical industry.

While construction work on the reactor was halted in 1960, the work on the uranium enrichment plant continued, and the bomb used in the first Chinese test explosion on 16 October 1964 was a uranium-based fission device. [4].

According to [3], this plant was converted to producing LEU in 1980, but produced weapons grade HEU from about 1964. The capacity is estimated to be between 10 000 and 50 000 SWU[3], based on the capacity of Soviet plants from the same period. This capacity would equal a production of between 60 and 300 kg HEU a year.[7]

The second Chinese gaseous diffusion enrichment plant, *Heping Uranium Enrichment Plant* in the Sichuan Province, started production in 1975, as one of several third line facilities in Sichuan. It was converted to producing LEU from 1987. This plant is supposedly larger than the Lanzhou plant, but it is unknown how much larger. Norris, Burrows and Fieldhouse [2] states that the capacity of the Heping plant might have been up to 20 times larger, producing 750 – 2 930 kg HEU per year compared to 150 – 330 kg a year in Lanzhou, but this is not confirmed by later sources [8].

The *International Panel on Fissile Materials* (IPFM) report for 2011 [9] states that China has a stockpile of 16 ± 4 tonnes of HEU, and that an additional 4 tonnes probably have been consumed in nuclear weapons test explosions or as fuel for nuclear research reactors. If it is assumed that most of this HEU was produced at Heping, this gives an average production of ap. 1 800 kg per year over 11 years of production time, corresponding roughly with the above estimate from Norris, Burrows and Fieldhouse.

4.3.2 Gas centrifuge enrichment plants

China has three newer gas centrifuge enrichment plants for commercial LEU production for fuel for nuclear power reactors. There are two plants in Hanzhong, in the Shaanxi province, and one in Lanzhou. The plants are commercial, but not under International Atomic Energy Agency (IAEA) safeguards. All three plants were constructed with Russian assistance after a 1992 agreement. [7]

[3] SWU: *Separative Work Unit,* a unit used to express the isotope separation capacity of an enrichment plant.

4.4 Nuclear reactors

The first Chinese nuclear reactor was the Jiuquan reactor, also known by the code name Plant 404. Jiuquan is a prefecture in the Gansu province, bordering on the Gobi desert. The reactor is situated in an isolated area, with severe weather conditions. The work on the reactor was started in 1958, with Soviet assistance, with the aim of producing plutonium. It is therefore reasonable to assume that the reactor was similar to Soviet plutonium producing reactors built in the same period (for instance in Tomsk-7[4]). When the Chinese – Soviet nuclear cooperation ended in 1960, the construction work at Jiuquan was halted, but resumed again in 1962 [3]. The reactor started operating in 1966 or 1967.

According to [10] and [3] the Juiquan reactor was a graphite-moderated, light water[5] cooled reactor using natural uranium fuel. Ref. [10] further states that the fuel rods were aluminium cladded, with a layer of nickel between the uranium and the cladding. This is a design similar to an early dual-use Soviet design, a pressurized water-cooled, graphite-moderated reactor type, capable of producing both weapons-grade plutonium and heat and electricity. In 1958 the first of a series of these reactors was built in Tomsk-7 [11].

The design capacity 250 MW thermal energy for the Juiquan reactor was reached in 1975. Later in the 1970s, the reactor was improved and the capacity further increased to a maximum of 500 MW_{th}. Most sources claim that this reactor was shut down in 1984, but that the site today still contains a reprocessing plant for separating plutonium from spent fuel. [6]

According to [3], although the initial reactor construction was based on Soviet designs, the Soviet Union in the end supplied as little as 5 % of the components needed for the reactor. The rest, including the fuel rods, were produced in China.

In the 1970s, China is known to have built a second plutonium producing reactor at a different site, Guangyuan in the Sichuan Province, as a part of the third line construction policy. This site is sometimes referred to as plant 821 [6]. Even less is known about this reactor, but the same sources suggest it is similar to the first reactor in Jiuguan, but with a larger capacity [3;10].

This is an unusual type of reactor, and in the 1970s, several other more modern designs would have been a possibility, for instance the *Calder Hall* type gas cooled design or similar. Other states that were starting up nuclear programmes in this period started with a pool-type research reactor. The British Calder Hall or *Magnox* type plutonium-producing design would also have been a possibility, as the plans for this had been de-classified and presented at a conference under the Atoms for Peace programme in the 1950s[6].

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[4] Tomsk-7 (*Seversk* today) was one of the Soviet closed cities, where important nuclear weapons facilities were located.

[5] *Light water* in nuclear reactor context means ordinary water (H_2O) as opposed to heavy water (D_2O).

[6] The Calder Hall type reactors were graphite-moderated but gas-cooled (carbon dioxide) with a secondary cooling circuit of water (also used for raising steam for the power turbines). They used natural isotopic uranium in metal bars cladded with magnesium alloy (hereby the name Magnox). Metallic uranium fuel is

All sources do however agree that the Guangyuan reactor was of the same type as the first reactor built in Jiuquan, and this might imply that the focus at this point was more on enlarging the nuclear programme by copying existing designs than on new developments and improvements.

This Guangyuan reactor supposedly started operating in the mid-1970s, and ceased operating in the late 1980s. The capacity is said to have been increased over the period. A declassified United States intelligence report from 1974 [12] states that a second Chinese nuclear reactor would be ready to start operations in 1975, but does not give any information about the design.

4.5 Reprocessing

Both sites containing the plutonium producing reactors, the Juiquan site and the Guangyuan site, also had reprocessing plants for extracting plutonium from the spent fuel.

In Juiquan, a pilot plant which operated from 1968 to 1970 was subsequently replaced by a larger main plant that operated between 1970 and 1984. Lewis and Xue [2] state that although the Chinese used a different plutonium separation technique provided by the Soviet Union in the 1950s, they later switched to the PUREX[7] process, and both Juiquan plants used this technique. This is in accordance with [10], which states that the plutonium production capacity of the main plant can be estimated to be around 70 kg per year. A new reprocessing plant on the same site is supposed to have been planned from 1986, but did not start operations until 2010. This plant is also mentioned in Norris, Burrows and Fieldhouse [2] from 1994.

4.6 Estimated plutonium production 1960 – 1990

Because of the lack of information about the Chinese plutonium producing reactors (see Section 4.4), it is extremely difficult to give a reliable estimate of the total plutonium production from the start of the programme up to the present. Nevertheless, several analyses exist, and the numbers from these can be used to give a rough upper estimate of how many plutonium-based nuclear weapons China could have produced over the years. Thee such estimates are presented below.

4.6.1 Norris, Burrows and Fieldhouse, 1994

In *Nuclear Weapons Data book, Volume 5* from 1994, Norris, Burrows and Fieldhouse [2] describe the two Chinese plutonium producing reactors and make a rough estimate of how much plutonium could have been produced. Their conclusion is that at full capacity each of the reactors could have produced around 300 – 400 kg of plutonium a year, giving an upper limit of about 15 tonnes produced for the whole period. However, given that it is unlikely that the reactors were producing at full capacity all the time, an estimate of 4 – 7 tonnes would be more likely.

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much easier to dissolve in the reprocessing plant than is the later form of ceramic oxide pellets, and is therefore easier to use for plutonium production than more modern designs. Also, the low neutron flux density and short burn-up times of natural uranium metal fuelled reactors mean that the Pu-239 content in the plutonium is higher, making it more suitable for weapons production.

[7] PUREX, Plutonium Uranium Extraction, a modern standard method of separating spent nuclear fuel.

4.6.2 Wright and Gronlund, 2003

One estimate by David Wright and Lisbeth Gronlund was published in Science and Global Security in 2003 [10]. This estimate is based on information about the Juiquan reactor from the literature, assumptions of the size of the cooling towers (mainly from satellite images), the reprocessing capacity at the Jiuquan site and information from known American and Soviet plutonium producing reactors. It also assumes a content of between 3 % and 5 % of the isotope Pu-240 in the produced plutonium, which is high-grade weapons plutonium. The second reactor, at Guangyuan, is assumed to be of the same type as the first reactor, but larger. The estimate also takes into consideration that there will in all likelihood have been considerable reactor downtime during the production, as well as other wastes and losses.

Their conclusion is that the total production at Jiuquan has been in the range of 0.5 to 1.5 tonnes; while between 1.5 and 3.5 tonnes would have been produced at Guangyuan. This gives a total Chinese production of weapons grade plutonium of between 2 and 5 tonnes, considerably less than the upper limit estimate in Nuclear Weapons Databook.

4.6.3 Hui Zhang, 2011

A new estimate of total Chinese plutonium production was published in Science and Global Security in 2011 by Hui Zhang from the Project on Managing the Atom at the Kennedy School of Government at Harvard University [8]. Hui Zhang's estimate is also included in the *International Panel on Fissile Materials* (IPFM) report for 2011 [9], a widely used source on fissile materials stockpiles.

Hui bases his estimate on the same information used in Wright and Gronlund, but in addition he uses several recently declassified Chinese documents that describe the construction and early running of the two plutonium production reactors. These documents reveal several problems encountered during this phase which slowed down the production. They also imply that the design power of the Guangyan reactor was not much larger than that of the Jiuquan reactor, but that it was somewhat more efficient at producing plutonium.

Hui ends up with a total estimate of 1.8 ± 0.5 tonnes. This is much lower than most previously published estimates, including the two mentioned here.

5 Chinese nuclear tests

China conducted its first nuclear test on 16 October 1964. This first test was a uranium-based fission bomb with a yield of 22 kt [4]. Three years later, in December 1967, the Chinese conducted their first full-scale test of a two-stage thermonuclear weapon, a 3.3 megaton (Mt) test explosion of a thermonuclear device using only uranium as fissile material, no plutonium. It is not known whether any other state had succeeded in building a thermonuclear bomb without plutonium at that time. Plutonium was not used by the Chinese until December 1968 in another

3 Mt explosion, the eighth Chinese nuclear test all in all. All these first tests were various types of atmospheric explosions, from towers, airplanes and even, in one case, a missile[8].

All Chinese nuclear test explosions have been conducted at Lop Nor (also spelled *Lop Nur*), a desert area in the Xinjiang province in the north east of China (Figure 5.1). A total of 47 tests were conducted at this site between 1964 and 1996, with a total yield of more than 22 000 kt, including about 21 000 kt from atmospheric explosions. [4]

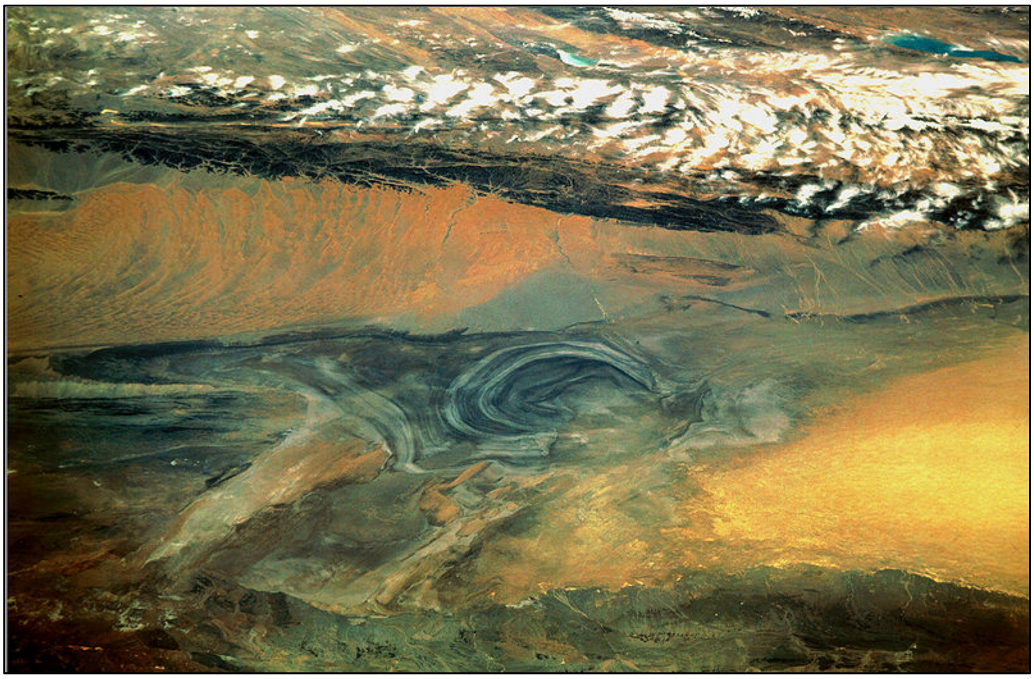

Figure 5.1 Satellite image of the desert area of Lop Nor (Wikipedia Commons)

In 1966, a missile was tested with a live nuclear warhead, resulting in an explosion with a yield of 12 kt. The missile, probably a DF-2 (see Section 9.2), was apparently launched from a missile base in the Gansu province to the Lop Nor test site, crossing several populated areas along its way. One source, Mark A. Stokes from the *Project 2049 Institute* [13], claims that this very risky test launch might not have been properly authorised within the government, but was rather a result of the chaos and fighting for power that took place during the Cultural Revolution.

The first Chinese underground nuclear test explosion took place in 1969, but China continued with atmospheric explosions also after this. The largest Chinese thermonuclear explosion recorded, was a 4 Mt explosion conducted in 1976. Atmospheric nuclear explosions, and especially explosions conducted close to the surface, create nuclear fallout that may be transported over large areas. Fallout from the tests in Lop Nor has been suspected of being the cause of elevated cancer rates in the area (see for instance [14]), but the Chinese government denies this.

[8] Atmospheric explosions make it possible to deduce the type of fissile material used from the composition of the fallout.

6 Nuclear weapons before 1970

6.1 The first nuclear weapons

The first Chinese nuclear explosive device was apparently of a relatively simple design. Most sources claim that the early designs were based on information received from the Soviet Union. However, Lewis and Xue [3] state, based on interviews with Chinese specialists, that at the early stage, the Chinese had only general information about possible nuclear weapons designs. Both gun-barrel and implosion designs were considered, but a decision was made to focus on implosion due to a need to save fissile material, even though this was expected to be more difficult to carry out.

In the book Lewis and Xue also describes experiments on different types of conventional high explosives required for the weapons at a site close to Beijing, as well as calculations for explosive lenses based on general mechanical principles, performed without the use of computers. Because of the lack of a proper theoretical background, more than a thousand prototype implosion constructions were made and tested before they had one they assumed would work.

Lewis and Xue [3] states that the first device used about 1000 kg of high explosives and more than 24 detonators; however, this seems to be based on a comparison with the first American implosion bombs, rather than any specific information about the Chinese device. In an article from 1987 [5], Lewis and Xue also state that the first Chinese nuclear weapon probably was fitted with a polonium-beryllium neutron initiator.

> There are two main designs for fission bombs.
> In a **gun-barrel** design, one piece of fissile material is fired into another piece so that the two pieces together constitute at least one *critical mass* of the material, the amount necessary to produce a self-sustaining nuclear chain reaction. This design is relatively simple to build, but it can only be used for uranium, as the joining method is to slow for plutonium.
>
> In an **implosion design**, the material is compressed by conventional explosives. When the fissile material is compressed, less of it is needed to sustain a nuclear chain reaction (i.e., its critical mass is reduced and a chain reaction may take place). This method can be used for both plutonium and uranium, and requires considerably less fissile material than a gun-barrel bomb. However, constructing a functioning implosion design is more demanding than the construction of a gun-barrel design.

6.2 More advanced nuclear weapons designs

It is not clear how much nuclear weapons design information the Chinese had received from the Soviet Union before the cooperation ended, and how much they developed themselves. However, the Chinese seem to have improved their nuclear weapons capabilities on their own quite quickly after the first test explosion.

The first test device burning thermonuclear fuel was detonated as early as two years after the first nuclear test, in May 1966. This test resulted in a 250 kt explosion [4]. The use of thermonuclear fuel in a weapon is not the same as having developed a complete thermonuclear weapon; thermonuclear fuel (deuterium and tritium or lithium) is used for “boosting” fission weapons by increase the number of neutrons available so that a larger part of the fissionable material will fission before the bomb blows itself apart. This can increase the yield substantially.

Even more advanced designs followed soon, and a first test of thermonuclear two-stage principles was conducted in December 1966, resulting in a yield of 120 kt. A two-stage weapon consists of a fission device as a primary charge, which sets off a more complicated secondary charge containing both fissionable materials and thermonuclear fuel. The thermonuclear fuel in the secondary charge is made to undergo fusion by the radiation burst from the primary charge.

A first full-scale test of a two-stage thermonuclear weapon was conducted in December 1967, resulting in a 3.3 Mt explosion. This test was an airdrop, suggesting that the physical size of the device must have been relatively small, compared to early two-stage devices made by other states. The first American complete thermonuclear device was an enormous construction that required cooling by liquid helium [15].

None of these first Chinese devices used plutonium, only enriched uranium. This is unusual when compared to what is known of the development of thermonuclear weapons in other nuclear weapons states. While the use of uranium only does not change the physical principles involved in thermonuclear weapons, it suggests that the primary charge would have to be larger, implying that the complete weapon could not simply be a copy of an existing foreign design. The first recording of a Chinese test device utilizing plutonium was a December 1968 explosion, yielding 3 Mt [4].

7 The nuclear programme after 1970

Very little is publicly known about Chinese nuclear weapons developed after the period up to 1970 covered by Lewis and Xue in *China builds the bomb* [3].

7.1 Development

The main aim of the Chinese nuclear weapons programme after the development of the first weapon types was most likely a reduction in size and weight in addition to improvements in reliability and efficiency in the use of materials. A reduction in size is necessary on order to produce warheads that can be delivered by long-range ballistic missiles. From the 1970s to the present, China has developed a range of nuclear capable missiles, including submarine launched missiles (SLBM). (See Chapter 9 on delivery vehicles.)

7.2 Estimated arsenal

China does not publish any official records of its nuclear arsenal. Information must therefore be based on other sources, such as official reports from other states, declassified intelligence reports and independent experts.

Norris, Burrows and Fieldhouse [2] state than by 1994, China had developed at least six types of nuclear bombs and warheads. This included two types of bombs for airplane delivery, one fission bomb with a yield between 20 kt and 40 kt and one thermonuclear bomb with a yield of about 3 Mt. There were four types of warheads for missiles, one small fission weapon of approximately 20 – 40 kt, two types of thermonuclear warheads for ground-launched missiles with yields of 3 Mt and 4 – 5 Mt, respectively, and one warhead for submarine-launched missiles of 300 – 400 kt.

Norris, Burrows and Fieldhouse [2] further state that the number of bombs for airplane delivery grew from 45 in 1970 to 150 in 1985, and was kept stable up to 1993. This number is an estimate, based on the number of nuclear capable airplanes. The total number of nuclear warheads for missiles is estimated to have grown from about 75 to more than 400 in the same period.

Other sources have considerably lower estimates for the total number of warheads. A partially declassified American Central Intelligence Agency (CIA) document from 1996 [16] states that China had an arsenal of estimated 200 – 300 deployed nuclear weapons. The report also states that China probably used the same warhead for different missiles.

In the *Nuclear Notebook* series published by the Bulletin of the Atomic Scientist, Kristensen and Norris estimate that the total number of Chinese nuclear warheads was only about 240 as late as in 2011, including about 178 deployed warheads [17]. This is based on information given in the annual reports to congress from the United States Office of the Secretary of Defense on *Military and Security Developments Involving the People's Republic of China* for several years up to 2010. Kristensen and Norris state that the arsenal includes warheads deployed on several different missiles, (DF-3A, DF-4, DF-5A, DF-21, DF-31 and DF-31A, with the largest number, around 60, on DF-21), as well as around 40 gravity bombs for aircraft delivery, of which about half are deployed. (See also Chapter 9 on delivery vehicles.)

8 Accusations of espionage

In January 1999, a committee on U.S. national security and military/commercial concerns with The People's Republic of China delivered a report to the House of Representatives regarding suspicions of extensive technical Chinese espionage against the United States, especially in the fields of nuclear weapons, supercomputers, missiles and space technology. The representative Christopher Cox (R-CA) was chairman of the committee, and the report is therefore often referred to as the Cox report. An unclassified version of the report was published later the same year [18].

The report describes the case of Peter (Hoong-Yee) Lee, a naturalized American born in Taiwan who between 1973 and 1997 worked as a scientist at several American laboratories which does nuclear weapons related work. Lee was accused of giving information to China about laser systems used to simulate nuclear fusion processes between deuterium and tritium on a small scale. (This can be used to advance the design of nuclear weapons without full-scale testing.) He was arrested and sentenced to a fine and one year in containment in 1998. Lee had also been investigated for transferring information about sensitive submarine detection systems, but was not charged for this, according to the report, in part because the United States Department of Defense was concerned that further investigation would compromise these sensitive systems further. The Cox committee believed that Lee had provided more information about thermonuclear weapons to the Chinese authorities than the investigation revealed, and that he was only one of several scientists involved in similar activities.

The Cox report was criticised for being too categorical based on little concrete evidence. Based on recommendations in the report, the United States administration set up a new team of intelligence experts to assess the damage from the alleged Chinese espionage, and an independent panel of nuclear weapons experts to review the assessment. The new report, published in 1999, contradicted the Cox report on many points. Although it was possible that China had gained information about nuclear weapons design by spying on the United States, it was also possible that the information could have been obtained from other sources, including espionage on other states, open publications, or indeed simply indigenous work in China. There was not enough evidence to draw any firm conclusions. [19]

It can also be mentioned that a partially declassified CIA document from 1996 [16], points to Russia as an important source for China's nuclear weapons programme, going as far as to say that "Russian nuclear weapons laboratories remain Beijing's primary source of equipment and technology". Shock waves and detonation physics as well as stockpile stewardship and diagnostic testing are mentioned as areas were Russian nuclear weapons laboratories have been assisting China.

With access to only the unclassified version of the Cox report, which does not contain much information on the basis for the statements, it is very difficult to assess the validity of the accusations. However, the report does contain information about the more recent developments of the Chinese nuclear weapons programme which is difficult to find in other sources.

8.1 Chinese tests of modern nuclear weapon types

The PRC likely does not need additional physical tests for its older thermonuclear warhead designs. But maintenance of the nuclear weapons stockpile for these weapons does require testing. The ban on physical testing to which the PRC agreed in 1996 has therefore increased the PRC's interest in high performance computing and access to sophisticated computer codes to simulate the explosion of nuclear weapons. (The Cox-report [18])

The Cox-report states that in the late 1970s, the Chinese saw a need to modernize their nuclear arsenal, and realised that upgrading it to the level of the other four nuclear weapons states, would demand enormous resources and be very difficult. According to the report, the Chinese then activated an espionage programme targeted at the United States nuclear weapons programme, often using ethnic Chinese scientists and engineers living in the United States.[9] Since the 1970s,

[9] It can be noted that based on the information in the nuclear test catalogue [4], the Chinese weapons programme seems to have developed unusually quickly also before the late seventies. Only three years

the Chinese have constructed lighter and more compact thermonuclear warheads for placement on missiles on mobile platforms, either road mobile platforms or submarines. The Cox report claims that the last series of nuclear tests in China, conducted before it joined the Comprehensive Test Ban Treaty (CTBT) in 1996, was a series of test of such weapons. According to [4], China conducted ten tests between 1992 and 1996, of which three were small explosions with yields below 20 kt and seven were "medium sized" explosions with yields between 20 kt and 150 kt.

Before this last series of tests, China had only conducted 37 nuclear tests. The Cox report claims that this is too few for China to have developed such small warheads based on data from their own tests alone, so they must have gained additional information from somewhere else. As Russian warheads are developed for larger missiles that can carry heavier payloads, the only likely source is the United States. The report argues that China must have stolen either warhead designs or computer simulation tools, or most likely both. The same argument is used for warhead maintenance. The reliability of complicated warheads deteriorates over time, due to chemical interactions between different materials inside the warhead, radioactive decay etc. By the time China joined the CTBT, they had not had such warheads long enough that they could have studied the development of them over time. The report mentions specifically computer codes used for maintenance planning of the American *W-88/Trident D-5* warhead at Los Alamos National Laboratory as something that must have been stolen.

8.1.1 The neutron bomb, W-70

The Cox report states that the Chinese tested an *enhanced radiation* nuclear warhead, a so-called *neutron bomb* in 1988. Only one Chinese test explosion in 1988 is mentioned in *Catalog of Worldwide Nuclear Testing* [4], an underground test with a yield of less than 20 kt. The test is described as "weapons related", but no other information about the purpose is available. Neutron bombs are weapons designed to release relatively large amounts of neutron radiation compared to their explosive yield. This constitutes a weapon that would kill people (and other living beings) while leaving infrastructure intact. During the cold war, this type of weapon was developed in the United States with the purpose of stopping a possible Soviet invasion of Europe, but none were deployed. The idea of this kind of weapon was very unpopular in most circles, and neutron bombs were feared to lower the threshold for a nuclear war. From 1985 warheads were no longer built with this capability, and the last ones were retired from service in 1991. [20]

The W-70 was one of the American warheads built with an enhanced radiation capability. It was relatively small and designed for use in the battlefield. The Cox report claims specifically that this design must have been stolen and copied by the Chinese at some time in the late 1970s or early 1980s.

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between the first test of a fission weapon (1964) and a full thermonuclear device (1967) implies very rapid progress.

8.1.2 Modern, small thermonuclear warheads, W-88

In 1995, following the CIA's receipt of evidence (provided by the PRC-directed "walk-in"[10]) that the PRC had acquired technical information on a number of U.S. thermonuclear warheads, including not only the W-88 Trident D-5 but five other warheads as well, the Department of Energy's investigation intensified. That investigation, however, focused on the W-88 and not the other weapons. (The Cox report [18])

The Cox-report states that the designs of W-88 and several other modern American thermonuclear warheads were stolen by the Chinese between the late 1970s and 1996. The first version of the warhead that was later named W-88 was developed in the late 1950s. This warhead differed from other older types of thermonuclear weapons by having a non-spherical primary charge (fission stage), which made it possible to reduce the size of the warhead considerably. The secondary (fusion stage) of the warhead is supposed to be spherical. Chinese modern thermonuclear warheads are stated to have the same combination of a non-spherical primary charge and a spherical secondary charge. [21]

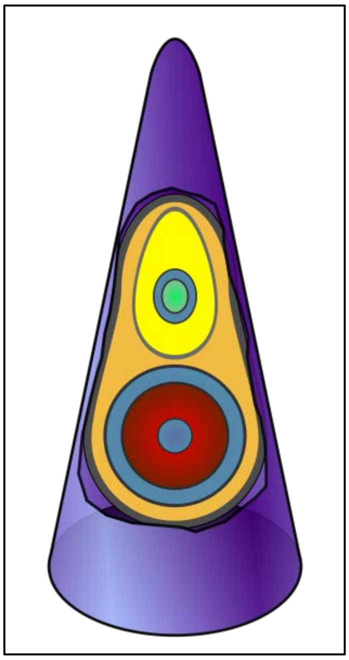


Figure 8.1 Sketch of the idea of a thermonuclear warhead with a non-spherical primary charge. In the drawing, the primary (in yellow) is slightly egg shaped, while the secondary (red and blue) is spherical. (Picture: Wikipedia Commons)

As mentioned, this combination makes it possible to reduce the size of a warhead considerably. This is especially important for a state that seeks the capacity to place more than one warhead on one missile, so-called multiple independently targetable re-entry vehicles (MIRV). An important advantage of MIRVed missiles is that they are better able to resist anti-ballistic missile systems.

[10] A "walk-in" is a term used in intelligence circles describing an incident where a person hands over information on his or her own initiative, without being prompted.

9 Delivery vehicles

This section reviews development and testing of missiles and other delivery vehicles in China and how this relates to the suggestions in the American reports and other sources.

9.1 Airplanes

China is assumed to have a very small number of aircrafts capable of delivering nuclear bombs, most importantly the H-6 bombers (Figure 9.1), which have been in use since the 1960s. These planes have a range of 3 100 km, and can carry one bomb each. An American official report from 2012 [22] claims that the H-6 might also be supplied with a limited-range nuclear capable cruise missile (DH-10), but this is not certain. According to both [22] and [17], China has approximately 20 deployed H-6 bombers.

Figure 9.1 A Chinese H-6 Bomber (Photo: Scanpix)

9.2 Missiles

The China Academy of Launch Technology (codename Project 2049), is the research and development organization mainly responsible for ballistic missiles and launch systems.
China tested its first domestically built ballistic missile on 5 November 1960. This was a version of the Soviet short-range missile R-2. Production of this missile continued until 1964, and the Chinese-built missiles were renamed *Dong Feng 1*, meaning East Wind (see Figure 9.2). These first missiles were not nuclear-capable. [2;6]

Figure 9.2   Dong Feng 1 in a military museum in Beijing (Photo: Scanpix/AFP-Stephen Shaver)

From the 1960s up to the present day, China has developed several different missiles in the Dong Feng (DF) series, some with nuclear capabilities and some without, see Table 9.1.

DF-2 was the first Chinese nuclear capable missile. This was probably the missile involved in the 1966 nuclear test explosion delivered by a missile (se Chapter 5). DF-2 was followed by various other missiles. DF-3, DF-4 and DF-5 were all liquid fuel, nuclear-capable missiles, and have been deployed in large numbers.

DF-21 was developed in the mid-1980s and is a short-range missile using solid propellant. One advantage of solid fuel is that it can be stored in advance inside the missile, considerably reducing the time necessary to prepare the missile for launching. There are several varieties of the DF-21, including both nuclear-capable and conventional varieties[11]. DF-21 and DF-21A are believed to be nuclear capable, while DF-21C (thermally-guided) is described as dual use and DF-21D (maritime) as conventional [23]. DF-21C and DF-21D are probably deployed. [24]

[11] The use of one type or similar missiles for both nuclear and conventional warheads is worrysome to analysts because it increases the risk of a conventional missile being mistaken for a nuclear one, which could unintentionally escalate a conflict.

Figure 9.3 A DF-31 missile being paraded in 1999 (Photo: AP photo Greg Baker/Scanpix)

DF-31 and DF-31A are the two newest Chinese Nuclear capable missiles (Figure 9.3). They are both solid-fuel, long-range missiles, with ranges of at least 7 200 km and 11 200 km, respectably. Jane's Strategic Weapon Systems states in an overview article from 2012 [25] that both missiles are believed to have three solid propellant stages, or two solid propellant stages and a payload bus. The article gives a total length of 13.0 m for DF-31 and 18.7 m for DF-31A, but states that these numbers are uncertain. These missiles have been deployed since 2006 or 2007. Modern Chinese missiles are assumed to be road-mobile, and in some cases transported by railway. There is also information that China has built tunnels through mountain ranges for transportation of missiles and missile launchers [26]. This is in accordance with the Chinese strategy of having a relatively small nuclear arsenal, but to keep the whereabouts of the missile launchers and the exact size of the arsenal as secret as possible.

There have been speculations that China is developing technology to fit several warheads on one missile, MIRV, but no observations of any actual tests of MIRVed missiles have so far been confirmed. DF-31 and DF-31A are probably too small to carry several warheads. There are speculations that one missile tested in 2012, DF-41, could be MIRV-capable, but this has not been confirmed [22;27].

According to a report published by the Swedish Defence Research Agency (FOI) in 2003 [24], DF-3 is in the process of being replaced with newer DF-21 missiles, DF-4 with DF-31, while DF-5 possibly is being kept for the time being, and might be reconfigured for MIRV. DF-5 is considerably larger than the newer DF-31 and DF-31A, according to Jane's [25;28], DF-5 is 36 m long and has a diameter of 3.6 m as opposed to about two meters for DF-31. Kristensen and Norris [17;23] from 2010 and 2011 are in accordance with FOI when it comes to the replacement of the DF-3 and DF-4 missiles, but state that it is unclear what will happen to the DF-5 missiles.

Missile name	Approx. range (km)	Fuel type	First recorded testing	Nuclear capable
DF-1	Short	Liquid	1960	No
DF-2	Medium	Liquid	1964	Yes
DF-3A	~ 3 100	Liquid	1966	Yes
DF-4	> 5 400	Liquid	1970	Yes
DF-5	13 000	Liquid	1971 (1980 full range)	Yes
DF-15	600	Solid	1984	No (?)
DF-21/DF-21A	1 800	Solid	1985	Yes
DF-31	> 7 200	Solid	1995	Yes
DF-31A	> 11 200	Solid	2008	Yes
DF-41	Unknown	Unknown	2012	Unknown
JL-1 (SLBM)	~ 1 000		1986	Yes
JL-2 (SLBM)	> 7 200	Solid	2002	Yes
DH-10 (Cruise missile)	~ 4 000		?	Dual use?

Table 9.1 Some of the Chinese missiles developed since the 1960s. ([2;17;24;25]

China has one type of cruise missile, Dong Hai 10 (DH-10), which some sources (see e.g. [17]) claim that could be dual use, even if there are probably none deployed with nuclear warheads today.

9.3 Submarines

China has both conventional and nuclear reactor powered submarines. Only the nuclear powered submarines are assumed to be armed with nuclear missiles.

9.3.1 The *Xia* class (Daqingyu, Type-092)

China's first nuclear powered, ballistic missile capable submarine was launched in 1981 and declared operational in 1986. This submarine class was given the codename *Xia* in the West, the Chinese name is supposedly *Daqingyu.* The submarine could be fitted with up to 12 Julang-1 (JL-1) missiles (see Table 9.1). However, most experts believe that this submarine class has been less than successful. Only two submarines have been completed and set afloat, and the only one remaining today has been in dry dock at the Jianggezhuang Naval Base at the east coast of China since 2008. [2;6]

9.3.2 The *Jin* class (Type-094)

China is currently developing a new submarine class referred to as the *Jin* class in the West, which is expected to replace the Xia class. The new submarine is believed to be fitted with twelve new JL-2 ballistic missiles (Table 9.1), but is still undergoing testing. JL-2 may be a submarine-launched version of the DF-31 long-range ballistic missile [6]. Two of five planned

Jin-class submarines are supposedly already deployed to the Navy for testing, but a report from the American Office of the Secretary of Defense from 2012 [29] states that the submarines are not yet fully operational, but are expected to be so within two years, i.e. in 2014.

10 Organisation

10.1 Doctrine and policy

From the time the nuclear weapons programme was started in the 1950s, China has always maintained that it will follow a strict *no first use* policy. This policy is quoted as: *"China will not be the first to use nuclear weapons at any time and under any circumstance, and unequivocally commits that under no circumstances will it use or threaten to use nuclear weapons against non-nuclear weapon states or nuclear weapon free zones."* [29]

In addition to this, China maintains that their policy is according to "*Maoist principles*", which probably means the policy Mao established while he was the Chairman of the Communist Party, the policy of *nuclear restraint.* Instead of developing a large arsenal, China has relied on secrecy about how many weapons it has, which type of weapons and where the weapons are placed. This is sometimes referred to as a policy of *quantitative and geographic ambiguity*.

While the Chinese public policy regarding nuclear weapons is very clear, no first use and no use against non-nuclear weapons states, the nuclear doctrine, the practical strategy for use of the weapons in a given situation, is more obscure and subject to significant levels of secrecy [30]. However, several sources point out that several Chinese military procedure handbooks and exercises focus on a tactic of Delayed Nuclear Counterstrike [22;31]. After a first nuclear strike from an adversary, the unit i charge of the nuclear missiles, the Second Artillery Force (see section 10.3) will lock itself down in secure bases for some time before launching a counterstrike.

10.2 International treaties and cooperation

In 1984, China joined the IAEA. China did not become a member of the NPT until 1992, despite being a recognised nuclear weapons state under the treaty. At this occasion, China stated that although it had always been and still was highly critical of the NPT's discriminatory nature, which allows some states the right to have nuclear arms while denying this to other states, it supported the aim of non-proliferation and disarmament. Since 1996, China has also been a signatory of the CTBT, but it has not yet ratified it. In 2004, China became a member of the Nuclear Suppliers Group (NSG), an international regime for export control. [6]

10.3 System

The Chinese nuclear capable missiles are organized under the so-called *Second Artillery*, sometimes also referred to as the *Chinese Strategic Rocket Force*. This unit is also believed to handle missiles with conventional warheads.

Norris, Burrows and Fieldhouse [2] include a description of the Second artillery as it was thought to operate in 1994. The Second Artillery was organised in smaller launch units. Each unit was responsible for a small number of missiles, possibly as small as one or two, of just one missile type. These units were then grouped according to geography. This manner of deploying the missiles in very small units was part of a strategy of reducing vulnerability by concealing and spreading the weapons out as much as possible. The nuclear capable bombers on the other hand were placed under the jurisdiction of the Air Force, while the nuclear submarines were placed under the Navy, as a part of the Chinese North Sea Fleet.

From 1954, the Second Artillery was under the direct command of the *Central Military Commission* (CMC), the organisation also indirectly in charge of the rest of the Chinese military forces: the PLA and the Ministry of Defence. The CMC worked on behalf of the Chinese Communist Party (CCP) Central Committee Politburo. Confusingly enough, in 1982, the Chinese established another Central Military Commission, without removing the first one. This new CMC was organised under the National People's Congress, a state organ roughly corresponding to a parliament. In reality, most of the members of the two CMCs were the same people, and the new organisation did not change the control over the nuclear capable missiles.

There is however reason to believe that the organisation of this part of the Chinese military has been reorganised and modernised after 1994. More information about how the present Chinese nuclear weapons capacity is organised, can be found in the 2012 Report to Congress of the *U.S.-China Economic and Security Review Commission* [22]. The section in this report about China's nuclear development, describes the Second Artillery as an independent branch of the PLA, under direct control of the CMC, which reports to the CCP Central Committee. While ultimately also under the control of the CMC, the remaining parts of the PLA (including the Air Force and Navy) are separated from it by a longer chain of command. Important military and civilian state officials are members of the CMC, including in 2011 both China's President (*Hu Jintao*) and Vice President (*Xi Jinping*, since November 2012 China's President), but their authority within the CMC followed their ranks in the Communist Party, not their position in the government.

From the start, China seems to have upheld its minimal credible deterrence doctrine with a policy of quantitative and geographic ambiguity. China has been dividing its nuclear capable missiles between a large number of launch sites in strictly secret locations, developing mobile missile launching platforms and a large system of tunnels that can be used to move nuclear capable missiles in secrecy. The aim of this seems to be to decrease the risk that an adversary would be able to take out China's entire nuclear arsenal in a first strike, while still keeping the actual number of nuclear warheads quite small.

11 Summary

Although China has had nuclear weapons since the 1960s, and is a recognised nuclear weapons state under the NPT, their arsenal is believed to be relatively small. Most modern sources estimate around 250 deployed weapons, dispersed between several types of ballistic missiles and gravity bombs for aircraft delivery. China is assumed to be in the process of developing MIRV technology, but does not yet have deployed missiles with this capacity.

The size of China’s total stockpile of fissile materials, weapons grade plutonium and highly enriched uranium, is clouded in secrecy. IPFM’s report for 2011 [9] estimates a total stockpile of 16 ± 4 tonnes of HEU and 1.8 ± 0.5 tonnes of weapons grade plutonium, an estimate lower than those previously published. However, even accepting the lowest of the reasonable estimates, China has more than enough fissile materials to maintain and increase its current nuclear arsenal for the foreseeable future.

Instead of developing a large arsenal, China has since the beginning of its nuclear weapons programme chosen to maintain a policy of quantitative and geographic ambiguity, meaning that the exact size of the arsenal and the location of the bases where the weapons are located are kept strictly secret. China seems to be continuing this policy by developing missiles that can be launched from mobile platforms, both on land and on the sea, and by maintaining a set of tunnels that missiles can be transported through without being seen from the air or by satellites.

List of abbreviations

CMC – Central Military Commission

CTBT – Comprehensive Nuclear-Test-Ban Treaty

CTBT – Comprehensive Test Ban Treaty

FOI – Swedish Defence Research Agency

HEU – highly enriched uranium

IAEA – International Atomic Energy Agency

IPFM – International Panel on Fissile Materials

LEU – low-enriched uranium

MIRV – multiple independently targetable re-entry vehicles

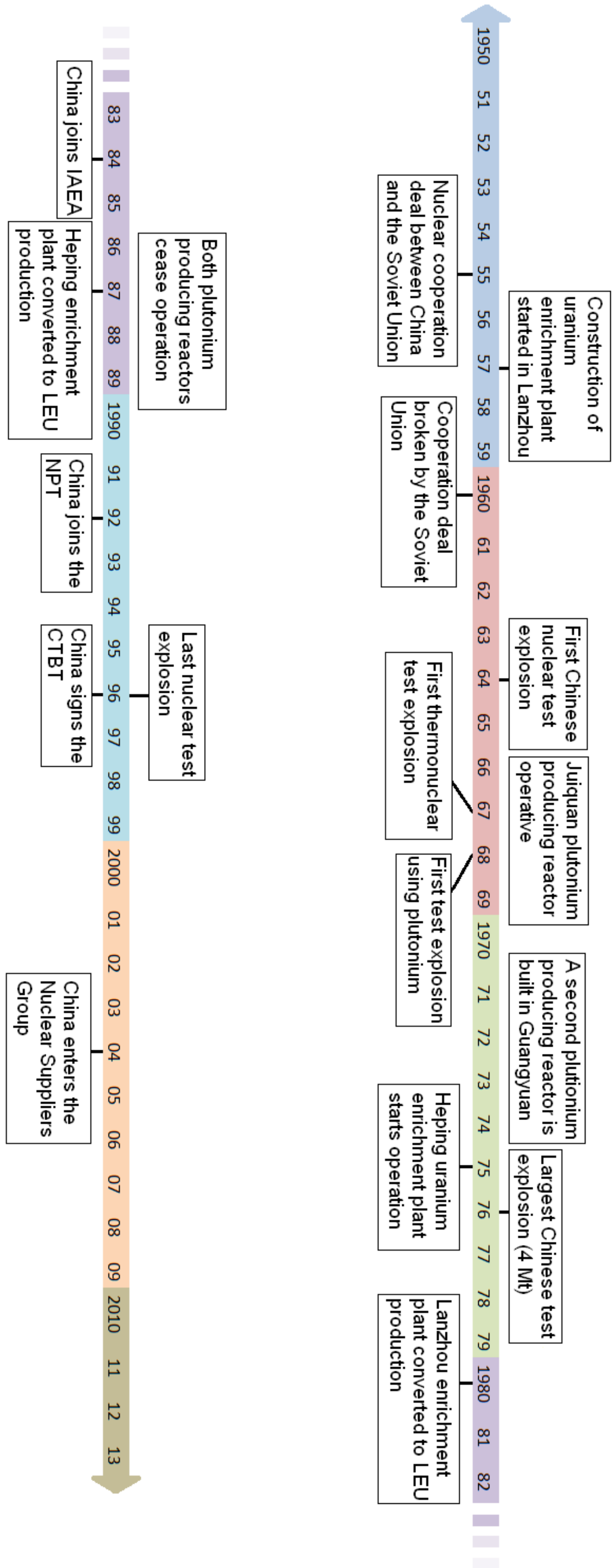
NPT – Treaty of the Non-Proliferation of Nuclear weapons

PLA – People’s Liberation Army

PRC – People's Republic of China

PUREX – plutonium uranium extraction

Appendix A Timeline of the nuclear weapons programme



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