DIIS REPORT

DIIS REPORT

Tamara Patton Schell

Governing Uranium in China

DIIS Report 2014:03

STOCKHOLM INTERNATIONAL
PEACE RESEARCH INSTITUTE

DIIS · DANISH INSTITUTE FOR INTERNATIONAL STUDIES

Danish Institute for International Studies, DIIS
Østbanegade 117, DK 2100 Copenhagen
Ph: +45 32 69 87 87
Fax: +45 32 69 87 00
E-mail: diis@diis.dk
Web: www.diis.dk

Layout: Mark Gry Christiansen
Printed in Denmark by Vesterkopi AS

ISBN 978-87-7605-657-5 (print)
ISBN 978-87-7605-658-2 (pdf)

Price: DKK 50.00 (VAT included)
DIIS publications can be downloaded
free of charge from www.diis.dk
Hardcopies can be ordered at www.diis.dk

Tamara Patton Schell, patton@sipri.org

Contents

Summary

China has quickly risen to the status of a key player in the international uranium market, a trend maintained by its ambitious nuclear energy expansion plans and diverse uranium procurement strategy. At the same time, China seeks to build an image as a state that is complicit with international arms control and non-proliferation norms and obligations in order to strengthen its position in an increasingly competitive global uranium market place. In the wake of the Fukushima nuclear accident, the Chinese government is also seeking to reassure its wary public that the government is capable of managing uranium and other radioactive materials in a safe and secure manner. With uranium ore concentrate (UOC) in the early stages of the nuclear fuel cycle existing as a traditionally loosely regulated commodity, these driving forces bring to light the question of whether Beijing possesses the necessary regulatory infrastructure to ensure the safety, security, and non-military use of UOC, and how any existing gaps in the system might be addressed.

This case study is part of a larger project on global uranium governance, led by the Danish Institute for International Studies (DIIS), which seeks to identify governance gaps in uranium accountability and control and provide policy recommendations for improving front-end transparency, security, and regulation. This report investigates the many intricacies of China's vast and growing governance structure surrounding uranium. It examines China's evolving uranium procurement strategy and regulatory agencies and dissects the many interwoven pieces of legislation that control uranium in its various forms. Based on the nature of China's uranium procurement activities, both domestically and abroad, it also makes recommendations on how UOC can be better captured by the existing nuclear governance system in order to ensure the security of this material, as well as possibly enhance China's long-term UOC procurement efforts.

China's uranium governance structure remains a dual civil-military bureaucracy, not so much due to military entities directly exerting influence, but rather because civilian regulatory agencies under the State Council possess dual civil-military mandates. China's large State-owned enterprises (SOEs), and the China National Nuclear Corporation in particular, are at the core of this integration, contributing to both China's civilian and military nuclear objectives. In recent decades, there has been a significant expansion of civilian regulatory capacities relevant to uranium under the

State Council. China now possesses a robust interagency licensing process, involving many organizations and theoretically involving many layers of oversight. However, there remain difficulties with the hierarchical nature of China's bureaucracy and key uncertainties over whether smaller, lower-ranked regulatory agencies can exert an effective level of authority over China's powerful SOEs.

In addition to the growth and development of new civilian regulatory agencies, China has also expanded the breadth of legislation governing uranium. With regard to UOC, a significant hindrance to progress in this regard concerns the need to clarify definitions related to natural uranium and uranium ore concentrate in key regulations. The common usage of the term 'natural uranium', left undefined throughout the legislation, results in imprecise definitions as to the legal standing of uranium ore concentrates (U_3O_8) and UF_4 compared to the relatively clearer legal status of UF^6 and UO_2 as clearly safeguarded materials. There is also uncertainty over whether uranium ore concentrates (UOC) actually qualify as 'uranium ore' or if UOC could in some cases be considered a source material. Given that uranium ore is discounted in many key pieces of Chinese legislation, this uncertainty represents a serious gap.

Certain challenges regarding the monitoring of UOC in China have to do with the already limited scope of safeguards in the country given China's status as a Non-Proliferation Treaty (NPT) Nuclear Weapon State. As of 2013, safeguards are only applied at one front-end fuel cycle facility. In addition, Chinese national legislation does not seem to treat UOC as a source material or special fissionable material. UOC could still be subject to safeguards in the context of a bilateral agreement, though given that China's conversion facilities are not under safeguards, it remains unclear exactly how these bilateral requirements will be met.

In general, the perception among Chinese interviewed for the report was that regulatory resources need to be directed to uranium at later stages of the fuel cycle and that regulation of early-stage uranium is unlikely to become a priority in the near future. However, the findings of this report indicate that China may be forced to develop its regulations and oversight of early-stage uranium further if it continues to diversify its procurement plans. As it procures uranium from countries with strict IAEA safeguards standards, or draws uranium from unconventional sources imported from abroad, China could run into unwanted barriers in the international market place unless it gives consideration to these issues.

Nuclear Energy Overview

Nuclear power development goals

Nuclear power is playing an increasingly prominent role in China's long-term strategic energy calculus, and this will continue to drive an increasingly diverse and vigorous uranium procurement strategy. Consisting of only 1.93% of generated electricity in 2013, nuclear power has remained the smallest fraction of China's energy makeup compared to the consumption of oil, natural gas, coal, and hydropower (Figure 1). However as China progresses through its 12th Five Year Energy Development Plan (2011-2015), the government has been vocal about plans to alter this balance.[1] Qian Zhimin, a former official of the National Energy Administration (NEA), argued that by 2020, nuclear power could be contributing 7%-8% of China's energy needs, an even higher rate than the official government target of 5%.

As of early 2013, China had 17 nuclear power reactors in operation and 28 under construction. An additional 50 reactors are planned to give a four-fold increase in nuclear capacity to at least 58 GWe by 2020, 200 GWe by 2030, and 400 GWe by 2050.[2]

The Fukushima nuclear reactor accident in Japan in 2011 did not prevent China from continuing with its extensive expansion program, but it may have caused the rate of expansion to decrease slightly. The target set by the National Development and Reform Commission (NDRC) in 2007 to have 40 GWe online by 2020 was upgraded to 70–80 GWe in 2010 and revised to 60–70 GWe in the aftermath of the Fukushima accident.[3] The Fukushima accident also instigated a period of renewed emphasis on safety and security throughout China's fuel cycle and reactor regulation systems. Although rapid nuclear energy development continues, a new air of caution surrounds the industry as it seeks measures to assuage the Chinese public's concerns and the decreased popularity of nuclear power among local governments. This effect is already impacting on the uranium procurement sector. For example, in July 2013, plans for a new uranium processing plant in Jiangmen city within the province of Guangdong were cancelled due to public demonstrations about the plant's environ-

1 Du Juan, 'Nuclear power to become 'foundation' of country's electrical system,' China Daily. 7 December 2011, http://www.chinadaily.com.cn/cndy/2011-12/07/content_14223281.htm.

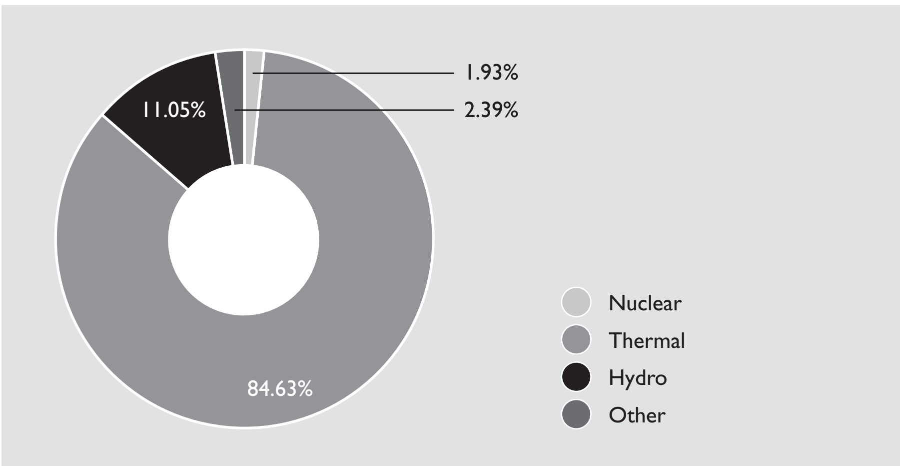
2 World Nuclear Association. 'Nuclear Power in China,' Updated 13 August 2013, http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/China--Nuclear-Power/#.Ugja9WQY2Ik.

3 World Nuclear Association. 'Nuclear Power in China,' Updated 13 August 2013, http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/China--Nuclear-Power/#.Ugja9WQY2Ik.

mental impact.[4] The government's aim of ensuring that no radiation exposure accidents occur to exacerbate this growing public resistance is likely to play a significant role in the evolution of China's nuclear energy and uranium industry regulations.

Supported by these long term goals of improving nuclear regulatory processes, nuclear power will continue to play an increasingly large role in China's energy framework, especially in coastal areas due to rapidly developing economies in these areas that remain far from China's coalfields.

Figure 1. Nuclear energy at 1.93% of total generated electricity in China in the first quarter of 2013. Source: CNNC.



Uranium demand and acquisition strategy

With China's rapid construction of new nuclear power plants, uranium requirements will increase significantly with each year. CNNC estimates that uranium requirements will jump from 4000tU in 2013 to 10,000-15,000tU in 2020.[5] In anticipation of this trend, the Chinese government is already importing much more uranium than it currently needs. *The China Daily* reported that China imported 17,135tU in 2010 and 16,126tU in 2011.[6]

4 Gerry Mullany, 'After Protest, China Cancels Plans for Uranium Plant,' New York Times. 13 July 2013, http://www.nytimes.com/2013/07/14/world/asia/china-uranium-plant.html?_r=0.
5 Weike Cong, 'Nuclear Industry in China, CNNC Presentation at the International Atomic Energy Agency, P. 10, http://www-pub.iaea.org/mtcd/meetings/PDFplus/2009/cn175/URAM2009/Session%20 1/8_33_Cong_China.pdf.
6 Q. Ding and L. Yiyu, 'Nation Plans to Import More Uranium', China Daily, 2012.

China intends to guarantee uranium supply for its nuclear power expansion plans through three primary channels: (1) domestic production, (2) overseas production, and (3) international trade/market purchases. This diversified strategy stems from the 'Two markets, two resources' policy launched in the 1990s, which specifies that China will seek to secure uranium resources through both domestic and overseas efforts. As of early 2013, it is still unclear how uranium income will be divided between the three areas. Some government statements specify that by 2020 a third of China's supply of natural uranium will come from domestic uranium production, a third from the overseas holding of uranium production, and a third through direct procurement from foreign suppliers. However, projections by independent market analysts predict a much less balanced procurement reality, with domestic resources accounting for the lowest amount of income, overseas resources accounting for a larger amount, and market purchases serving as by far the dominant source of uranium.[7] Given that China is actively seeking to determine the extent of some recently discovered deposits such as those in Inner Mongolia, it remains to be seen whether these new sources will contribute to a more balanced implementation of China's three-pronged strategy. This will depend not only on the extent of the deposits but also on the grade of the uranium, as China's resources tend to be of lower quality, with 85% estimated to be below a grade of 0.2.[8]

In 2013, domestic production still contributes the lowest amount of uranium among the three channels. China's current domestic production estimate is approximately 800 tU per year, and the government has announced a goal of 5,000tU of domestic production by 2020.[9] In hopes of reaching this goal, the Chinese government has taken measures to emphasize the importance of uranium fuel supply, including the promotion of domestic production and the introduction of regulations to allow quasi non-government institutions to conduct uranium exploration in China.[10] This

7 Jeffrey R. Faul, 'China's Uranium Procurement Strategies, NUKEM, Inc. World Nuclear Fuel Market Conference, Seville Spain, June 2011, http://www.nukem.de/fileadmin/nukem/mediapool/presentations/China%E2%80%99s%20Uranium%20Procurement%20Strategies%20WNFM%20June%206,%202011%3B%20Seville,%20Spain.pdf.

8 Zhang Yi, 'Recent Development of Uranium Industry in China, Supply and Demand, Department of Geology & Mining, CNNC Presentation, P. 29, http://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/ws_IAEA_CYTED_UNECE_Oct12_Lisbon/21_Zhang.pdf.

9 Jeffrey R. Faul, 'China's Uranium Procurement Strategies, NUKEM, Inc. World Nuclear Fuel Market Conference, Seville Spain, June 2011, http://www.nukem.de/fileadmin/nukem/mediapool/presentations/China%E2%80%99s%20Uranium%20Procurement%20Strategies%20WNFM%20June%206,%202011%3B%20Seville,%20Spain.pdf.

10 Zhang Yi, 'Recent Development of Uranium Industry in China, Supply and Demand, Department of Geology & Mining, CNNC Presentation, P. 29, http://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/ws_IAEA_CYTED_UNECE_Oct12_Lisbon/21_Zhang.pdf.

revitalized exploration has led to a pronounced increase in the discovery of domestic uranium resources from 2009 to 2012, and a 2012 cumulative resource estimate from CNNC indicates that domestic uranium resources totalled 221,500tU in early 2013.[11]

Overseas production of uranium currently consists of the second largest source of uranium for China, and this amount is expected to increase gradually as new operations begin to bear fruit. In recent years, China has initiated uranium mining operations or exploration activities throughout Africa, including in Namibia, Niger, and Zimbabwe. It continues its operations in Kazakhstan, which remains the largest source of uranium from China's international operations. More recently, China has entered into partnerships with Canada and Australia by directly supporting exploration and the development of new mining operations for eventual export to China.

Market purchases are projected to continue to be the largest source of uranium for China. China has entered into long-term purchasing agreements with Kazakhstan, and more recently with Australia and Canada. The Canadian partnership emerged due to an amendment to Canadian legislation, which has allowed the country to supply China directly with uranium.

Beyond this three-pronged strategy, China is also looking into alternative sources of uranium. One of these sources is extraction from phosphates. China views the extraction of uranium from phosphate rocks as having two positive aspects: domestic nuclear industry supply, and minimization of contamination of agricultural soils due to the fact that leaving a high uranium content in fertilizers can be damaging.[12] China has an estimated 25% of the world's phosphate reserves (second only to Morocco).[13] Other unconventional sources of uranium that China has looked into include black shale, coal tailings, copper, and gold.

11 Weike Cong, 'Nuclear Industry in China, CNNC Presentation at the International Atomic Energy Agency, http://www-pub.iaea.org/mtcd/meetings/PDFplus/2009/cn175/URAM2009/Session%201/8_33_Cong_China.pdf.

12 Dr. David V. LeMone et al,'Phosphate Rocks: Sustainable Secondary Source for Uranium and their Agricultural Impact – 9481,' WM Conference, March 2009, P. 9, http://www.wmsym.org/archives/2009/pdfs/9481.pdf.

13 Magdi Ragheb, Mohammed Khasawneh, 'Uranium Fuel as Byproduct of Phosphate Fertilizer Production,' Proceedings of the 1st International Nuclear and Renewable Energy Conference, Amman, Jordan, March 2010, http://mragheb.com/Uranium%20Fuel%20as%20byproduct%20of%20phosphate%20fertlilizer%20%20production.pdf.

Figure 2. Domestic uranium resources in China. Source: CNNC 2012.

Chinese province	Local uranium operation	Target production
Jiangxi	Xiangshan	29000 tU
	Ganzhou	12000 tU
	Taoshan	105000 tU
Guangdong	Xiazhuang	12000 tU
Guangdong	Zhuguangnanbu	10500 tU
	Heyuan	4000 tU
Hunan	Lujing	9000 tU
Guangxi	Ziyuan	11000 tU
Xinjian	Yili	28000 tU
	Turpan-Hami	10000 tU
Inner Mongolia	Erdos	23000 tU
	Erlian	33000 tU
	Songliao	2000 tU
Hebei	Qinlong	8000 tU
Yunnan	Tengchong	6000 tU
Shanxi	Lantian	2000 tU
Zhejiang	Dazhou	2000 tU
Total		**221500 tU**

Key domestic development areas

Mining

The acceleration of domestic uranium resource development in China is due in large part to uranium developers learning how to integrate and function within China's existing metal ore mining infrastructure. Mr Cao Shudong, Assistant General Manager at CNNC, explains that China's Mineral Resources Law (矿产资源法) exists to manage the metal ore mining process by vetting companies desiring to exploit land and then granting them exclusive rights to mine the area. However, Cao notes that a major difficulty for uranium mining actors is that large areas of land within China have already been registered in the national system as areas for oil, coal or other minerals, thus effectively preventing uranium exploration and mining in these areas. This is seen as a serious problem given that in geological stratification uranium is usually above the coal seam, so companies extracting these resources end up destroying valuable uranium deposits in their operations. [14]

In order to deal with these challenges, Cao explains that in recent years companies have tried to work around these policy hurdles through ad-hoc measures such as CNNC signing cooperative area development agreements with local governments and with companies such as Sinopec, Petro China and the Shenhua Group to help ensure that all available mineral resources in an area are effectively extracted by the relevant companies. Such agreements by CNNC exist in provinces such as Jiangxi, Hunan, Shaanxi, Liaoning, Guangdong, and Sichuan.[15]

Such ad-hoc measures have contributed to revitalizing exploration of uranium within China and a pronounced increase in the discovery of domestic uranium resources from 2009 to 2012. In northern China, these areas include Yili, Erlian, Turpan-Hami, Erdos and Songliao basins. In southern China, new mining operations have commenced in Taoshan, Zhuguangnanbu, Heyuan, Lujing and Dazhou. A cumulative resource estimate from CNNC indicates that domestic mines totalled 221500tU in early 2013.[16]

UOC Production Centres

In addition to stepping up mining operations, China is also expanding its domestic UOC production capacity by augmenting existing production centres as well as planning new installations. China currently operates four major mining and milling centres and plans to expand the production capacity of three significantly: the Fuzhou production centre from 350tU per year to 500tU per year, the Chonyi centre from 150tU per year to 300tU, and the Yining centre from 330tU per year to 500 tU per year.[17] With China's current domestic UOC production at 800tU per year, these

14 Ma Zhe, [Relying on Uranium Resources and Support for both Internal and external Markets], China Energy Report, December 2012, (in Chinese), http://www.gdfushefanghuxiehui.com/newsview.asp?viewid=751&class=2.
15 Ma Zhe, [Relying on Uranium Resources and Support for both Internal and external Markets], China Energy Report, December 2012, (in Chinese), http://www.gdfushefanghuxiehui.com/newsview.asp?viewid=751&class=2.
16 Weike Cong, 'Nuclear Industry in China,' CNNC Presentation at the International Atomic Energy Agency, http://www-pub.iaea.org/mtcd/meetings/PDFplus/2009/cn175/URAM2009/Session%201/8_33_Cong_China.pdf.
17 Ibid., P. 17.

augmented capacities should provide the necessary leeway to process domestically extracted uranium ores.

Conversion centres

There is very little information publicly available on China's uranium conversion facilities, and there are differing reports on their operational capacity. China is commonly reported as having a UOC conversion capacity of 3000 tU per year, placing it far below the capacity of other international converters. The World Nuclear Association reports that a conversion plant at Lanzhou with a capacity of about 1000 tU/yr started operation in 1980 but may now be closed, and that another conversion plant at Diwopu in Gansu province has a capacity of about 500 tU/yr.[18] AREVA also notes that two conversion plants are operating at Lanzhou and Diwopu producing a total of about 2,000 tU/yr.[19]

Due to the relatively small capacity of these plants compared to other international conversion centres, these facilities are most likely primarily dedicated to domestic supply needs. Further conversion capacity was planned with the new China Nuclear Fuel Element Co (CNFEC) plant at Daying Industrial Park in Heshan city, Guangdong province, quoted at 14,000 t/yr by 2020. However plans for this location were cancelled in July 2013 in response to protests by the public.[20]

Despite the currently low capacity of China's conversion facilities, China is still serving as a commercial converter for foreign entities in certain cases. For instance, Uzbekistan, which is mining 2300 to 2600 tonnes of uranium per year, is currently using Chinese facilities to convert its uranium. After undergoing further processing at the hydrometallurgical plant in Navoi, a portion of the uranium concentrate is shipped by rail to Alashankou in China's north-western province of Xinjiang for delivery to Chinese conversion facilities.[21]

18 'China's Nuclear Fuel Cycle,' World Nuclear Association, September 2013, http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/China--Nuclear-Fuel-Cycle/#.UjYs9sacmuI.

19 'AREVA in China,' AREVA, November 2007, http://contractchina2007.areva.com/events_home/liblocal/docs/China%20Press%20kit%20November%202007.pdf

20 'China's Nuclear Fuel Cycle,' World Nuclear Association, September 2013, http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/China--Nuclear-Fuel-Cycle/#.UjYs9sacmuI.

21 McGraw, Tim, 'New Developments in Uzbekistan Uranium Production,' NUKEM, 12 July 2011, http://www.nukem.de/fileadmin/nukem/mediapool/presentations/New%20Developments%20in%20Uzbekistan%20Uranium%20Production%20NEI%20July%2012%2C%202011%3B%20Washington%20DC.pdf

Enrichment centres

According to the International Panel on Fissile Materials, China operates three civilian uranium enrichment plants, one of which is under safeguards (Shaanxi – 1000 SWU), another has been offered for safeguarding (Lanzhou II – 500 SWU), and the third is not safeguarded (Lanzhou (new) 500-1000 SWU).[22] The facility at Shaanxi has been the focal point of the development of safeguards in China for early fuel cycle uranium. Reporting on the development of safeguards at this facility, a joint effort by the IAEA, the Ministry of the Russian Federation on Atomic Energy (Minatom), and the China Atomic Energy Authority (CAEA) seems to be focusing on the handling of UF_6 and enriched uranium. The report does list the detection of the diversion of 'natural uranium' (undefined) as an objective of safeguards at the facility, but details for implementing this aspect are not described.[23]

China and unconventional sources of uranium

Unconventional sources of uranium are sources from which uranium is only recoverable as a minor by-product, such as phosphate rocks, non-ferrous ores, porphyry copper, carbonate, black shale and coal-lignite. In their most recent Red Book report, the IAEA and OECD noted that no systematic appraisal of unconventional uranium resources has been conducted in China.[24] Although China is unlikely to engage full bore in the extraction of uranium from unconventional sources as long as traditional U_3O_8 mining and milling methods remain less expensive and more readily available, China is engaging in research, exploration, and initial extraction in certain areas. This section gives a brief overview of China's activities across these various markets and the government's thinking on the potential of unconventional sources as a serious resource for uranium acquisition.

Phosphates

Most of the unconventional uranium resources reported to date in the Red Book are associated with uranium in phosphate rocks. China is currently the world's largest producer of phosphate rock, extracting 65 MM tonnes in 2010. However, the uranium market intermediary NUKEM reports that there are no known plans to extract the associated uranium in a systematic manner.[25]

22 http://fissilematerials.org/facilities/uranium_enrichment.html
23 'Tripartite Enrichment Project: Safeguards at Enrichment Plants Equipped with Russian Centrifuges - IAEA-SM-367/8/02' International Atomic Energy Agency, http://www-pub.iaea.org/MTCD/publications/PDF/ss-2001/PDF%20files/Session%208/Paper%208-02.pdf
24 'Uranium: resources, production and demand (Redbook),' IAEA and OECD, 2011.
25 Frame, Brian, ' Market Impact of Byproduct Uranium,' NUKEM, 7 April 2011, http://www.nukem.de/

Nevertheless, in the face of its growing uranium requirements, China has begun to consider phosphates more seriously as an option. Chinese researchers have noted that extraction of uranium from phosphate rocks has the benefit of minimizing contamination of agricultural soils while at the same time helping to guarantee the domestic nuclear industry a supply of uranium.[26] China reportedly possesses a facility in Taiwan where uranium was extracted from wet phosphoric acid with a capacity of 10 tonnes of uranium per year, though there is little information available on the current status of this facility. [27]

Coal-ash

Over the past decade, China has also engaged in the exploration of uranium resources from the reprocessing of coal ash from power plants. In early January 2007, the Canadian company Sparton engaged with China's Xiaolongtang Guodian Power Company to test and possibly commercialize the extraction of uranium from waste coal ash at the company's thermal power stations in Yunnan province. This made Sparton the only foreign company permitted to produce uranium in China. Sparton, together with its partner ARCN (the remote sensing and research branch of China National Nuclear Corporation), identified Xiaolongtang and nearby power plants as a possible major supply of uraniferous coal ash.[28]

In 2010, Sparton reported that the power plants located near its site burned coal with a uranium content averaging 65 parts per million. At the time, the company reported recovering the uranium at a cost of $20 to $35 a pound. At the end of 2013, with uranium priced at $35 a pound, it remained to be seen whether Sparton's technology would be able to compete with traditional resources and methods.[29]

In a separate case, the extraction of uranium from coal tailings was an issue of contention between Indonesia and China. In 2009, it was reported for four years prior,

---

fileadmin/nukem/mediapool/presentations/NUKEM%20By-product%20Uranium%20Presentation%20WNFC%20April%202011.pdf

26 Hu, Z. Y., H. X. Zhang, Y. F. Wang, S. Haneklaus, and E. Schnug, 2007. Combining energy and fertilizer production – vision for China's future, International Symposium Protecting Water Bodies from Negative Impact of Agriculture, Loads and Fate of Fertilizer Derived Uranium, Braunschweig, Germany.

27 Ragheb, Magdi, 'Uranium Resources in Phosphate Rocks,' 19 March 2013, http://mragheb.com/NPRE%20402%20ME%20405%20Nuclear%20Power%20Engineering/Environmental%20Remediation%20of%20Radioactive%20Contamination.pdf

28 ' Sparton produces first yellowcake from Chinese coal ash,' World Nuclear News, 16 October 2007, http://www.world-nuclear-news.org/newsarticle.aspx?id=14224

29 'Out of the Ashes,' Wall Street Journal, 22 February 2010, http://online.wsj.com/news/articles/SB10001424052970203917304574414713352371376

coal tailings were exported to China at the price of about Rp. 200/kg [US$ 0.021/kg]. Indonesia's Nuclear Energy Supervisory Board stated that it regretted that there was no regulation with which to monitor these transactions or to prohibit them.[30]

Black shale

Black shale is widely distributed across northwestern and southern-central China. These deposits are mainly exposed in Yunnan, Guizhou, Sichuan, Hunan, Hubei, Jiangxi, and Zhejiang provinces and Guangxi Zhuang Autonomous Region. The most economically significant uranium deposits are reportedly in Hunan, Jiangxi and Guangxi Zhuang.[31] While the majority of uranium deposits in China are in the form of sandstone (35%), granite (28%), and volcanic veins (21%), at 10% black shale actually makes up a fairly significant portion of the overall makeup, with 6% coming from additional sources.[32]

China is also exploring the uranium resources via black shale outside its borders. In August 2009, China's CGN Uranium Resources Co and Uzbekistan's Geology and Mineral Resources Committee set up the Uz-China Uran joint venture to prospect for uranium in the Kyzyl Kum Desert.[33] Uran was planning to start black shale uranium mining in the Navoi region of Uzbekistan in 2013.[34]

Copper

China has reportedly engaged in uranium recovery from copper. When the Australian mining company BHP Billiton Ltd. planned to export semi-processed copper concentrates with significant uranium content to China, Canberra raised the matter with Beijing, and the Chinese government swiftly provided safeguard arrangements for the uranium it recovered.[35] There is little additional information available on whether China intends to extract uranium from copper imports in a systematic manner.

30 'Export of uranium-containing tailings from Indonesia to China taking place unregulated since 2005,' Kompass via Wise Uranium 7 December 2009, http://www.wise-uranium.org/ureg.html#IDEXPCN

31 'Uraniferous Black Shale and Related Uranium Mineralization Features in South China,' Acta Geologica Sinica, Volume 74, Issue 3, pages 602-604, September 2000. http://onlinelibrary.wiley.com/doi/10.1111/j.1755-6724.2000.tb00030.x/abstract

32 'Uranium resource potential and recent major exploration progress in China,' Presentation at China International Nuclear Symposium, Beijing Research Institute of Uranium Geology, CNNC, 2013.

33 'Uzbekistan seeks joint uranium-producing project with China,' RIA Novosti via Wise Uranium, 19 August, 2011. http://www.wise-uranium.org/upuz.html

34 'Uzbek-Chinese joint venture plans to start uranium mining in Navoi region,' Trend via Wise Uranium 6 October 2011. http://www.wise-uranium.org/upuz.html

35 Mark Hibbs, 'Iran and Secondary Uranium Sources,' Arms Control Wong, 23 August 2013, http://carnegieendowment.org/2013/08/23/iran-and-secondary-uranium-sources/gkb3.

Governance Framework and Key Actors

A myriad of regulatory agencies with widely varying responsibilities are charged with implementing uranium regulations in China. Though China's nuclear bodies originated with a military purpose, the bureaucracy has grown and evolved such that nearly all of the agencies now charged with nuclear safety, security, and safeguards fall under the State Council and are therefore theoretically under civilian control. These relevant regulatory agencies all rank at either the ministerial or vice-ministerial level, with the ministerial level organizations reporting directly to the State Council as the chief administrative authority of China. China's state-owned enterprises (SOEs) or large nuclear corporations are the primary implementers of China's nuclear energy and uranium procurement strategy and also wield great power and influence within the bureaucracy.

In this regard, the most interesting facet of the overall regulatory structure is that China's SOEs actually rank as vice-ministerial bodies, therefore effectively putting them on the same bureaucratic level as several of the key agencies charged with regulating these companies' actions such as the National Nuclear Safety Administration (NNSA) and the China Atomic Energy Authority (CAEA). Especially given the importance and emphasis China places on rank at both the individual and organizational levels, this equal ranking between the regulators and the regulated companies raises questions as to the ability of China's regulatory bodies to manage and drive uranium safety and security effectively.

In addition to this particular challenge, another systemic issue resides in the fact that many of the relevant regulatory bodies have differing mandates and pursue different objectives. There is therefore a difficulty with both overlapping responsibilities and regulatory coordination between the different instruments. Although CAEA comes closest, China does not have a primary regulatory authority charged with having the 'last say' on both domestic and international nuclear affairs, and different responsibilities remain embedded in different places throughout the bureaucracy. While this would not be a problem in itself, the lack of coordination between the different responsible organizations leaves important questions about how existing regulatory gaps would be identified and managed.

The following sections discuss the historical development of China's current governance system, followed by an introduction of key regulatory actors and their primary roles regarding uranium safety, security, and safeguards management.

Historical overview

Although the governance structures comprising uranium regulation in China have been in a perpetual state of reorganization since the inception of China's nuclear program, the dual military–civilian nature of China's uranium governance framework has remained constant. To this day, the framework remains a blended civil-military structure, even though the regulatory agencies on the civilian side have significantly multiplied and developed in more recent years.

One of the key focal points of the dual civil–military nature of China's nuclear bureaucracy lies with the China National Nuclear Corporation (CNNC), the major state-owned enterprise dealing with nuclear affairs in China. CNNC reports openly that it shoulders the dual historical responsibilities for the building of China's national defence force as well as the development of nuclear energy for civil use. Historically, in its earlier formations CNNC developed the atomic bomb, hydrogen bomb and nuclear submarines, as well as the first nuclear plants on the Chinese mainland.[36]

Today, CNNC remains the main body for China's nuclear technology industry, while simultaneously functioning at the core of China's nuclear weapons infrastructure. CNNC reports that it is engaged in scientific research and development, design and construction, production and operation in both the nuclear military industry and the nuclear power industry. Moreover, CNNC sees the integration of military and civil production as a part of its mission description.[37] CNNC now has over a hundred secondary member units across over twenty provinces, autonomous regions and municipalities with 100,000 employees.[38] Another key representation of the dual civilian–military nature of CNNC can be seen with the extensive linkage between individuals involved in its civil and military projects. For instance, CNNC has a relationship with the Chinese Academy of Sciences (CAS) and the Chinese Academy of Engineering (CAE). Seven individuals from CAS and eleven from CAE serve dual posts as academicians with both CNNC and their home institutions.[39]

CNNC has a complicated history involving several restructurings as China sought to create an internationally competitive nuclear power entity directly from an originally isolated military nuclear program. CNNC began as the Third Ministry of Machine

36 China National Nuclear Corporation, Overview, http://www.cnnc.com.cn/tabid/643/Default.aspx.
37 China National Nuclear Corporation, Human Resources, Academics, http://www.cnnc.com.cn/tabid/104/Default.aspx.
38 China National Nuclear Corporation, Overview, http://www.cnnc.com.cn/tabid/643/Default.aspx
39 China National Nuclear Corporation, Human Resources, Academics, http://www.cnnc.com.cn/tabid/104/Default.aspx

Building (MMB) in 1955 with the advent of China's nuclear program, and was renamed the Second MMB in 1958. In these early years, China began to construct fissile-material production facilities with assistance from the Soviet Union. Highly enriched uranium (HEU) production began in 1964 and plutonium production in 1966.[40] In parallel to this effort, China had also begun prospecting for uranium on its own territory in 1955, initially with help from the Soviet Union, and the development of the first uranium mines and mills in China occurred in 1958.[41] Operation of the Chenzhou and Dabu mines as well as of the Henyang mill (all in Hunan Province) commenced in 1962 and 1963 respectively.[42] It is therefore possible that the first processed military uranium was of Chinese domestic origin as opposed to Soviet-supplied.

From the mid 1950s through the mid 1960s, prospecting of uranium was carried out countrywide and was focused on detecting outcropping uranium deposits. From the mid 1960s to the mid 1970s, exploration in the vicinities of established uranium occurrences and in formerly untouched regions with conceptually and technically more sophisticated methods resulted in the discovery of number of deposits in South China. From the mid 1970s into the 1980s, prospecting focused on unexplored areas in the North China Platform (e.g. Erlian Basin and Inner Mongolia), and in northeast China where additional resources in volcanic and sandstone-type deposits were discovered. From the 1980s, exploration efforts concentrated on finding new deposits with better economic characteristics in terms of grade, reserves or extraction amenability.[43]

In 1982, the Second MMB was renamed the Ministry of Nuclear Industry as a symbolic name change geared to represent a transition toward a greater emphasis on civilian nuclear energy from a former military focus. Before this point, the Second MMB was managed mainly by the Commission for Science, Technology and Industry for National Defence (COSTIND), an entity operating directly under the Central Military Commission at the time. With its transition to the MNI, the Second MMB began to gain more autonomy as a Ministry under the State Council. Much of the nuclear infrastructure—uranium mining, nuclear material production, reactor operation, etc.—was placed under the management of MNI and taken out of the

40 Zhang, Hui (2011) 'China's HEU and Plutonium Production and Stocks', Science & Global Security, 19: 1, 68.
41 Dahlkamp, Franz. "Uranium Deposits of the World: Asia," Springer 2009. P 32-34.
42 Dahlkamp, Franz. "Uranium Deposits of the World: Asia," Springer 2009. P 34.
43 Dahlkamp, Franz. "Uranium Deposits of the World: Asia," Springer 2009. Pg 32-34.

direct control of COSTIND.[44] A key motivation for this restructuring was to reduce government controls on state-owned enterprises (SOEs) to improve their efficiency and make them more responsive to market demand by giving them greater latitude to negotiate business deals, set up new business activities, and attract investments.[45]

In coordination with the high-level split between MNI and COSTIND, dependent nuclear research laboratories also began to divide themselves along either side of this new line. Organizations with expertise that could support the nuclear power industry became aligned with MNI, while those with weapons design expertise remained under the control of COSTIND. For example, the China Institute of Atomic Energy (CIAE), the Beijing Institute of Nuclear Engineering, and the Shanghai Nuclear Research and Design Academy were among those that began drifting to the civilian side. The China Academy of Engineering Physics (CAEP), the Institute of Applied Physics and Computational Mathematics (IAPCM), and the Northwest Institute of Nuclear Technology (NINT) were those that remained under the control of COSTIND.[46] This process of gravitation was largely influenced by budgetary issues in that each research body wanted to be more closely aligned with the umbrella agency that was most likely to appropriate more funding due to its similar objectives.[47]

However, the military–civilian split was only ever partial due to the fact that the nuclear material production facilities that came under the management of MNI were still needed to produce materials for military use. In addition, COSTIND continued to exert strong influence on both sides of the divide as an organization answering to both the Central Military Commission and the State Planning Committee of the State Council.[48]

The next few decades saw a gradual shift in the balance between civilian and military nuclear priorities. During the 1970s and 1980s, China gradually stopped fissile material production for military purposes. The Lanzhou and Heping gaseous diffusion plants stopped producing HEU in 1964 and 1975 respectively. The Jiuquan reactor

44 Wen L. Hsu, 'The Impact of Government Restructuring on Chinese Nuclear Arms Control and Nonproliferation Policymaking,' *The Nonproliferation Review,* Fall 1999, P. 154, http://cns.miis.edu/npr/pdfs/wen64.pdf.
45 Wen L. Hsu, 'The Impact of Government Restructuring on Chinese Nuclear Arms Control and Nonproliferation Policymaking,' *The Nonproliferation Review,* Fall 1999, P. 153, http://cns.miis.edu/npr/pdfs/wen64.pdf.
46 Wen L. Hsu, 'The Impact of Government Restructuring on Chinese Nuclear Arms Control and Nonproliferation Policymaking,' *The Nonproliferation Review,* Fall 1999, P. 154, http://cns.miis.edu/npr/pdfs/wen64.pdf.
47 Wen L. Hsu, 'The Impact of Government Restructuring on Chinese Nuclear Arms Control and Nonproliferation Policymaking,' *The Nonproliferation Review,* Fall 1999, P. 155, http://cns.miis.edu/npr/pdfs/wen64.pdf.
48 Wen L. Hsu, 'The Impact of Government Restructuring on Chinese Nuclear Arms Control and Nonproliferation Policymaking,' *The Nonproliferation Review,* Fall 1999, P. 155, http://cns.miis.edu/npr/pdfs/wen64.pdf.

and Guangyuan reactors stopped producing plutonium in 1984 and 1989.[49] China reportedly produced 20 ± 4 tons of HEU, 2 ± 0.5 tons of plutonium and currently has stockpiles of about 16 ± 4 tons of HEU and 1.8 ± 0.5 tons of plutonium available for weapons.[50] Both remaining stocks of HEU and plutonium are sufficient to significantly expand the Chinese nuclear arsenal if China ever decided to do so.

This winding down of military fissile material production stood in direct contrast to the strengthening of civilian nuclear activities. In 1988 MNI was reorganized as the China National Nuclear Corporation (CNNC). [51] By the late 1990s, China decided to decommission the Guangyuan site along with other military fissile material production sites.[52] Also during this decade, China began to target its domestic uranium exploration and mining efforts on sandstone uranium deposits amenable to in-situ leaching, a more advanced technique at the time, which reflected the maturing of China's civilian uranium mining infrastructure.[53]

This maturation in the civilian uranium industry was also reflected in the reorganization of its overall structure. Almost twenty processing plants served by a number of mostly small mines had been active in China prior to the 1980s. CNNC and its predecessors operated most of the plants, but local governments also operated a few small ones. Beginning in the 1980s, thirteen plants were closed or put on standby. This reflected China's efforts to create a more consolidated and easier to manage system that could more easily respond to domestic and market demands.[54]

In the late 1990s, China's nuclear governance structures went through a major restructuring, a key point of which was the transition of COSTIND from a body answering to both the Central Military Commission and the State Council to one only falling under the jurisdiction of the State Council. In this process, CNNC was

49 Hui Zhang, 'China,' in: Global Fissile Material Report 2010, International Panel on Fissile Material, pp. 97-106, http://belfercenter.ksg.harvard.edu/files/Hui-Zhang-China-Chapter-Global-Fissile-Materials-Report.pdf.
50 Hui Zhang, 'China,' in: Global Fissile Material Report 2010, International Panel on Fissile Material, pp. 97-106, http://belfercenter.ksg.harvard.edu/files/Hui-Zhang-China-Chapter-Global-Fissile-Materials-Report.pdf
51 Weike Cong, 'Nuclear Industry in China, CNNC Presentation at the International Atomic Energy Agency, http://www-pub.iaea.org/mtcd/meetings/PDFplus/2009/cn175/URAM2009/Session%201/8_33_Cong_China.pdf.
52 Mark Hibbs, 'China Said to be Preparing for Decommissioning Defense Plants,' Nuclear Fuel, 17 May 1999, www.lexis-nexis.com.
53 Dahlkamp, Franz. "Uranium Deposits of the World: Asia," Springer 2009. P 34.
54 Dahlkamp, Franz. "Uranium Deposits of the World: Asia," Springer 2009. P 34.

also moved under the 'new' COSTIND and the State Council. This was a significant milestone for China's nuclear program, highlighting its renewed focus on civilian nuclear activities.

At the same time, China was slowly beginning to integrate itself into existing international agreements and norms. China became a member of the International Atomic Energy Agency (IAEA) in 1984 and acceded to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) in 1992. As described by Wen Hsu in the Non-proliferation Review, these commitments required a bureaucracy to administer China's interactions with the IAEA and foreign states. When MNI existed, it was natural to have the ministry handle the interactions with IAEA. But when MNI became CNNC, it meant that a commercial entity would be representing the state in international matters. Therefore, to endow CNNC with the proper authority, it was simply given another name: the China Atomic Energy Authority (CAEA). The CNNC brochure stated that 'CNNC is also known as CAEA to deal with matters between China and the IAEA.' In fact, one official could be representing both organizations. Many CNNC officials would carry two different business cards, one representing CNNC and another CAEA; the former would be used when conducting commercial business and the latter when conducting government business. This began a new mixing of government functions and commercial activities.[55]

In 2003, the Chinese government created the State-owned Assets Supervision and Advisory Commission (SASAC), defined as a 'special organization directly under the State Council' to oversee China's state-owned enterprises in a comprehensive manner, ranging from financial and taxation obligations to compliance with all relevant laws, regulations and guidelines. This was a major shift toward management consolidation, with the top two or three SOEs from each sector in China being brought under SASAC's control, including CNNC and CGN, for a current total of about 117 SOEs. With little information publicly available on SASAC, it remains unclear how the entity manages to enforce and monitor regulations across such a large and diverse group of SOEs, given that different sets of laws and regulations will apply to each. Up to late 2013, SASAC appeared still to be dealing with these challenges, with reports that Beijing was at a crucial stage of implementing new reforms to SOEs and

55 Wen L. Hsu, 'The Impact of Government Restructuring on Chinese Nuclear Arms Control and Nonproliferation Policymaking,' *The Nonproliferation Review,* Fall 1999, P. 156, http://cns.miis.edu/npr/pdfs/wen64.pdf.

gearing up to issuing a new set of reforms intended to deal with issues of declining profits, unprofessional management, rising liability and overcapacity.[56]

In a second major reorganization, in March 2008, China created the Ministry of Industry and Information Technology (MIIT), and several organizations, including CAEA and COSTIND, were both brought into MIIT. COSTIND was also renamed the State Administration for Science, Technology and Industry for National Defence (SASTIND), in a process that seems to demote its administrative standing. Although CAEA was previously administered by COSTIND, today it is unclear what level of influence the new SASTIND has over the nuclear regulator. MIIT appears to treat SASTIND and CAEA as two separate entities, with SASTIND largely focused on administering conventional weapons export controls and CAEA focusing on the nuclear aspects. Indeed, if CAEA were truly subordinate to SASTIND, given SASTIND's demotion from a ministerial-level entity to a vice-ministerial-level administration, CAEA could continue to face even more difficulties in exercising authority over the more powerful, influential and higher-ranking SOEs.

56 'China to Unveil More Reforms for State-Owned Enterprises at Key Session -SASAC,' Wall Street Journal, 31 October 2013. http://online.wsj.com/article/BT-CO-20131031-708505.html

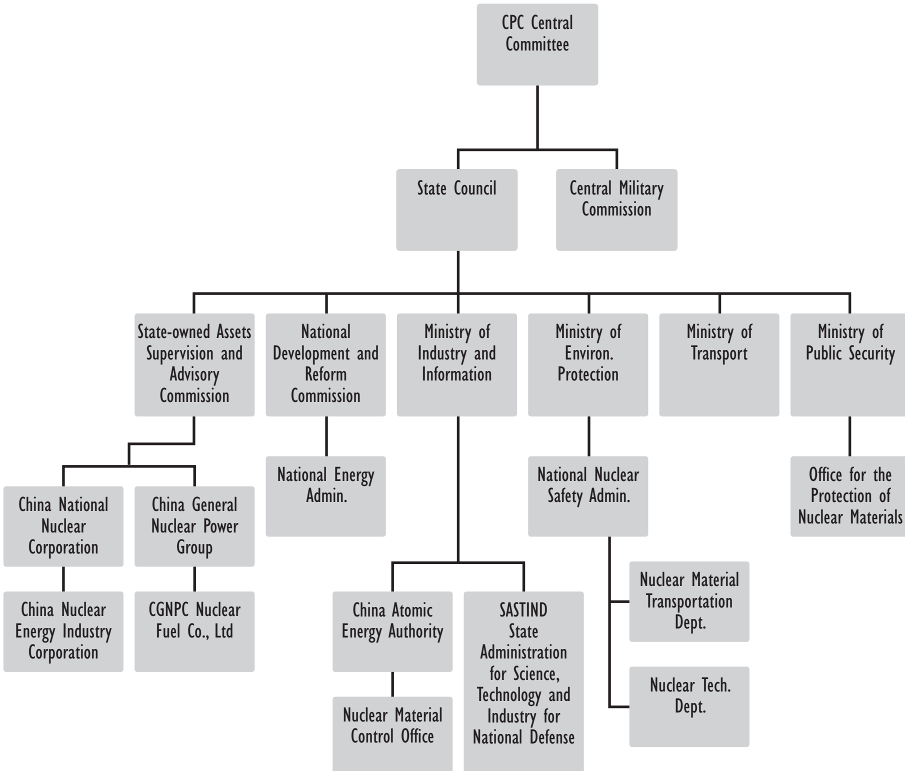


Figure 3. Key government agencies under the State Council involved in the safety, security, safeguards, and physical protection of uranium.[57]

Details on Key Uranium Regulatory Agencies

China National Nuclear Corporation

The China National Nuclear Corporation (CNNC) is a state-owned enterprise (SOE) which implements the great majority of nuclear-related affairs in China. Since its early iterations, CNNC has fielded the dual-role of developing China's nuclear weapons arsenal as well as its nuclear power industry. Today, CNNC is the main body for China's nuclear industry and also remains at the core of the national strategic nuclear deterrent infrastructure. CNNC has over a hundred secondary member units

57 Sources: Interviews and ministry websites.

across over twenty provinces, autonomous regions and municipalities with 100,000 employees.[58] It also carries out extensive international cooperation in nuclear power, nuclear fuels and nuclear technology applications and has established science and technology exchanges and economic and trading relations with over forty countries and regions, including Russia, France, Germany, the United Kingdom, the United States, Canada, Japan, South Korea, Pakistan, Mongolia, Kazakhstan, Jordan, Niger, Algeria, Namibia and Australia.[59]

CNNC's president and vice-presidents are directly appointed by the premier of the State Council. The current president is Mr Sun Qin, former deputy director of the National Energy Administration (NEA).[60] Although he is often mentioned as a 'party secretary,' this appears to reflect recognition of his status as a general member of the Communist Party of China rather than as an actual committee member. This is in contrast to his predecessor, Kang Rixin, who was a member of the 17th Central Committee of the CPC but was expelled from the party on corruption charges. SOE heads are often able to influence policy-making and agenda-setting by virtue of their bureaucratic rank, their technical knowledge of their industries and global markets, and the economic might of their firms.[61] Sun Qin's lack of membership in the Central Committee may be one attempt to control CNNC better in the face of its growing power and influence.

Since July 2012, CNNC's Bureau of Geology (BOG), China Nuclear Uranium Corporation (CNUC) and China Uranium Corp. Ltd. (CUC) have been merged into one entity known as the Geology and Mining Sector. This is a significant consolidation geared to give CNNC greater control of and coordination between the research bodies that influence China's uranium mining decisions and activities.

China Nuclear Energy Industry Corporation

A subsidiary of CNNC, the China Nuclear Energy Industry Corporation (CNEIC) is one of two companies authorized by the state to carry out import and export trading of nuclear fuel and related products. Over the past 26 years, CNEIC has been primarily engaged in the international trading of nuclear fuel and related products,

58 China National Nuclear Corporation, About Us, http://www.cnnc.com.cn/tabid/643/Default.aspx.
59 China National Nuclear Corporation, International Cooperation, http://www.cnnc.com.cn/tabid/646/Default.aspx.
60 http://baike.baidu.com/view/488501.htm
61 Susan V., Lawrence, Michael F. Martin, 'Understanding China's Political System,' Congressional Research Service, March 2013, P. 35, http://www.fas.org/sgp/crs/row/R41007.pdf.

the supply of nuclear fuel to domestic nuclear power plants, and the domestic and international transportation of nuclear fuel.[62]

Today, CNEIC is the government's main instrument for purchasing natural uranium, low-enriched uranium products and fuel assemblies from abroad. Since the 1980s, CNEIC has also occasionally exported products such as natural U_3O_8 and UF_6, low-enriched UF_6, and fuel assemblies for research reactors to power utilities in Europe, the United States, and Japan. The United States, as one recipient, reported several mishaps with these exports, including containers with damaged valves such as those reported by Westinghouse.[63] CNEIC is also the sole supplier of fuel assemblies to the Pakistan Chashma NPP.[64]

In addition to its role as a focal point for imports and exports, CNEIC also manages the majority of uranium transportation activities, both domestically and internationally. For over twenty years, CNEIC has played a large role in the land (highway and railway), sea and air transportation of natural uranium, low-enriched uranium and fuel assemblies.[65]

China General Nuclear Power Group

Formerly known as China Guangdong Nuclear Power Group, China General Nuclear Power Group (CGN) is the second major nuclear power corporation in China, though it has remained significantly smaller than CNNC. Recent moves by the company reflect a new strategic ambition to readjust this longstanding imbalance, especially when it comes to uranium exploration. Company spokesman Hu Guangyao said, 'The name change is to better meet the needs of future development of the group, to promote the coordinated development of nuclear power, uranium resources and non-nuclear clean energy.'[66]

62 China Nuclear Energy Industry Corp., Nuclear Fuel, http://www.cneic.com.cn/en/html/2006-11-16/yelei2006111685802.html.
63 Inspection Report 30B Cylinder Containing Uranium Hexafluoride, issued by Carolina Materials Testing Company, Inc., LTR-RAC-12-57 Attachment E, http://pbadupws.nrc.gov/docs/ML1219/ML12192A174.pdf.
64 China Nuclear Energy Industry Corp., International Trade, http://www.cneic.com.cn/en/html/2006-10-25/service20061025170507.html.
65 China National Energy Corp., Transportation Service, http://www.cneic.com.cn/en/html/2006-7-6/service200676223231.html.
66 'CGNPC renamed to reflect expansion', World Nuclear News, May 2013, http://www.world-nuclear-news.org/C-CGNPC_renamed_to_reflect_expansion-1505134.html.

CGN was established in 1994 and was 45% owned by the provincial government, 45% by China National Nuclear Corporation (CNNC), 10% by China Power Investment Corp (CPI), and was later placed under the supervision of the State-owned Assets Supervision and Advisory Commission (SASAC). However, in September 2012, a change in CGN's ownership structure was approved, with SASAC itself taking an 82% stake in the company, while the provincial governments' and CNNC's holdings dropping to 10% and 8%, respectively.[67] These changes, particularly the greatly reduced ownership by CNNC, are likely to alter the balance of Chinese uranium efforts significantly both domestically and abroad, as CNNC and CGN become competing actors.

CGN Nuclear Fuel Co. Ltd.

Similar to CNNC's CNEIC, the CGN Nuclear Fuel Co. Ltd (NFC) is the second company in China with exclusive rights to import and export uranium.[68] Created in 2006 as CGN Uranium Resources Co., Ltd. (CGN-URC), the company has wasted no time in catching up with CNEIC by acquiring large supply contracts (such as that with Kazakhstan) and lucrative mining projects (such as the Husab mine with Namibia).

State-owned Assets Supervision and Administration Commission

Established in 2003, the State-owned Assets Supervision and Administration Commission (SASAC) oversees 117 so-called 'central enterprises' out of approximately 120,000 state-owned enterprises. The 117 key SOEs include CNNC and CGNP. There are two main levels of SASAC: the central SASAC which supervises 117 central SOEs and the provincial SASAC which supervises SOEs incorporated within the relevant administrative region.[69]

SASAC is referred to as a special organization directly under the State Council, ranking on par with ministerial-level organizations.[70] As the only organ in this category, SASAC has a unique legal standing meant to allow it to exert the necessary authority

67 'CGNPC renamed to reflect expansion', World Nuclear News, May 2013, http://www.world-nuclear-news.org/C-CGNPC_renamed_to_reflect_expansion-1505134.html.

68 Sun Ruofan, 'Fuel Supply Strategies of CGNPC,' CGNPC Presentation, April 2012, P. 17, http://www.wnfc.info/proceedings/2012/presentations/sun_ppt.pdf.

69 Wang Yi, 'New SASAC Rules to Enhance Risk Control of Chinese SOEs' Outbound Investments,' Norten Rose Fulbright, February 2012, http://www.nortonrosefulbright.com/knowledge/publications/63109/new-sasac-rules-to-enhance-risk-control-of-chinese-soes-outbound-investments.

70 The Organizational Structure of the State Council, Chinese Government's Official Web Portal, http://english.gov.cn/links.htm.

over SOEs. Indeed, SASAC wields a great deal of power in terms of being responsible for the fundamental management of SOEs, appointing and removing top executives, and ensuring that SOEs pay dividends to the state. SASAC strives to centralise several functions that were formerly dispersed over various government agencies and party organisations. By taking all central enterprises away from the control of various government agencies and putting them under the unitary supervision of an organ that reports directly to the State Council, the central government asserted its authority.[71]

Most of the decision-making or supervisory power is still vested in the central SOEs: SASAC reserves its supervisory power for a limited range of circumstances. Central SOEs are reportedly free to decide on and implement any overseas investment plans within their primary business sector. They have to include these in their annual investment plans (filed with SASAC) and keep SASAC informed of any additional investment within the primary business sector but outside the filed plan, and of any correspondence with other regulatory authorities such as the National Development and Reform Commission and the Ministry of Commerce. SASAC approval is only required for overseas investment which falls outside the primary business scope of that particular SOE.[72]

In accordance with related regulations, SASAC dispatches supervisory panels to the supervised enterprises on behalf of the State Council.[73] However, due to the large number of companies SASAC must oversee, management occurs in a very macro-sense, with compliance with more detailed safety and security legislation left to more specialized regulatory bodies such as the National Nuclear Safety Administration or the China Atomic Energy Authority.

As of 2013, SASAC's management framework was reportedly failing on a large scale, largely because SOEs were still undertaking both corporate and political tasks. The heavy government intervention in the management of these companies was reportedly resulting in declining profits, unprofessional management, increasing liabilities and

71 Mikael Mattlin, 'Chinese Strategic State-Owned Enterprises and Ownership Control, Asia Paper, Brussels Institute of Contemporary China Studies, P. 8, http://www.vub.ac.be/biccs/site/assets/files/apapers/Asia%20papers/Asia%20Paper%204(6).pdf.

72 Wang Yi, 'New SASAC Rules to Enhance Risk Control of Chinese SOEs' Outbound Investments,' Norten Rose Fulbright, February 2012, http://www.nortonrosefulbright.com/knowledge/publications/63109/new-sasac-rules-to-enhance-risk-control-of-chinese-soes-outbound-investments.

73 State-owned Assets Supervision and Administration Commission of the State Council (SASAC), the People's Republic of China, Main Functions and Responsibilities of SASAC, http://www.sasac.gov.cn/n2963340/n2963393/2965120.html.

overcapacity due to redundant projects.[74] Reforms to be launched in late 2013 could therefore seek to deregulate the relationship between SASAC and the SOEs further.

State Administration for Science Technology and Industry for National Defense (SASTIND)

The State Administration for Science, Technology and Industry for National Defense (SASTIND) is the most recent iteration of the former Commission for Science, Technology and Industry for National Defense (COSTIND), which used to oversee both CNNC and CAEA before later reforms. SASTIND is an administratively weaker version of COSTIND, operating beneath the new Ministry of Industry and Information Technology (MIIT), whereas COSTIND was previously an organization that reported directly to the State Council (and, in a prior iteration, also to the Central Military Commission).[75] Although CAEA previously operated under the purview of COSTIND, it is unclear whether SASTIND maintains the same level of authority in its new, demoted formulation. It appears that SASTIND and CAEA are being increasingly treated as separate entities, for example, participating as separate entities in China's interagency license review process for nuclear materials and exports.[76]

National Energy Administration

Established in 2008, the National Energy Administration (NEA) is a vice-ministerial body under the National Development and Reform Commission (NDRC) and is responsible for formulating and implementing energy development plans and industrial policies; promoting institutional reform in the energy sector; and administering energy sectors, including coal, oil, natural gas, power (including nuclear power), and renewable energy.[77] In terms of its relationship with CNNC and CGN, NEA is seen as a coordinator. For example, if several companies are competing to develop uranium resources in the same country, it would be NEA's job to guide the coordination process. NEA has difficulty in carrying out this job largely due to its lower, vice-ministerial rank and insufficient personnel resources.[78]

74 'China to Unveil More Reforms for State-Owned Enterprises at Key Session -SASAC,' Wall Street Journal, 31 October 2013. http://online.wsj.com/article/BT-CO-20131031-708505.html

75 Wen L. Hsu, 'The Impact of Government Restructuring on Chinese Nuclear Arms Control and Nonproliferation Policymaking,' *The Nonproliferation Review,* Fall 1999, P. 160, http://cns.miis.edu/npr/pdfs/wen64.pdf.

76 Li Hong, 'Chinese Nonproliferation Policy and Export Control Practice,' presentation Taibei, 28 August 2013, http://csis.org/files/attachments/130828_LiHong.pdf.

77 National Development and Reform Commission (NDRC) People's Republic of China, National Energy Administration, http://en.ndrc.gov.cn/mfod/t20081218_252224.htm.

78 Interview with CNNC, Beijing, June 2013.

Since 1949, China has tried many different formulations in attempts to create an effective national-level energy institution. The NEA is the latest iteration of this process, replacing the former National Energy Bureau, though experts argue that the new formulation will still not be enough to coordinate and manage China's fragmented energy bureaucracy.[79]

Policy paralysis in the energy bureaucracy stands in sharp contrast to the activism of SOE's such as CNNC. More often than not, it is China's energy firms that initiate major energy projects and policies that are later embraced by the government.[80] In line with this, as it develops China's nuclear energy policy, the NEA seems to be reacting to developments in the uranium mining sector initiated by the SOEs rather than driving a prescribed balance between domestic and overseas uranium production.

NEA's inability to drive the SOEs also stems from its inherent lack of authority as a dramatically small and lower-ranking vice-ministerial organ. Given that SOEs report to SASAC and therefore report de facto directly to the State Council, NEA does not have the direct capability to direct them. Herein lies an inherent contradiction that, although NEA is charged with designing and implementing an energy strategy, it does not have the authority to direct the actors who are key to implementing that strategy.

National Nuclear Safety Administration

The National Nuclear Safety Administration reports to the Ministry of Environmental Protection and is responsible for nuclear safety regulation and licensing, as well as the physical protection of nuclear material. It is also responsible for safety supervision and management regarding the transport of radioactive materials.[81] Several pieces of legislation call for NNSA's involvement in regulating UOC, though its involvement in the regulatory process is mostly limited to transport container certification.

According to the 1987 *Regulations for the Control of Nuclear Material* (Article 6), NNSA is responsible for the safety oversight of civilian nuclear material and nuclear material control. Its main responsibilities mandated by this key piece of legislation are (1) the development of nuclear material control regulations; (2) to supervise civilian

79 Downs, Erica. 'Chinas New Energy Administration,' Brookings Institute, P., 42.
80 Downs, Erica. 'Chinas New Energy Administration,' Brookings Institute, P. 42.
81 National Nuclear Safety Administration, [International Responsibilities], October 2009, (in Chinese), http://nnsa.mep.gov.cn/jgsz/200910/t20091028_180316.htm.

nuclear material control and implementation of regulations; and (3) to approve nuclear materials licenses.[82]

NNSA originally had a staff of approximately a hundred, a tiny fraction of that of CNNC. When NNSA took an unpopular stand, CNNC was known to exert its influence. For example, during the licensing for construction of a pilot reprocessing plant, NNSA wanted to examine the full design before issuing the license. CNNC, however, was pressed for time, and the compromise was that NNSA would review and approve the license on a piecemeal basis.[83]

In January 2011, the State Council Research Office (SCRO) recommended that the NNSA should be an entity directly under the State Council Bureau, making it an independent regulatory body with authority.[84] Currently, the NNSA reports to the Ministry of Environmental Protection, again giving it the status of a vice-ministerial agency. Like the National Energy Administration, the NNSA thus ranks evenly with the SOEs it is charged to manage rather than above them.

China Atomic Energy Authority

The China Atomic Energy Authority was created directly out of CNNC to handle interactions with IAEA. China's 1987 *Regulations on Nuclear Materials Control and 1990 Rules for the Implementation of Regulations on Nuclear Materials Control* specified that CAEA's Office of Nuclear Material Control (ONC) was created to carry out this task for the 'whole country.' These regulations also specify that the office has the authority to review and issue licenses for nuclear materials, while NNSA and COSTIND have the role of approving licenses. Furthermore, although NNSA was tasked with punishing violators, the punishment of revoking the licenses was subject to the approval of ONC.[85]

82 Ministry of Industry and Information Technology of the People's Republic of China, [Nuclear Material Management Regulations], (in Chinese), http://www.miit.gov.cn/n11293472/n11505629/n11506225/n11508136/n11984163/12009157.html.
83 Wen L. Hsu, 'The Impact of Government Restructuring on Chinese Nuclear Arms Control and Nonproliferation Policymaking,' *The Nonproliferation Review,* Fall 1999, P. 156, http://cns.miis.edu/npr/pdfs/wen64.pdf.
84 World Nuclear Association. 'Government Structure and Ownership, Nuclear Power in China Appendix 1.' July 2013, http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/Appendices/Nuclear-Power-in-China-Appendix-1--Government-Structure-and-Ownership/#.UgjF2GQY2Ik.
85 Wen L. Hsu, 'The Impact of Government Restructuring on Chinese Nuclear Arms Control and Nonproliferation Policymaking,' *The Nonproliferation Review,* Fall 1999, P. 158, http://cns.miis.edu/npr/pdfs/wen64.pdf.

CAEA's Department of International Cooperation is responsible for licensing nuclear imports and exports and issuing government guarantees to foreign nuclear regulatory bodies. This office also serves as the principal licensing office for exports of nuclear materials and equipment and technology for nuclear power reactors, in addition to being responsible for issuing Chinese government guarantees regarding the end-use of nuclear materials and technologies imported into China.[86] CAEA's Office of Nuclear Material Control and the Office of Nuclear Emergency are involved in license review, inspection, and rule-making.

The level of authority CAEA has relative to other organizations is unclear. It is also unclear whether CAEA now falls under SASTIND or directly under the MIIT.

Ministry of Public Security

The Ministry of Public Security is China's principal police and security authority and is responsible for day-to-day law enforcement. Relevant to uranium, and key among its responsibilities, the *1994 Rules on Physical Protection for International Nuclear Materials Transport* specify that MPS is responsible for establishing focal points within main producing regions (both domestically and internationally) to deal with the physical protection of nuclear material. In addition, the Ministry of Public Security's Office for the Protection of Nuclear Material for the Physical Protection of Nuclear Material Management Agency (公安部核材料保护办公室为核材料实物保护的管理机构) is responsible for dealing with criminal cases of nuclear material violations.

It remains unclear from this legislation and from the Ministry's website whether there are any specific subdivisions which handle affairs related to nuclear material.

Ministry of Transport

The Ministry of Transport is an agency under the State Council responsible for railway, road, air and water transportation regulations. In March 2013, it was announced that the Ministry of Railways (MOR) would be dissolved and its duties taken up by the Ministry of Transport (safety and regulation), State Railways Administration (inspection) and China Railway Corporation (construction and management).[87]

86 Li Hong, 'Chinese Nonproliferation Policy and Export Control Practice,' presentation Taibei, 28 August 2013, http://csis.org/files/attachments/130828_LiHong.pdf.

87 'China scraps Railways Ministry in Streamlining Drive,' BBC, 10 March 2013, http://www.bbc.co.uk/news/world-asia-china-21732566.

Given that most domestic uranium transport is by rail, this is a significant absorption by the MOT.[88]

The MOT has many responsibilities in terms of ensuring the safety, security, and compliance of transportation entities handling natural uranium. These duties are detailed in the 2011 Provisions on the Administration of the Road Transport of Radioactive Articles and the 2005/2013 Provisions on the Administration of the Road Transport of Dangerous Goods.

Other Entities Relevant to Uranium Governance

Other relevant regulatory and administrative agencies within China include the General Bureau of Customs, charged with ensuring that uranium entering and exiting the country is accompanied by the requisite permissions.

The Ministry of Foreign Affairs' Department of Arms Control reports on issues of international arms control, disarmament, non-proliferation, and export control. It organizes the development of relevant policies, works with other departments to manage related cases, and organizes negotiations on relevant international treaties and agreements.[89]

In China, the Ministry of Commerce is generally focused on dealing with dual-use exports and imports, and therefore does not typically deal with nuclear material-related issues, which is left to CAEA. MOC does, however, have a role in China's interagency licensing process as one of the several entities that must provide permission for importing uranium from overseas.

China's Ministry of Land and Resources is charged with supervising the examination, approval, registration and licensing of the rights to explore and to mine mineral resources and to approve any foreign investment of uranium within China (as with the case of Spartan and the reprocessing of uranium from China's coal-ash). It is also charged with undertaking the management of mineral reserves and to administer exploration work.[90]

88 Interview, CNNC, Beijing, June 2013.
89 Department of Arms Control, Ministry of Foreign Affairs of the People's Republic of China, http://www.fmprc.gov.cn/eng/wjb/zzjg/jks/.
90 'Responsibilities of the Ministry of Land and Resources,' Ministry of Land and Resources of the People's Republic of China, http://www.mlr.gov.cn/mlrenglish/about/mission/200710/t20071015_656461.htm.

National Uranium Regulations and Implementation

Corresponding to the fact that there are numerous regulatory agencies involved in managing uranium affairs in China, many of these agencies have issued sets of their own regulations governing uranium both within China and overseas. Over the years, this has resulted in a tangled web of overlapping regulations, some of which extend to UOC and other primary uranium products, and some that only cover uranium at later stages of the fuel cycle.

The various regulations governing uranium are issued at four basic levels that indicate the scope and rank of that piece of legislation.

Level 1: Laws

At Level 1, the highest level, are laws that are typically issued by the Central Committee of the National People's Congress and sanctioned by the President.

The most relevant law concerning early fuel cycle uranium in China is the *2003 Law of the People's Republic of China on the Prevention and Control of Radioactive Pollution*. This is a relatively new law which specifies that 'State Council environmental protection administrative authorities' are in charge of supervising and inspecting measures to prevent radioactive pollution at nuclear facilities and during the development of uranium mines.

Article 12 of this law is particularly notable for the fact that it holds 'units' liable for radioactive pollution rather than whole entities. The law states that units that operate nuclear facilities, use nuclear technology, or engage in uranium or other radioactive materials mining are liable for any pollution. This seems to indicate that if an accident occurs, the blame would fall upon a set of individuals rather than whole companies. This loophole may pose a risk of decreasing the motivation of large, multifaceted corporations such as CNNC to ensure that existing regulations on uranium handling and transport are followed.

Level 2: State Regulations

At Level 2 are State Regulations issued by the State Council that are usually focused on more specific issues but can still be quite broad. The first and foundational set of regulations for nuclear material control in China was the *1987 Regulations for Control of Nuclear Materials*. In its 2003 White Paper on 'Concrete Measures for Non-Proliferation Export Control', China points to this set of regulations as the country's means of instituting a licensing system for nuclear materials and defining the measures for nuclear materials control, nuclear materials licenses, of nuclear materials accountancy, the physical protection of nuclear materials, and relevant rewards and punishments. This set of regulations also first specified that the National Nuclear Safety Administration would be responsible for the safety oversight of civilian nuclear material and nuclear material control. The legislation also called on the 'nuclear industry' or state-owned companies to develop regulations on effective nuclear material control. Most significantly, these regulations explicitly state that uranium ores and primary products are not covered by the ordinance.

Figure 4: China's key legislation on front-end fuel cycle uranium

Chairman of the PRC (Level 1 Laws)
2003 Law of the People's Republic of China on Prevention and Control of Radioactive Pollution « 中华人民共和国放射性污染防治法 »
State Council (Level 2 -State Regulations)
1987 Regulations for Control of Nuclear Materials « 中华人民共和国核材料管制条例 »
2005 Regulations on the Safety and Protection of Radioisotopes and Radiation Devices « 放射性同位素与射线装置安全和防护条例 »
2006 Regulations of the People's Republic of China on Nuclear Export Control « 中华人民共和国核出口管制条例 » (first published in 1997, updated in 2006)
2001 Nuclear Export Control List « 核出口管制清单 »
2010 Radioactive Materials Transportation Safety Management Regulations « 放射性物品运输安全管理条例 »
State Council (Level 3 –Departmental Regulations)
1990 Rules for the Implementation of Regulations on Nuclear Materials Control « 中华人民共和国核材料管制条例实施细则 »
1997 Circular on Strict Implementation of China's Nuclear Export Policy « 国务院关于严格执行我国核出口政策有关问题的通知 »
Ministry of Public Security and CAEA (Level 3 –Dept. Reg.)
1994 Rules on Physical Protection for International Nuclear Materials Transport « 核材料国际运输实物保护规定 »
Ministry of Environmental Protection (Level 3 –Dept. Reg.)
2006 Regulations on the Administration of Safety Permission of Radioisotopes and Radiation Devices « 放射性同位素与射线装置安全许可管理办法 »
2010 Regulations on the Administration of Permission on Transport Safety of Radioactive Articles « 放射性物品运输安全许可管理办法 »
2011 Regulations on Radioisotopes and Radiation Safety and Protection Management « 放射性同位素与射线装置安全和防护管理办法 »
Ministry of Transportation (Level 3 –Departmental Regulations)
1995 Provisions on the Administration of the Railway Transport of Dangerous Goods « 铁路危险货物运输管理规则 »
2011 Provisions on the Administration of the Road Transport of Radioactive Articles « 放射性物品道路运输管理规定 »
2005/2013 Provisions on the Administration of the Road Transport of Dangerous Goods « 道路危险货物运输管理规定 »
AQSIQ (Level 4 –National Standards)
1990 Regulations for Safety Transportation of Radioactive Materials « 放射性物质安全运输规定 » (equal to 2003 IAEA-TS-R-1)
2003 Basic Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources « 电离辐射防护与辐射源安全基本标准 »
2010 Regulations for Radiation and Environment Protection in Uranium Mining and Milling « 铀矿冶辐射防护和环境保护规定 »

The 1987 Regulations also state that its provisions do not apply to nuclear material that is under the control of the military. Given that CNNC is a 'civilian' entity under the State Council which also contributes to nuclear weapons development activities, this is a difficult distinction to make.

These regulations also specify which entities must apply for a permit to handle nuclear materials through a system based on the quantity of materials that that company is dealing with. Article 9 Section 1 states that a license is required for entities transferring or producing greater than 0.01 'effective kilograms' of uranium or products containing uranium.[91] As the definition of an effective kilogram in the regulations is based on a concentration of U-235, this means that any entities producing or transferring 100 kg or more of UOC would be required to have a license.

Level 3: Departmental Regulations

Level 3 Departmental Regulations are regulations issued beneath the State Council at the ministerial level that typically elaborate departmental responsibility in implementing State Regulations or Laws.

The *1990 Rules for the Implementation of Regulations on Nuclear Materials Control* builds on 1987 Regulations. In Chapter 5 of the Regulations on the national accounting and management of nuclear materials, Article 13 Section 2 states that uranium ores and primary products, as well as nuclear materials that have been transferred to the military, do not belong to the accounting system. This wording seems effectively to exclude UOC from the accounting system, though given that 'uranium ores' and 'primary products' are not defined terms, there is still room for uncertainty.

1994 Rules on Physical Protection for International Nuclear Materials Transport is a Level 3 Departmental Regulation issued by the Ministry of Public Security and the China Atomic Energy Authority. These regulations were meant as an implementation measure under the Convention on the Physical Protection of Nuclear Material (CPPNM) and state that the provisions of the regulations are in accordance with CPPNM as well as the 1987 Regulations. The goals of these regulations are stated as protecting nuclear material in international transport and preventing loss, theft, robbery, vandalism and illegal transfer.

91 Relevant to natural uranium and UOC, Article 22 states that 'for uranium with a U-235 isotopic content of less than 1% but more than 0.5%, the number of effective kilograms would be the actual weight of the material multiplied by 0.0001.'

Unlike the 1987 and 1990 regulations, the 1994 regulations do not mention uranium ore explicitly, but they do state that the regulations cover any material containing one or more of the following ingredients: Pu-239, U-235, U-233, or natural uranium. It therefore follows that uranium ore and other primary uranium products would be subject to the physical protection guidelines specified in this regulation, at least when in international transport or storage.

Level 4: National Standards

At Level 4 are the National Standards which have been developed for technical requirements that need to be standardized nationwide. Although these standards make up the core of relevant standardization and technical regulations in China, only about 15% of National Standards are compulsory.[92]

Figure 5. Details on the physical protection of natural uranium from the *1994 Rules on Physical Protection for International Nuclear Materials Transport*. As a Category III material, UOC would be subject to the listed physical protection measures.
Note: this is not an official translation.

Article XIX Temporary Storage Protection Measures
Category III: this material must be stored in a controlled personnel access site;
Category II: the storage area for this material shall be surrounded by a physical barrier, and there are security guards guarded day and night surveillance alarm equipment and, if necessary, security personnel should get in touch with the local police to determine the alarm mode;
Category I: this material must comply with Category II specifications and in addition persons entering the site must be reviewed, security personnel should maintain contact with the local police, and when necessary, can apply for support to ensure the security of nuclear materials.

Article XX Transport Protection Measures
Category II and III: when transporting this material, the sender, recipient and carrier should arrange in advance the time of transport, route, and stops. Details of the transportation shall not be disclosed to unauthorized personnel. Security and escort personnel must regularly check the security of nuclear materials, packaging and other conditions, identify problems and ensure timely disposal.
Category I: In addition to the measure for Category II and III transport, this material must be guarded day and night by security and escort personnel.
More than 500 kilograms of natural uranium: the shipper shall notify in advance to the consignee, the mode of transport, expected time of arrival, receiving certificates and so on.

92 Quality Partnerships LLC, Groups of Standards in China, http://quality-partnerships.cn/standards-in-china/hierarchy-of-standards-in-china/.

Category Definitions	
附件1：核材料国际运输实物保护级别划分	Annex I: Physical protection of nuclear material in international transport
未经照射的	Unirradiated Uranium
Category I: 5千克或	**Category I:** 5 kg or more
Category II: 5千克以下	**Category II:** less that 5 kg
Category III: 1千克或1千克	**Category III:** 1 kg or more
235含量达到或超过20%的	U-235 content of 20% or more
Category I: 5千克以上	**Category I:** 5 kg or more
Category II: 1千克以上	**Category II:** 1 kg or more
Category III: 以下15克以上	**Category III:** 15 grams or more
235含量达到或超过10%,低于20%的	U-235 content of 10% or more, but less than 20%
Category II: 10千克或	**Category II:** 10 kg or more
Category III: 10千克以下	**Category III:** less than 10 kg
235含量超 过天然铀， 低于10%的	U-235 content more than natural uranium, but less than 10%
Category III: 10千克或10千克以上	**Category III:** more than 10 kg or 10 kg
天然铀	Natural uranium
Category III: 10000千克以上蠣	**Category III:** 10,000 kg or more

National implementation of international agreements

After decades of gradual progress, China has come to attach great importance to the multilateral non-proliferation regime. China concluded an Agreement for the Application of Safeguards in China with the IAEA in 1988; it signed an Additional Protocol to the above Agreement in 1998 and completed its domestic legal procedures for the entry-into-force of the Additional Protocol in 2002. It also acceded to the Convention on the Physical Protection of Nuclear Materials in 1989 and established a State System for the Accountancy and Control of Nuclear Materials.[93] And finally, at

93 Communication of 26 January 2004 from the Permanent Mission of the People's Republic of China to the International Atomic Energy Agency regarding China's Nuclear Policies and Practices, INFCIRC/627, 2 February 2004, http://www.iaea.org/Publications/Documents/Infcircs/2004/infcirc627.pdf.

the 14th Plenary meeting of the Nuclear Suppliers Group (NSG) held in May 2004, China was accepted as a participating government in the export control group.[94]

Natural uranium, except in large batch quantities, remains largely unregulated under these agreements (see Figure 6).

Figure 6. Natural Uranium and China's International Commitments

International Agreement	Does the agreement or China's direct national implementation measures regulate natural uranium?
IAEA Safeguards Agreement	Yes, but only in quantities greater than 10 metric tons of natural uranium.
Additional Protocol	No
Convention on the Physical Protection of Nuclear Materials	Yes, but only in quantities over 10,000kg of natural uranium.
NSG	Yes, but only in quantities over 500kg of natural uranium within a 12 month period.

China-IAEA Safeguards Agreements

Article 33 of the 1989 China-IAEA Safeguards Agreement specifies the starting point of safeguards as follows:

> *'Safeguards under this Agreement shall not apply to material in mining or ore processing activities, as well as to uranium or thorium until they have reached the stage of the nuclear fuel cycle where they are of a composition and purity suitable for fuel fabrication or isotopic enrichment.'*

In addition, Article 90 specifies:

> *'The term "source material" shall not be interpreted as applying to ore or ore residue.'*

Both of these provisions rule out raw uranium ores and rocks. However, as neither provision is isotopically defined, there is still room for some ambiguity. For instance, the treatment of uranium ore concentrate or yellowcake in the form of U_3O_8 is not immediately clear. If it were to be classified as an ore, it would not be covered.

94 Sean Lucas, 'China Enters the Nuclear Suppliers Group: Positive Steps in the Global Campaign against Nuclear Weapons Proliferation,' November 2004, http://www.nti.org/analysis/articles/china-enters-nuclear-suppliers-group/.

However, there remains the fact that U_3O_8 can technically be converted into powder form and directly fabricated as fuel, in which case it would be covered. Nevertheless, in China's implementation of its safeguards agreement, it does not treat UOC as a safeguarded item.

There are currently only three facilities in China listed as falling under IAEA safeguards or as containing safeguarded material as of December 2010 (see Figure 7). This does not indicate that facilities not listed are used for military purposes, but rather China has only chosen to allow safeguards at these select facilities for various commercial and security reasons.

In accordance with the fact that UOC is typically not subject to safeguards in China, the country does not currently allow safeguards on any of its domestic uranium conversion activities either. In the context of UOC that may be subject to bilateral safeguards agreements, such as UOC imported by China from Australia or Canada, how safeguards are applied to this material remains unclear. Reports on the implementation of safeguards at the Shaanxi uranium enrichment plant seem only to indicate that receipts and shipments of UF6 are verified, with no mention of any storage or monitoring of UOC.[95]

Figure 7. Facilities under IAEA safeguards or containing safeguarded material on 31 December 2010

Facility type	Facility name
Power reactors	QSNPP Hai Yan, Zhe Jiang
Research reactors	HTR-10 Nankou, Beijing
Conversion plants	*None listed*
Fuel fabrication plants	*None listed*
Reprocessing plants	*None listed*
Enrichment plants	China Shaanxi Han Zhang, Shaanxi Province
Additionally under Agency safeguards were 496 locations outside facilities (LOFs) in 97 States and in Taiwan, China.	

95 'Tripartite Enrichment Project: Safeguards at Enrichment Plants Equipped with Russian Centrifuges,' International Atomic Energy Agency, IAEA-SM-367/8/02, http://www-pub.iaea.org/MTCD/publications/PDF/ss-2001/PDF%20files/Session%208/Paper%208-02.pdf.

Additional Protocol

China's Additional Protocol, concluded with the IAEA in 2002, is unique in that it does not allow IAEA inspectors physical access to any facilities. The AP does, however, require China to provide information on nuclear imports and exports to and from NNWS, and on activities in cooperation with NNWS relating to the nuclear fuel cycle.

Relevant to uranium mines and natural uranium, Article 2 of the AP specifies that China must provide the Agency with information specifying the location and operational status of uranium mines and concentration plants in China which are involved in production for a NNWS, as well as the current annual production of such mines and concentration plants for that NNWS. Under the same article, the IAEA also has the power to request information regarding source material which has not reached the composition and purity suitable for fuel fabrication or for being isotopically enriched (e.g. yellowcake) if China exports this material in excess of 10 metric tons per year to the same NNWS. However, this Article also states that the provision of this information does not require detailed nuclear material accountancy, indicating that China must only provide information on the bulk exports or imports, rather than the chain of custody of this material throughout the early stages of China's fuel cycle.

In any case, the information on natural uranium should be available within China's system if the IAEA were to request it due to the fact that it should be harvested by national regulations. First, China should be able to report the specified 'Ten metric tons of uranium' within a twelve-month period, given that its companies are already required to report shipments of over 10,000 kg of uranium (10 metric tons equivalent) under the 1994 *Rules on Physical Protection for International Nuclear Materials Transport*. In addition, China's 2001 Nuclear Export Control List also requires the reporting of this material as a source material when transporting in excess of 500 kg within a twelve-month period.

Nuclear Suppliers Group

China became a member of the Nuclear Suppliers Group (NSG) in 2004. NSG does not regulate yellowcake if the Government believes the exported material will not be used for nuclear purposes, or if it is exported in quantities of less than 500 kg.

China's prior legislation is consistent with NSG provisions. In September 1997, the government promulgated the Regulations on the Control of Nuclear Export, stipulating that no assistance in whatever form should be provided to nuclear facilities that are not under IAEA safeguards. In addition, China's Nuclear Export Control List, updated in 2001, is consistent with both of the NSG's exceptions on source material and natural uranium provisions. Therefore, it is safe to say that China could legally export UOC in small quantities to any state, or even large quantities if the government had reasonable assurance that the material would not be used for nuclear purposes.

There is some controversy with China's implementation of its NSG commitments with regard to China's supply of two small power reactors to Pakistan, Chashma 3 & 4, including the supply of fuel assemblies. Contracts for Chashma units 1 & 2 were signed in 1990 and 2000, before China joined the NSG in 2004, and this has been Beijing's argument for why the transaction does not violate its existing commitments. The agreement for units 3 & 4 was announced in 2007 and signed in October 2008.[96]

The Convention on the Physical Protection of Nuclear Materials (CPPNM)

The CPPNM is mainly implemented in China by the *1994 Rules on Physical Protection for International Nuclear Materials Transport*. Despite its title, this set of regulations contains provisions for uranium stored or in transit both within China and overseas. For more information, see section 5, 'Overseas Uranium Activities and Regulation', of this report.

The 1994 Rules are consistent with CPPNM's provision that for natural uranium other than in the form of ore or ore-residue, transportation protection for quantities exceeding 500 kilograms of uranium must include advance notification of shipment, specifying the mode of transport, expected time of arrival and confirmation of receipt of the shipment.

China's national interpretation of CPPNM through the 1994 Rules actually go one small step further in its regulation of natural uranium in storage and in transport. Whereas CPPNM states that natural uranium should simply be 'protected in accordance with prudent management practice,' China takes an extra precaution by classifying natural uranium in large quantities (in excess of 10,000 kg) as a Category III material. In accordance with CPPNM and the 1994 Rules, this means that such large quantities of natural uranium would (1) need to be stored in a controlled per-

96 China's Nuclear Fuel Cycle, World Nuclear Association, September 2013, http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/China--Nuclear-Fuel-Cycle/#.UjXcVsacmuI.

sonnel access site, and (2) when transporting this material, the sender, recipient and carrier should arrange in advance the time of transport, route, and stops, and details of the transportation cannot be disclosed to unauthorized personnel.

Overseas Uranium Activities and Regulation

Overseas uranium mining is currently the second largest source of uranium income for China behind market purchases. Activities surrounding this large and growing stream of resources coming to China from a diverse range of countries will continue to grow, especially in line with China's view that new uranium exploration is one of the most cost-effective ways of acquiring overseas uranium.

China is currently active in a diverse and growing pool of countries, including Kazakhstan (which remains the largest source of China's overseas uranium mining income), Australia, Canada, Niger, and Namibia. In addition, China is also conducting newer exploration and mining projects in Botswana, Jordan, Kyrgyzstan, Mongolia, Russia, Zimbabwe, Tanzania and Zambia.[97]

Evidence suggests that China processes uranium ore from its overseas mining operations directly at or nearby the foreign site, converting it to yellowcake before the uranium is brought back to China.[98] This makes sense given the high cost and inefficiency of transporting bulk uranium ore, as well as the difficulties and dangers associated with the overseas transport of UF_6 as a highly sensitive and difficult-to-handle material.

Key challenges

China is facing several key challenges in terms of its overseas activities. Some China experts argue that these challenges lie in the form of a dearth of experience in the management of global uranium extraction companies, a lack of knowledge of the legislation and domestic policies of foreign countries, political risks in host countries and the fact that China is a late player in the game.[99] China is competing for access in

97 'CNNC begins Trails at Uranium Mine in Niger,' People's Daily Online, 24 March 2011, http://english.people.com.cn/90001/90778/90860/7329801.html ; Jeffrey R. Faul, 'China's Uranium Procurement Strategies, NUKEM, Inc. World Nuclear Fuel Market Conference, Seville Spain, June 2011, http://www.nukem.de/fileadmin/nukem/mediapool/presentations/China%E2%80%99s%20Uranium%20Procurement%20Strategies%20WNFM%20June%206,%202011%3B%20Seville,%20Spain.pdf.

98 'First Uranium from Niger Mine,' World Nuclear News, 4 January 2011, http://www.world-nuclear-news.org/ENF-First_uranium_from_Niger_mine-0401117.html.

99 Q. Xie, M. Hua, and P. Wu, 'China's uranium industry, 'going out' policy: opportunities and challenges (Woguo youkuangye 'zouchuqu' suo mianlin de jiyu yu tiaozhan),' China Mining Magazine, vol. 20, no. 12, pp 16-19, 2011, (in Chinese).

the Central Asian uranium market with Russia and India in Kazakhstan and Mongolia, while South Korea and Japan also buy significant amounts of uranium there and Iran is looking to raise its imports as well. India is also competing with China in Namibia and Niger.[100]

Cao Shudong, CNNC Assistant General Manager of the Division of Geology and Minerals, has explained China's strategy in dealing with the intense competition overseas. First, he states that 80% of the world's uranium resources have been proved to lie with the Canadian mining companies (Cameco), Areva Group and Australia's Rio Tinto, with the remainder divided between another eight companies in the hands of the market such that it is very difficult for China to acquire high-quality overseas uranium. Indeed, the Chinese have shown that they will often pay above market prices for mines, companies and other assets in order to remain competitive in this increasingly crowded market.[101] However, Cao also states that this artificially large upfront investment works itself into cooperative agreements to develop existing overseas mines, building into a higher cost of natural uranium output, and is therefore undesirable. He asserts that China's efforts to start from the bottom and engage in self-discovered uranium exploration actually results in less upfront investment, relatively low production costs, and better overall economic benefits.[102]

Regulations applicable to China's uranium operations overseas

China has established a three-entity system for governing the safety and physical protection of its uranium assets overseas. The Ministry of Public Security (MPS), the China Atomic Energy Authority (CAEA), and China's state-owned enterprises (SOEs) are held jointly responsible for the physical protection of uranium under the *1994 Rules on the Physical Protection for International Nuclear Materials Transport*.

The regulations specify that the Ministry of Public Security is responsible for establishing focal points within the main producing regions to deal with the physical

100 Massot and Chen. 'China and the Global Uranium Market: Prospects for Peaceful Coexistence,' P. 7, 2013.
101 R. Weitz, 'China's uranium quest part 2: the turn to foreign markets,' China Brief, vol.11, no. 16, pp. 12-15, 2011.
102 Ma Zhe, [Relying on Uranium Resources and Support for both Internal and external Markets], China Energy Report, December 2012, (in Chinese), http://www.gdfushefanghuxiehui.com/newsview.asp?viewid=751&class=2.

protection of nuclear material. From its Beijing headquarters, as well as from these outposts, MPS' main responsibilities are:

1 The security of international transport for the import and export of nuclear materials, on-shore work-place inspection, and guidance in accordance with the requirements to implement safety precautions;
2 The supervision and inspection at work sites for nuclear material pre-shipment, loading and unloading, as well as the supervision and inspection of temporary storage sites;
3 Organization and coordination of the import and export of nuclear material and shore crime investigation;
4 Safety checks for the entry and exit of nuclear materials.

In addition to these responsibilities, the Ministry of Public Security's Office for the Protection of Nuclear Material for the Physical Protection of Nuclear Material Management Agency (公安部核材料保护办公室为核材料实物保护的管理机构) has the following main responsibilities:

1 Inspection and supervision of international transport of nuclear material in the implementation of physical protection measures;
2 Security of nuclear material and exchange of relevant intelligence for international collaboration; responsible for turning over any accused persons and extradition of criminals to the relevant national, regional and international organizations charged with handling criminal cases on nuclear materials;
3 In the case of criminal infringement of the international transport of nuclear material, to notify the relevant national, regional and international organizations for assistance;
4 To examine and approve the international transport of nuclear material in country border crossings, as well as investigate cases of nuclear material transport and border crossings conducted without the approval of the Chinese government;
5 To handle domestic nuclear transportation exemption permits;
6 To provide protection if foreign governments or international organizations request permission to transport nuclear material through China.

Under the same piece of legislation, CAEA is designated as responsible for managing the international transport of nuclear material and domestic use, storage, transport safety, protection and management. Under Article 7, and in cooperation with the Foreign Ministry, CAEA has the following responsibilities:

1 To develop regulations on the physical protection of nuclear material in international transport;
2 To develop standards for the physical protection of nuclear material in international transport;
3 Examination and approval of international transport of nuclear material physical protection permits;
4 Supervision and inspection of the physical protection of nuclear material in international transport implementation;
5 Sectoral negotiations with foreign governments regarding the physical protection of nuclear material in international transport within the context of bilateral or multilateral agreements; international technical exchange and cooperation on physical protection measures
6 Review and confirmation of foreign government departments and the physical protection of nuclear material documents.

Finally, Article IX states that the legal representatives of business units (i.e. SOEs) have the responsibility for implementing the physical protection of nuclear material in international transport. Under this article, SOEs are responsible for:

1 Establishing a physical protection management system for the international transport of nuclear material with strict measures;
2 Organizing and implementing international transport of nuclear material physical protection work;
3 Applying for physical protection of nuclear material in international traffic permits;
4 Providing authorities with the annual plan and relevant information concerning the international transport of nuclear material protection, and cooperating with the supervision and inspection departments.
5 Those involved in the carriage of nuclear material in the international transport sector should assist in safeguarding the security of nuclear materials.

Regulating Exports and Imports of Early Fuel Cycle Uranium

Term supply agreements with foreign partners have been the major source of China's uranium. Due to recently secured agreements, this is likely to remain the case for the foreseeable future, but it is also possible that increasing income from overseas mining operations and new domestic deposit discoveries could gradually alter the current balance.

China's largest current supplier of uranium is Kazakhstan in terms of both term supply deals and joint ventures. Other major suppliers of uranium at various stages of the fuel cycle include AREVA (term supplies plus fuel for AREVA reactors), Tenex/TVEL (similar to AREVA), Cameco, and Rio Tinto. Others (current or in advanced negotiation) include Paladin, Urenco, and BHP. A bilateral safeguards agreement will also allow for increased imports from Australia, and more recently, Canada.[103]

Both Canada and Australia required a bilateral safeguards agreement with China in order to allow the trade and export of uranium to Chinese territory. Both agreements naturally prohibit the use of the imported uranium for nuclear weapons purposes. However, in achieving this end, the two agreements differ in a significant way. Whereas the agreement with Australia allows for the substitution of uranium (i.e. if China were ever to use Australian uranium for military purposes, an equivalent amount somewhere else in China must be brought under safeguards), Canada requires that no Canadian uranium be used for military purposes, probably requiring additional bilateral safeguards measures to supplement existing IAEA measures.

Key Actors

Only two Chinese companies have authorization to import uranium. These exclusive rights belong to the China Nuclear Energy Industry Corporation (CNEIC), a subsidiary of CNNC, and the CGN Nuclear Fuel Co., Ltd (CGN-NFC)(formerly known as Uranium Resources Co., Ltd.), a subsidiary of the China General Nuclear Power Corporation (CGN).

103 Massot and Chen. 'China and the Global Uranium Market: Prospects for Peaceful Coexistence,' P. 8, 2013.

CNEIC is long established in this area, being active since the 1980s. However, CGN-NFC has been occupying an increasing share of the market since its establishment in 2006.

China and Australia

In April 2006, Australia and China signed two bilateral safeguards agreements to open the way for Australia to supply uranium to China's growing nuclear energy industry. The *Nuclear Material Transfer Agreement* and *Nuclear Cooperation Agreement* put in place safeguards to ensure that Australian uranium supplied to China will be used solely to produce electricity. The Nuclear Transfer Agreement allows Australian uranium to be used in designated Chinese nuclear facilities, while the Nuclear Cooperation Agreement allows, among other things, for China to explore for uranium in Australia.[104]

In order to ensure that Australian uranium does not contribute to China's nuclear weapons, the undisclosed bilateral agreements reportedly establish a system involving equivalent quantities. The Australian Department of Foreign Affairs and Trade explains the system as follows:

> '*China has agreed to use AONM (Australian obligated nuclear material—Australian uranium and nuclear material derived from this) only at nuclear facilities covered by its safeguards agreement with the IAEA.*
>
> *However, uranium conversion facilities are before the 'starting point' for IAEA safeguards procedures and are not included in IAEA safeguards agreements with nuclear weapon states.*
>
> *In accordance with long-standing international principles of accounting for nuclear material, on receipt of AONM (yellowcake) in China an equivalent quantity of converted natural uranium in the form of uranium hexafluoride will be added to the inventory of a facility designated for safeguards – e.g. an enrichment plant.*

104 'Australia Starts Shipping Uranium to China,' World Nuclear News, 21 November 2008, http://www.world-nuclear-news.org/ENF-Australia_starts_shipping_uranium_to_China-2111086.html.

This will have exactly the same effect as if the yellowcake had moved through the conversion plant, and will ensure that after receipt in China, AONM remains in a facility designated for safeguards and listed under the agreement at all times.'[105]

This system, while still requiring a robust reporting and verification system, is still relatively more relaxed than the system established with Canada. Both China and Australia ratified the agreement through an exchange of Diplomatic Notes in Beijing in January 2007. The agreements entered into force thirty days after ratification. Accordingly, the legal framework for Australian uranium producers to commence exports to China was subsequently put in place, though details of the verification system remain undisclosed to the public.

China and Canada

In 2010, Saskatchewan's Cameco struck two long-term deals to sell 52 million pounds of uranium concentrate to China, but because exporting Canadian uranium to China was not allowed at the time, it had to ship the uranium from other countries, such as Namibia and Kazakhstan.[106]

Efforts to mitigate this challenge have since been underway, and on February 9, 2012, Prime Minister Stephen Harper announced the successful completion of substantive negotiations on an agreement that will allow for increased exports of Canadian uranium to China. The Canadian government attests that this increased collaboration will allow Canadian companies to benefit from even greater access to China's civilian nuclear power sector and enhance Canada's export activities and bilateral relations with China.[107]

The new agreement is in the form of a Protocol that will supplement the Agreement between the Government of Canada and the Government of the People's Republic of China for Co-operation in the Peaceful Uses of Nuclear Energy of 1994. The

105 Australian Government, Department of Foreign Affairs and Trade, Australia-China Nuclear Material Transfer Agreement and Nuclear Cooperation Agreement, November 2007, http://www.dfat.gov.au/geo/china/treaties/faq.html.

106 Campell Clark, Shawn McCarthy, 'Harper Relaxes Accountability Rules for China's Use of Uranium,' The Globe and Mail, 6 September 2012, http://www.theglobeandmail.com/news/politics/harper-relaxes-accountability-rules-for-chinas-use-of-uranium/article2333398/?utm_medium=Feeds%3A%20RSS%2FAtom&utm_source=Politics&utm_content=2333398.

107 Prime Minister of Canada, Agreement with China on Canadian Uranium Exports, 9 February 2012, http://www.pm.gc.ca/eng/media.asp?id=4646.

Protocol is a legally binding instrument that will govern and facilitate the export of Canadian uranium to China.

According to Ernie Regehr, Senior Fellow at the Simons Foundation in Vancouver, elaborating on that assurance, officials also confirm that any uranium supplied by Canada will ultimately be used exclusively in facilities covered by International Atomic Energy Agency (IAEA) safeguards. But like the Australian deal, the Canadian UOC that China receives will require further processing before it is transferred to facilities under IAEA safeguards, so there will be a requirement to fill that gap in the safeguards system with separate arrangements to verify the non-diversion of any of these materials before they enter the safeguarded facilities. Such supplemental verification arrangements are to be developed during the detailed negotiations over the final Protocol. The details of that tracking await the final agreement, which is unlikely to be disclosed to the public. [108]

This issue could be dealt with more easily if some of China's facilities at Lanzhou were to come under safeguards. One enrichment facility at Lanzhou is currently offered for safeguards. Given the conversion capacities at Lanzhou, if safeguards were to be implemented, it would afford a safeguarded destination for Canadian UOC to be stored until further enrichment.

China and Kazakhstan

Unlike the case of Australia and Canada, China does not have a bilateral safeguards agreement with Kazakhstan, despite the fact that it has become the largest supplier of uranium to China. In addition to preceding supply agreements, CNEIC more recently signed a long-term uranium supply contract with KAZATOMPROM on February 21, 2011 for a total of 30,000 tU to be supplied from 2011 to 2020.[109] Instead of an independent agreement, on 31 October 2008, the former foreign ministers of China (Yang Jiechi) and Kazakhstan (Marat Tazhin) signed a protocol on amendments and supplements to the agreement establishing the Kazakh-Chinese Committee for Cooperation of 2004. Among the documents signed was an agreement on cooperation between state-owned KazAtomProm and the China Guangdong Nuclear Power Co

108 Disarming Conflict, Ernie Regehr, http://disarmingconflict.ca/ernie-regehr/.

109 Weike Cong, 'Nuclear Industry in China, CNNC Presentation at the International Atomic Energy Agency', P. 29, http://www-pub.iaea.org/mtcd/meetings/PDFplus/2009/cn175/URAM2009/Session%201/8_33_Cong_China.pdf.

(CGN) on the joint development of uranium resources, production of nuclear fuel, long-term trade in natural uranium, nuclear power generation and the construction of nuclear power plants. An additional agreement signed between KazAtomProm and the China National Nuclear Corp (CNNC) focuses on the implementation of long-term nuclear cooperation projects.

In October 2007, KazAtomProm President Moukhtar Dzhakishev said that CNNC and CGN are to take a 49% stake in a uranium mining venture in Kazakhstan, with KazAtomProm retaining a 51% stake. In exchange, KazAtomProm would take equity in Chinese nuclear fuel processing or electricity generation plants. 'This is the first time China has allowed any foreign company to become a shareholder in its atomic power industry enterprises,' said Dzhakishev.[110]

Licensing for overseas uranium

The Ministry of Environmental Protection's 2010 Regulations on the Administration of Permission on the Transport Safety of Radioactive Articles details the interagency licensing process for how natural uranium would be imported from overseas sites:

1 While referring to the contracts and agreement between the importing and exporting countries, CAEA and the State Administration of Science Technology and Industry for National Defense (SASTIND) should issue a certificate for the purchase of imported raw materials;
2 Ministry of Environmental Protection to review and approve the import details and requirements;
3 After receiving permission, the company should apply to the Ministry of Commerce for a permit.
4 The company should then go to the General Administration of Customs for final permissions.

The whole process is valid for six months and for multiple imports.[111]

110 'China and Kazakhstan sign Cooperation Agreements,' World Nuclear News, 4 November 2008, http://www.world-nuclear-news.org/enf-china_and_kazakhstan_sign_cooperation_agreements-0411084.html.
111 Interview, NNSA, Beijing 2013; 2010 Regulations on the Administration of Permission on Transport Safety of Radioactive Articles 《放射性物品运输安全许可管理办法》.

Transportation of Uranium

Key transportation entities

In addition to their roles as exclusive importers and exporters of uranium, CNNC's China Nuclear Energy Industry Corporation (CNEIC) and CGN Nuclear Fuel Co. Ltd. (CGN-NFC) are also the two key transporting entities for both domestic and overseas uranium shipments. In addition to carrying out the shipments themselves, much of the manual labour is also contracted out to various subcontractors.

CNEIC reports that it has accumulated twenty years of practical experience in the land (highway and railway), sea and air transportation of natural uranium, low enriched uranium and fuel assembly.[112] The company also states, '*In response to the current worsening environment of international nuclear fuel transportation, CNEIC is intensifying the work of nuclear fuel transportation to ensure absolute safety and reliability.*'[113]

While CNEIC has long dominated the transportation industry in China and abroad, it appears that CGN-NFC is working towards becoming a more active contributor in this area, as it established its own transportation company in September 2010.[114]

Regulating domestic transportation of uranium

Most domestic transportation of UOC in China takes place by rail, with significantly less being transported via trucks and by road.[115] In special cases, especially when uranium is being transported over long distances from the northwest province of Xinjiang and where the government perceives a greater potential risk of terrorism, China also reportedly employs the protection of the military, in addition to the measures described in this section.[116]

112 China Nuclear Energy Industry Corp., Transportation Service, http://www.cneic.com.cn/en/html/2006-7-6/service200676223231.html.
113 Ibid.
114 Sun Ruofan, 'Fuel Supply Strategies of CGN,' CGN Presentation, April 2012, P. 11, http://www.wnfc.info/proceedings/2012/presentations/sun_ppt.pdf.
115 Interview, CNNC, Beijing, June 2013.
116 Interview, CNNC, Beijing, June 2013.

Monitoring and permissions regarding uranium transportation within China are the joint responsibility of four primary agencies: the China Atomic Energy Authority, the National Nuclear Security Administration (under the Ministry of Environmental Protection), the Ministry of Transportation, and the Ministry of Public Security.

The *2010 Radioactive Materials Transportation Safety Management Regulations* issued by the State Council also grant transportation supervision and management rights to local municipal governments.[117] In this way, MoT and MPS personnel can act through their local outposts.

Permissions

There are four types of permissions relevant to transporting natural uranium.

1 The first is a 'nuclear materials permission'. This permission is reviewed by the NNSA and CAEA, and issued by CAEA.
2 The second permission is a 'radioactive materials permission'. This permission is issued by the MEP. Both types of permission are needed to transport natural uranium.[118]

In addition, two special permissions must be obtained from the Ministry of Transportation to allow the transport of natural uranium (designated as a class III radioactive material) by road or rail.[119]

1 The first permit needed is a 'radioactive goods road transport permit' required by the *2010 Regulation on the Administration of Permission on Transport Safety of Radioactive Articles*.
2 The second permit required is a 'dangerous goods road transport permit' required by the *Provisions on the Administration of the Road Transport of Dangerous Goods* regulations (published in 2005, updated in 2013).[120] The 'dangerous goods' permit from MoT terminates on the 30th day of the original approval authority and within 10 days of the closure of the 'road transport operators permit' or 'road

117 [2010 Radioactive Materials Transportation Safety Management Regulations] 《放射性物品运输安全管理条例》, (in Chinese), http://www.gov.cn/zwgk/2009-09/22/content_1423508.htm.
118 Interview with NNSA, Beijing, June 2013.
119 Interview with NNSA, Beijing, June 2013.
120 Interview with NNSA, Beijing, June 2013; [Provisions on the Administration of the Road Transport of Dangerous Goods], 《道路危险货物运输管理规定》, (in Chinese).

hazards Cargo transport permits,' and' road transport permits' must be returned to the original permit authority'.

Container Security

In order to receive permission from the NNSA, the relevant transporter must meet the container requirements specified in the *2010 Regulation on the Administration of Permission on Transport Safety of Radioactive Articles*.[121] This set of regulations is issued by the Ministry of Environmental Protection and inspected by the NNSA.

The regulations apply to the transport of radioactive materials (including uranium yellowcake as a Category III material) and includes fines and penalties for safety violations and the use of unapproved containers both domestically and overseas. Other penalties include those for transporting materials by road without a permit (Article 62) and for transporting to China without a permit (Article 64).

Vehicle Technical Requirements

Both relevant regulations from the Ministry of Transportation (i.e. the *2011 Provisions on the Administration of the Road Transport of Radioactive Articles* and the *2005/2013 Provisions on the Administration of the Road Transport of Dangerous Goods*) detail vehicle requirements for natural uranium transport.

Both sets of regulations require vehicles transporting uranium to meet the following requirements:

1 Vehicle technology performance in line with national standards, 'commercial vehicles performance requirements and test methods' (GB18565) requirements,
2 Vehicle technical levels to industry-standard 'operating vehicle technology classification and assessment requirements' (JT/T198) ;
3 Vehicle dimensions, axle load and quality must meet the national-standard 'road vehicle dimensions, axle load and quality limits' (GB1589) requirements;
4 Vehicle fuel consumption must be in line with industry-standards 'working truck fuel consumption limits and measurement methods' (JT719) requirements.

121 Ministry of Environmental Protection, [2010 Regulation on the Administration of Permission on Transport Safety of Radioactive Articles], 《放射性物品运输安全许可管理办法》, (in Chinese), http://www.mep.gov.cn/gkml/hbb/bl/201009/t20100930_195242.htm.

Other special vehicle requirements include:

1 The enterprise must own at least five vehicles or more (not including trailer beds);
2 Approved contained mass must be below one ton for vans or enclosed trucks;
3 Vehicles must be equipped to meet online monitoring requirements, with travel data recording instruments and a satellite positioning system.

Equipment requirements:

1 An effective communication tool;
2 The necessary supplies and radiation protection monitoring instruments as certified by law.

Monitoring and Tracking Systems

It is not clear from the above requirements whether the vehicles' specified monitoring and tracking equipment (i.e. equipment to meet online monitoring requirements, including a travel data recording instrument and a satellite positioning system) are placed on both the vehicle and the trailer bed carrying the load. The wording of the regulation indicates that the tracking equipment only needs to be on the vehicle in order for the company to be in compliance.

Article 46 of the *2005/2013 Provisions on the Administration of the Road Transport of Dangerous Goods* states that companies transporting dangerous goods should monitor their vehicles via satellite monitoring or any other means that allows for the 'correct and timely' monitoring of speeding, fatigue driving, not following road lines, or other illegal driving behaviour. The article mandates that monitoring data should be kept for a minimum of three months, and any illegal driving information and information on how the situation was dealt with should be kept for at least three years.[122]

These regulations also state that municipal organs of the Ministry of Transportation will conduct on-site inspections of transporters to ensure that trucks, trailer beds, and containers are in compliance with the stipulated regulations. However, the regulations do not state how often these inspections occur, or which types of sites are inspected.

122 [Road Transport of Dangerous Goods Regulations], 1 July 2013, (in Chinese), http://baike.baidu.com/view/439613.htm.

Interestingly, in contrast to the regulations stipulated by the Ministry of Transportation, the regulations issued by the Ministry of Environmental Protection have slightly different requirements in terms of tracking devices on vehicles. Article 32 of the *2010 Regulation on the Administration of Permission on the Transport Safety of Radioactive Articles* states that only Class I materials must use satellite positioning systems during transport. For Class II and III materials (including natural uranium), the regulations only call for the use of 'online monitoring'.

Personnel

Under the Ministry of Transportation's two sets of relevant regulations, there are also special requirements regarding the personnel allowed to operate vehicles transporting natural uranium. Both regulations state that drivers must have an appropriate 'special vehicles' driving license and be no more than sixty years of age.

In addition, the *2010 Regulation on the Administration of Permission on the Transport Safety of Radioactive Articles* state that drivers engaged in the transport of radioactive materials and loading and unloading management personnel must pass an examination by the municipal districts of the local people's government transportation departments to obtain a 'road transport of radioactive substances' qualification certificate.

Overseas transportation of uranium

Regulations

In addition to the physical protection regulations for the international and overseas transport of uranium from the *1994 Rules on Physical Protection for International Nuclear Materials Transport* detailed in section 5 of this report, there is also a record-keeping system for international imports registered directly with the State Council. The *2010 Regulation on the Administration of the Transport Safety of Radioactive Articles* specifies the following:

For Class I radioactive materials arriving in the PRC from abroad, or transported via the territory of the PRC, the shipper must draw up an analysis report for the transport of radioactive materials and radiation of nuclear safety to obtain the approval of the State Council for the review of the nuclear safety regulatory authorities. Examination and approval procedures must follow the provisions of Article 75, paragraph 3 of the regulations.

For Class II and III radioactive materials arriving in the PRC from abroad, or transported via the territory of the PRC, the shipper must submit a 'transport of radioactive materials radiation monitoring report' to the State Council for the record of nuclear safety regulators.

After handling the customs formalities, shippers and carriers must submit to the State Council ratification the 'nuclear transport of radioactive materials and radiation safety analysis report' if dealing with a Class I material (such as enriched uranium). If dealing with a Class II or III material such as uranium, the shipper or carrier will be issued with a proof of filing of the 'radioactive materials transport radiation monitoring report.'

Key uranium ports

China has a large number of large, multi-functional sea and land ports for receiving overseas shipments, though only a few of these can be confirmed as dealing with uranium. Figure 9 illustrates the locations of confirmed ports in relation to China's uranium conversion and enrichment facilities. Due to the more central locations of China's key early-stage uranium processing facilities, UOC must travel a great deal further once it arrives in the country.

With the diversity of locations from which uranium is now being sourced, China's SWS Research Group recommends that a uranium spot market be developed more fully in order to reduce transportation distances and thereby reduce inherent risks to the cargo. In particular, the group recommends developing an Asia-Pacific Uranium Spot/Futures Market that could make exchanges with Europe and Africa.[123]

Sea ports

Ocean shipping is the main method of overseas uranium transportation, and this is typically carried out by container ships, cargo ships and roll-on ships. Most overseas uranium transportation is reportedly carried out by the China Ocean Shipping Company (COSCO).[124] COSCO Logistics and COSCO Shipping Co. Ltd. are two subsidiary companies responsible for overseas uranium transportation.[125] In particular,

123 [Report 10. Protect the Safety of U Import, Logistics Reminds Priority], 保护铀资源进口安全，物流应须优先考虑——基于全球型本土化的中国资源全周期战略布局研究系列报告（铀篇）之九. (in Chinese).
124 [Report 10. Protect the Safety of U Import, Logistics Reminds Priority], 保护铀资源进口安全，物流应须优先考虑——基于全球型本土化的中国资源全周期战略布局研究系列报告（铀篇）之九. (in Chinese).
125 Cosco Logistics, http://www.cosco-logistics.com.cn/; Cosco Shipping CO., LTD., http://www.coscol.com.cn/.

the COSCO Shipping Co. Ltd. is the only company qualified to transport nuclear fuel, nuclear equipment sets, and spent fuel.

In recent years, China has worked to strengthen its container transport system, concentrating on the construction of a group of deep-water container wharves at Dalian, Tianjin, Qingdao, Shanghai, Ningbo, Xiamen and Shenzhen. Of these ports, only Shanghai and the additional port of Zhanjiang in the south are confirmed as dealing with uranium.

Shanghai remains listed as the busiest port in the world in terms of both cargo tonnage and number of containers. The Yangshan port, located off the coast of Shanghai and connected to it by a road bridge, is China's newest deep-water port and has received uranium shipped from both Australia and Canada.[126]

The southern port of Zhanjiang has been reported as receiving uranium from Canada.[127] The Zhanjiang port is a natural deep-water harbor with 39 wharves for containers, general cargo and bulk cargo, as well as special facilities for dangerous goods, petroleum, chemicals, liquid chemicals, storage and packaging. Since 2004, the port has become a land, sea and air transport hub.[128]

Other possible sea ports for the receipt of uranium may include Dalian, Qingdao and Tianjin, as implied by the Chinese research organization SWS in a report analyzing possible uranium trade routes based on published routes of special vessels by COSCO Shipping Ltd (Figure 8).[129]

126 'CGNPC: Natural Uranium Supply from Australia,' Dynabond Powertech Service, 13 November 2012, http://www.dynabondpowertech.com/en/nuclear-power-news/international-news/6390-cgnpc-the-establishment-of-the-channel-of-the-natural-uranium-supply-in-australia; Regulatory Issues – Canada, WISE Uranium Project, 29 October 2013, http://www.wise-uranium.org/uregcdn.html#CDNEXPCN.

127 Uranium Trade – Current Issues, WISE Uranium Project, 20 November 2013, http://www.wise-uranium.org/utiss.html#UTRANSP.

128 General Info of Zhanjiang Port, China Ports, 24 October 2013, http://www.chinaports.com.cn/general-info-of-zhanjiang-port/.

129 保护铀资源进口安全，物流应须优先考虑—基于全球型本土化的中国资源全周期战略布局研究系列报告（铀篇）之九.

Figure 8. Routes used by COSCO Special Cargos[130]

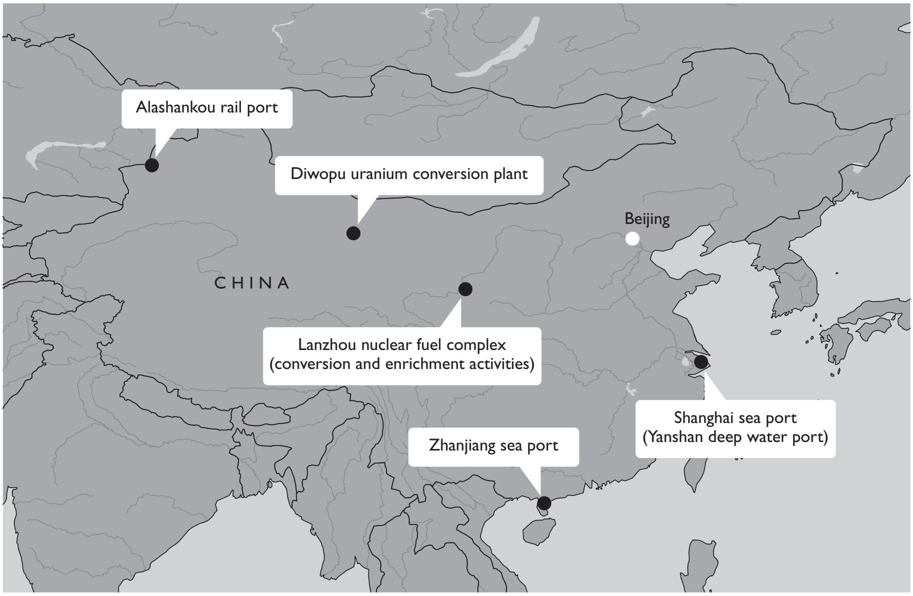
	Ports	Description
African routes	Shanghai, Tainjin, Lagos, Nigeria, Durban, South Africa, Dar es Salaam, Tanzania, Richards Bay, Abidjan, Saldanha, Maputo	Covers China, Japan and Korea to East/South/West Africa, High density.
American routes	Dalian, Qingdao, Tianjin, Shanghai, Guanta, Callao, Havana, Santos, Rio de Janeiro, Sepetiba, Buenos Aires, Cartagena, Puerto Cabello, Palua, Point Lisa etc.	From China to Central and South America.
Mediterranean/ Europe routes	Tianjin, Shanghai, Qingdao, Yokohama, Inchon, Tarous, Skikda, Rotterdam, Piraeus, Antwerp.	Via Suez Canal, the Black Sea.
Pan-Southeast Asian routes	Inchon, Zhenjiang, Yokohama, Dalian, Shanghai, Paradip, Chittagong	From North China, Japan and Korea to Southeast Asia.

Land ports

The Alashankou rail station, located very near the China-Kazakhstan border in China's northwestern province of Xinjiang, is an important point for the receipt of uranium arriving from Central Asia. Uranium from the Navoi region of Uzbekistan is reportedly transported to Alashankou by rail. Another likely but unconfirmed rail port is Khorgos, a newer rail line and station constructed to facilitate greater cargo trade between China and Kazakhstan by up to an additional 30 million MT per year.

130 *From COSCO and SWS Research*

Figure 9. China's key UOC ports relative to its uranium conversion facilities



Conclusions and Recommendations

As China's uranium governance structures continue to develop and evolve, there are several specific areas that could be improved to address the key challenges described in this report towards enhancing uranium governance in the early stages of the fuel cycle.

The first challenge is the obscurity in uranium definitions throughout Chinese legislation. In many regulations, it is not clear whether UOC is considered as falling under the category of uranium ores, which is actually directly discounted in many places. In this regard, China should clarify its interpretation of a source material, natural uranium and uranium ore, especially in older regulations such as the *1987 Regulations for the Control of Nuclear Materials* and the *1990 Rules for the Implementation of Regulations on Nuclear Materials Control*, since many other relevant regulations in China are based on these foundations.

A second challenge is the unclear implementation of existing regulations by the SOEs, as well as obscurity in the exact mechanisms that the relevant regulatory agencies use to ensure the SOEs' compliance, such as inspection frequency and form verification. In particular, it remains unclear how the SOEs themselves ensure compliance by subsidiary contractors both within China and overseas. To deal with this, inspecting agencies could be encouraged to publish a summary of the results of annual inspections to the greatest extent allowed by national security concerns. Even if these reports were not published publicly, an internal reporting system shared amongst the relevant government agencies could help establish a stronger culture of oversight and compliance in the implementation of the various regulations. In particular, given the likely growth in competition between CNNC and CGN, this process could help to develop a beneficial culture of 'competitive compliance' as both key SOEs aim to demonstrate their responsibility and accountability.

A final challenge described in the report is the hierarchical and stove-piped nature of China's uranium governance bureaucracy in contrast to the fact that many national regulations overlap and call for similar oversight measures from different agencies. This is compounded by the potential difficulties of regulatory agencies (e.g. CAEA, NNSA, NEA) in exercising effective authority over the SOEs due to their heavy influence, high-ranking officials, and vice-ministerial standing. China could address these issues by developing greater coordination between key regulators with overlapping monitoring duties such as CAEA and NNSA, and also by confirming at least vice-ministerial standing for these already increasingly autonomous entities. This also holds for more strategic regulators such as NEA, which has suffered in its many iterations from over-responsibility, limited personnel, and an inherent inability to coordinate the many members of the uranium market effectively. In brief, a clearer and more strategic division of labour in terms of oversight and monitoring, as well as increased coordination amongst relevant agencies could go a long way in improving the existing system without reinventing it.

The pace and nature of China's uranium governance reforms and restructuring in recent years represent clear efforts to improve the effectiveness of China's uranium management and procurement strategy, as well as the competitiveness of its SOEs in the international uranium market. However, in many places throughout China's uranium governance structure, there are already solid elements that can be further built upon, and even places where China goes beyond an international requirement, as in the case of CPPNM. In brief, measures including clarifying the definitions and implementation of existing regulations, strategically utilizing the growing culture of domestic nuclear competition, and increasing coordination amongst certain nuclear regulators could significantly enhance the safety, security, and accountability of uranium within China and in its overseas operations. Introducing these measures could help open even more doors for Beijing's uranium procurement aims, as they would represent clear steps demonstrating its commitment to nuclear non-proliferation.