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Evolution of Safeguards Over Time: Past, Present, and Projected Facilities, Material, and Budget

L Kollar
CE Mathews

July 2009

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Evolution of Safeguards over Time: Past, Present, and Projected Facilities, Material, and Budget

Lenka Kollar

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July 23, 2009

Introduction

The International Atomic Energy Agency (IAEA) was formed in 1957 in order to promote safe, secure, and peaceful application of nuclear technologies to the betterment of mankind. One of the main goals of the IAEA is to safeguard nuclear material from diversion into non-peaceful uses and thus prevent nuclear proliferation. There are 187 signatories to the Nuclear Nonproliferation Treaty, and all non-nuclear weapon state parties must conclude a safeguards agreement with the IAEA. As the number of nuclear facilities and volume of nuclear material grows, so does the extent of safeguards. While safeguards activities have grown significantly over the 50 year course of the IAEA, the safeguards budget has not grown at the same rate. Also, a zero real growth safeguards budget scenario is predicted for the future, despite expected increased demand for safeguards activities throughout the world.

This study examines the past trends and evolution of safeguards over time and projects growth through 2030. The report documents the amount of nuclear material and facilities under safeguards from 1970 until present, along with the corresponding budget. Estimates for the future amount of facilities and material under safeguards are made according to non-nuclear-weapons states' (NNWS) plans to build more nuclear capacity and sustain current nuclear infrastructure. Since nuclear energy is seen as a clean and economic option for base load electric power, many countries are seeking to either expand their current nuclear infrastructure, or introduce nuclear power. In order to feed new nuclear power plants and sustain existing ones, more nuclear facilities will need to be built, and thus more nuclear material will be introduced into the safeguards system. The projections in this study conclude that a zero real growth scenario for the IAEA safeguards budget will result in large resource gaps in the near future.

Safeguarded Facilities and Nuclear Material 1970 to Present

In 1970 there were only 82 facilities under IAEA safeguards: 10 nuclear power plants, 68 research reactors and 4 fuel fabrication plants, along with 74 other locations. The most current numbers from 2007 show that there are now 648 nuclear installations: 236 nuclear power plants, 151 research reactors, 18 conversion plants, 42 fuel fabrication plants, 8 reprocessing plants, 15 enrichment plants, 101 separate storage facilities and 77 other facilities, along with an additional 481 other locations. These facilities are listed by state in Appendix A. The breakdown of the number of installations by the type of facility under IAEA safeguards from 1970 to 2007 is shown in Figure 1. The most dramatic increase occurred in the 1970s, followed by a gradual increase until the late 1990s. The 2000s have not seen an increase in the number of safeguarded facilities thus far; however, many countries have plants currently under construction or planned that will consume safeguards resources in the very near future.

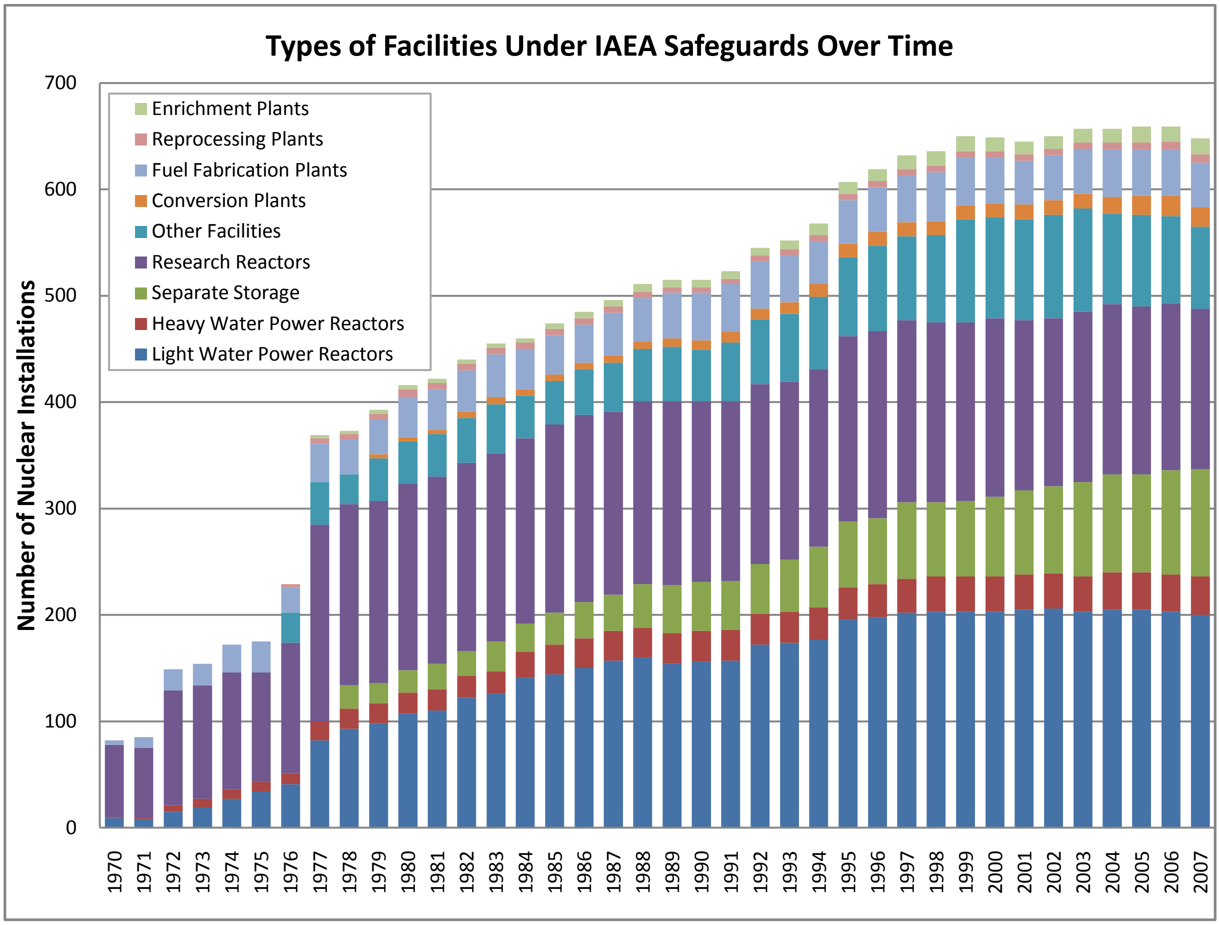

Figure 1: Number of installations under IAEA safeguards by type from 1970 to present.[1]

It is important to note that some facilities consume higher levels of safeguards resources than others. For example, light water power reactors (LWRs) are generally simpler to apply safeguards to than heavy water power reactors (HWRs) because LWRs use large fuel assemblies that are replaced during specific outage periods when the reactor is shutdown, while HWRs use smaller fuel assemblies than can be replaced while the reactor is online, thus making it difficult to achieve safeguards objectives in a timely fashion, and also offer additional diversion paths which must be addressed through the safeguards approach. Conversion and enrichment facilities also consume significant safeguards resources because they process material in bulk form, and enrichment plants present challenges in protecting against all diversion or misuse scenarios. Some LEU fuel fabrication plants and most storage facilities allow item accounting methods to dominate the safeguards approach, which also can facilitate the use of short-notice random inspections. Reprocessing plants separate plutonium and uranium from spent fuel and thus have a high potential for diversion or misuse, and pose challenges related to timeliness and meeting detection objectives due to large throughputs and measurement uncertainties. Research facilities use relatively much smaller amounts of nuclear material than commercial facilities, but still require application of safeguards and careful monitoring of a dynamic design-information environment.

[1] Source: IAEA Annual Reports for 1970 to 2007, www.iaea.org/About/Policy/GC/GC51/Agenda/

Correlating to the increase in the number of safeguarded facilities over time, the amount of safeguarded nuclear material has also dramatically increased. To sustain operating nuclear power plants, uranium must be mined, milled, converted, usually enriched, and fabricated into fuel. All of this material entering safeguarded facilities is then also monitored under safeguards, thus constantly increasing the amount of nuclear material under safeguards. Far less material is removed from safeguards (as waste, for example) than is introduced into the fuel cycle. Nuclear material usually enters safeguards at a conversion facility, before entering an enrichment or fuel fabrication plant.

While commercial uranium for nuclear power plants is low enriched (LEU), high enriched uranium (HEU) and plutonium are sometimes used in research reactors and other research facilities around the world. The IAEA has designated the amount of a certain type of nuclear material that would be needed to make a nuclear weapon as a significant quantity (SQ) of material. A significant quantity of LEU is 75 kg, but only 8 kg for plutonium and 25 kg for HEU, calculated in the total of the isotope U-235 or element Pu contained.[2]

The significant increase of safeguarded material over time is shown in Figure 2. In 1970 there were 447 SQs of material under IAEA safeguards. There are currently 151,749 safeguarded SQs, a more than 300 fold increase in only 40 years. Since nuclear material will continue to accumulate, there is estimated to be an increasing trend of safeguarded material in the future as current power plants continue to operate and new ones are built.

[2] Source: “The Evolution of International Safeguards” presentation by Jim Tape, June 8, 2009

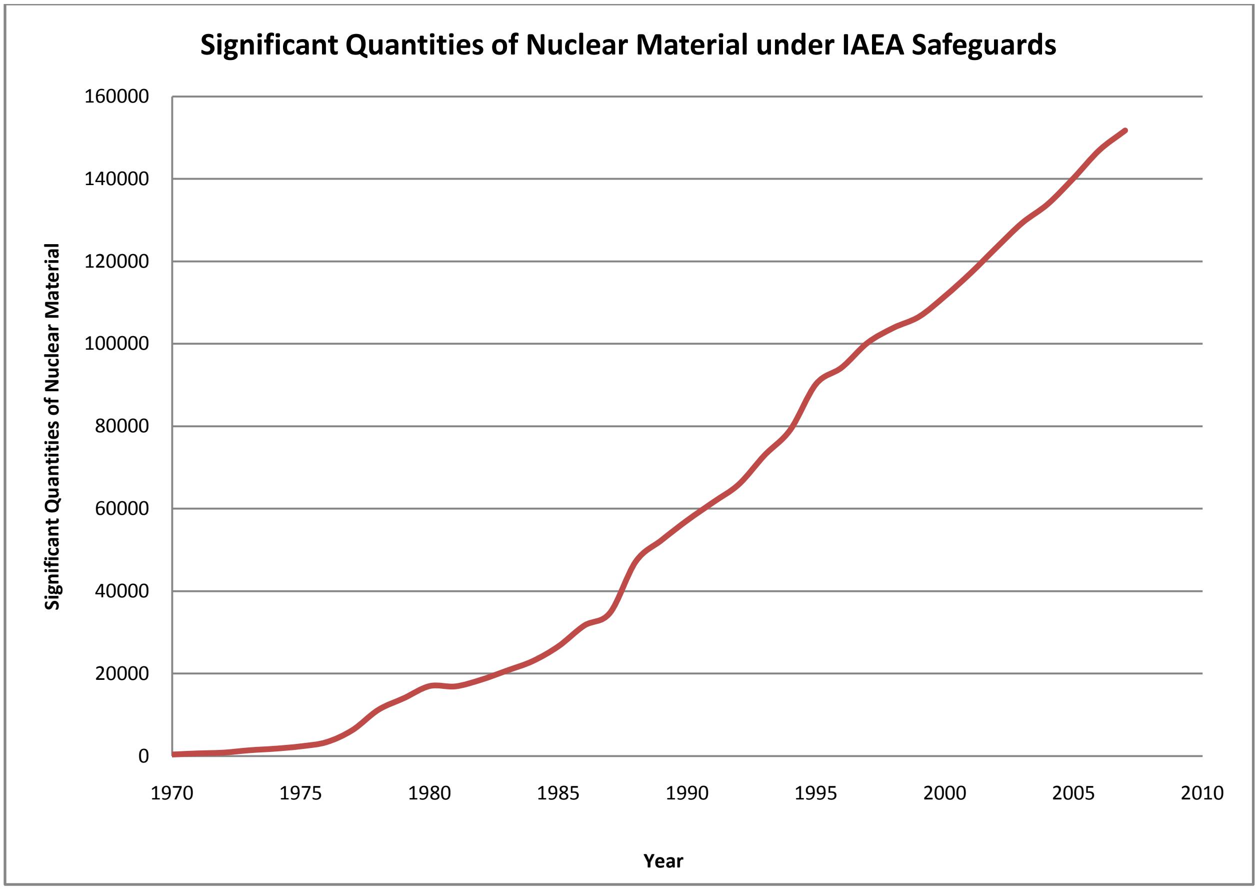

Figure 2: SQs of nuclear material under IAEA safeguards from 1970 to 2007.[3]

Evolution in Safeguards Activities Over Time

Significant events have caused the safeguards regime of the IAEA to reorganize and strengthen. In 1991, Iraq was found to be in violation of its safeguards agreement, for pursuing a clandestine nuclear weapons program. South Africa signed the Nonproliferation Treaty (NPT) as NNWS in 1991 but later revealed that the country had dismantled a nuclear weapons program just prior to acceding to the NPT. By 1994, after 3 years of inspections, the IAEA confirmed that South Africa had dismantled their weapons program. The Democratic People's Republic of Korea (DPRK) first announced that they would withdraw from the NPT in 1993 followed by international suspicions of a nuclear weapons program, and negotiated agreements to contain and monitor the plutonium production reactor and spent fuel. The DPRK officially withdrew from the NPT in 2003, becoming the first state ever to do so (and its withdrawal has not been accepted by the NPT States party due to procedural oversights). These events prompted the IAEA to compose the Additional Protocol (AP) to the Safeguards Agreements, which provided the IAEA with additional access to information, locations and technical verification measures to aid in the discovery of indicators of undeclared nuclear activities.

Comprehensive safeguards are based on INFCIRC/153 and allow the IAEA to inspect all nuclear material declared by that state. The Additional Protocol (AP), based on INFCIRC/540,

[3] Source: IAEA Annual Reports for 1970 to 2007, www.iaea.org/About/Policy/GC/GC51/Agenda/

helps the IAEA to look for undeclared nuclear material or activities. The AP has given the IAEA more access but has also expanded the safeguards system and introduced new resource intensive activities which take place both in Vienna and in the field. Safeguards under the AP include use of short-notice random inspections, unattended remote monitoring, access to all locations on every nuclear site, all locations provided in the expanded declaration, the increased collection of environmental samples, along with other measures.[4] These activities give the IAEA more responsibility (reaching conclusions about the absence of indicators of undeclared activities in a state) and thus a greater scope of work for its employees.

There are currently 71 states with safeguarded nuclear activities.[5] Figure 3 shows the breakdown of the AP status for these 71 states. A state with comprehensive safeguards has not yet signed the AP. Once it is signed, the state composes a declaration of all nuclear-related activities and provides it to the IAEA, which is then evaluated for consistency with other information available to the IAEA. Once the AP is put into force, the IAEA takes extra effort to verify that all nuclear activities are declared and remain in peaceful uses. Once this broader conclusion is reached, the state has entered into "integrated safeguards." As of 2009, 18 states have put the AP into force but have not yet reached the broader conclusion. The IAEA must undergo extra effort to verify the nuclear activities of these states. Additionally, 10 more states have signed the AP and plan to put it into force in the near future.[6]

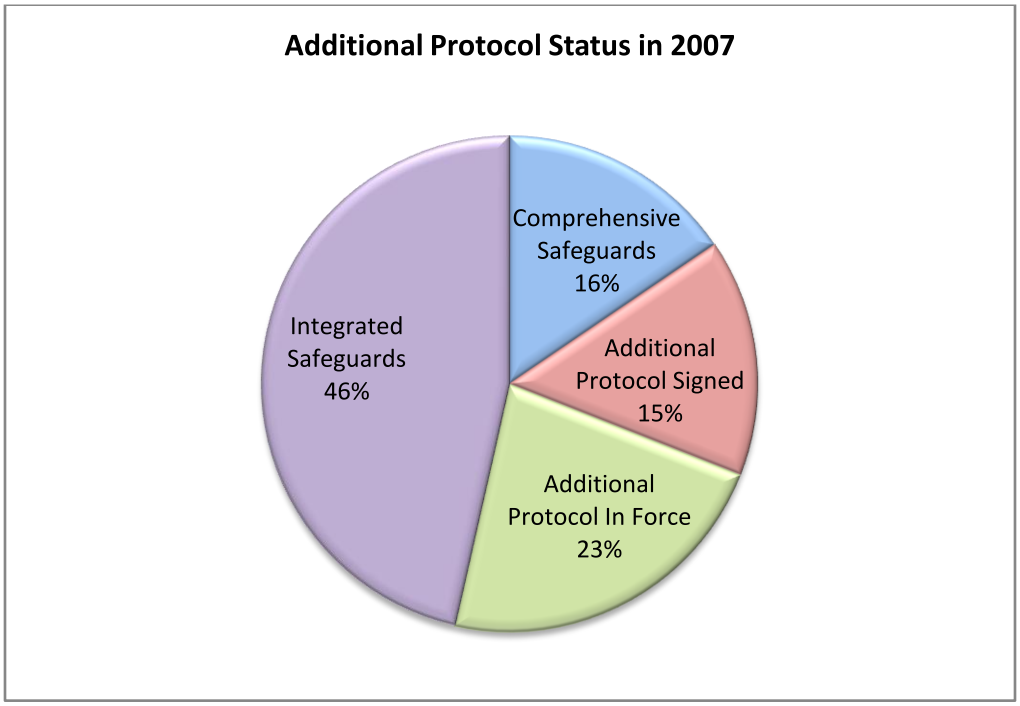

Figure 3: Additional Protocol status as of 2007 in 71 states with safeguarded nuclear activities.[7]

[4] Source: IAEA, "IAEA Safeguards: Stemming the Spread of Nuclear Weapons," 2001
[5] Source: IAEA Annual Report for 2007, www.iaea.org/Publications/Reports/Anrep2007/index.html
[6] Source: IAEA Website, "Additional Protocols to Nuclear Safeguards Agreements," July 9, 2009, www.iaea.org/OurWork/SV/Safeguards/sg_protocol.html
[7] Source: IAEA Website, "Additional Protocols to Nuclear Safeguards Agreements," July 20, 2009, www.iaea.org/OurWork/SV/Safeguards/sg_protocol.html

In 2007, there were also a significant number of facilities in states with the AP signed or in force but not yet under integrated safeguards. Figure 4 shows the break down of the number of facilities by the AP status of each state. The AP was first signed in 1997 and grew to having a majority of nuclear facilities under integrated safeguards within 10 years. However, it can be seen that this transformation from comprehensive to integrated safeguards has had an impact on on the IAEA safeguards budget.

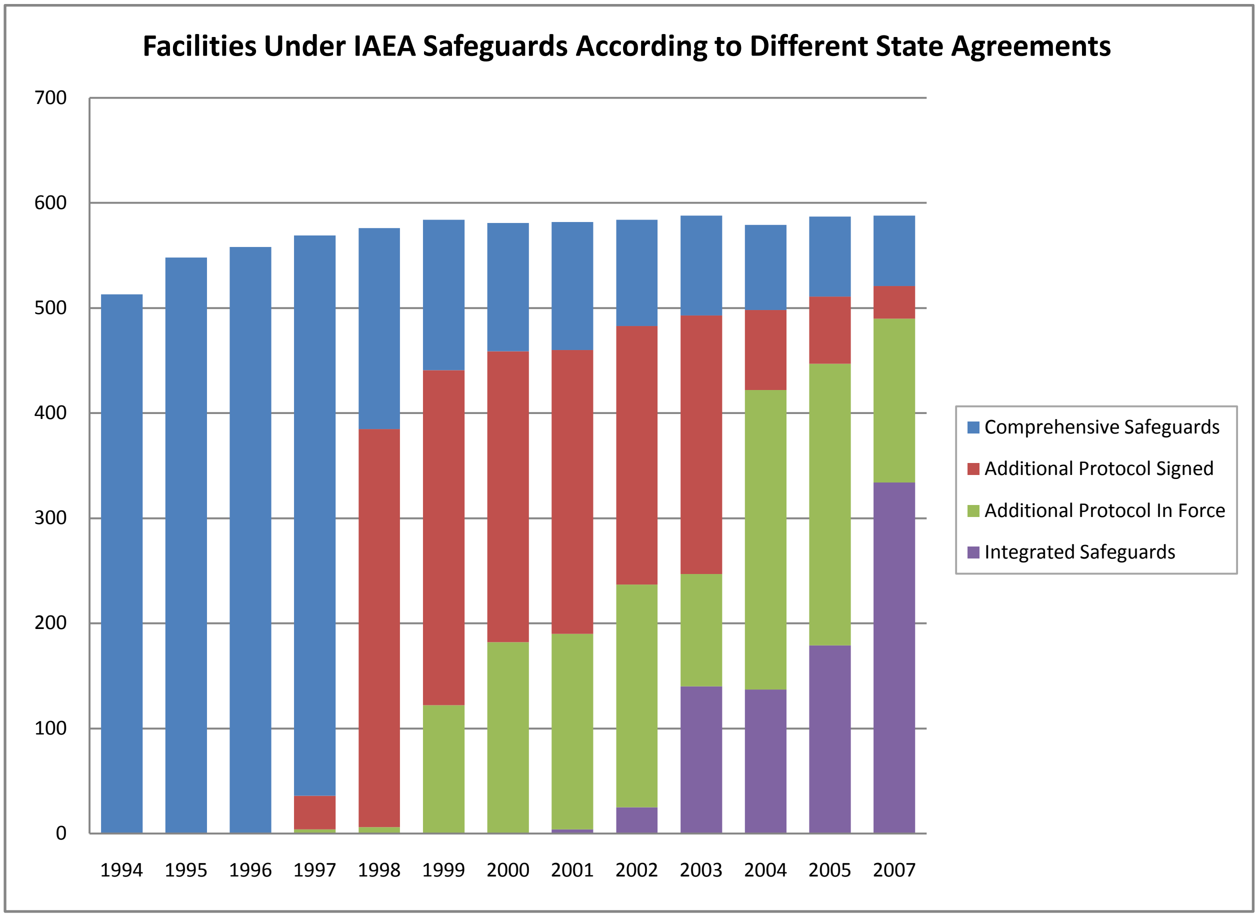

Figure 4: Number of safeguarded nuclear facilities in the world according to AP status of corresponding state.[8, 9] *Facilities include power reactors, research reactors, conversion plants, fuel fabrication plants, reprocessing plants, enrichment plants, separate storage facilities, and other facilities, according to the IAEA Annual Reports.*

Future Projection of Safeguarded Facilities and Nuclear Material

As the demand for electricity increases in both industrialized and developing nations, many countries are looking into creating or expanding their nuclear energy infrastructure. Figure 5 shows the LWR and HWR plants under IAEA safeguards from 1970 to 2007. The World

[8] Source: IAEA Annual Reports for 1994 to 2007, www.iaea.org/Publications/Reports/Anrep2007/index.html
[9] Source: IAEA Website, "Additional Protocols to Nuclear Safeguards Agreements," July 20, 2009, www.iaea.org/OurWork/SV/Safeguards/sg_protocol.html

Nuclear Association provides information on countries that have new plants under construction or are planning to build more in the future. Assuming that all plans for power plants succeed and that safeguards activities begin as the plants are put online (in reality, they begin much earlier), a projection is made of how many plants in NNWS will be eligible for safeguards through 2030. This projection includes existing plants in India that are eligible and expected to be under IAEA safeguards in the near future. It is assumed that all existing plants remain under safeguards (which they usually do, even after being decommissioned) or that the state replaces lost nuclear capacity with a new nuclear plant. Figure 5 shows that the number of plants will more than double in about 20 years. There will also be nearly twice as many HWR plants, which, as mentioned before, take more effort to safeguard due to the heightened possibility of diversion of nuclear material.

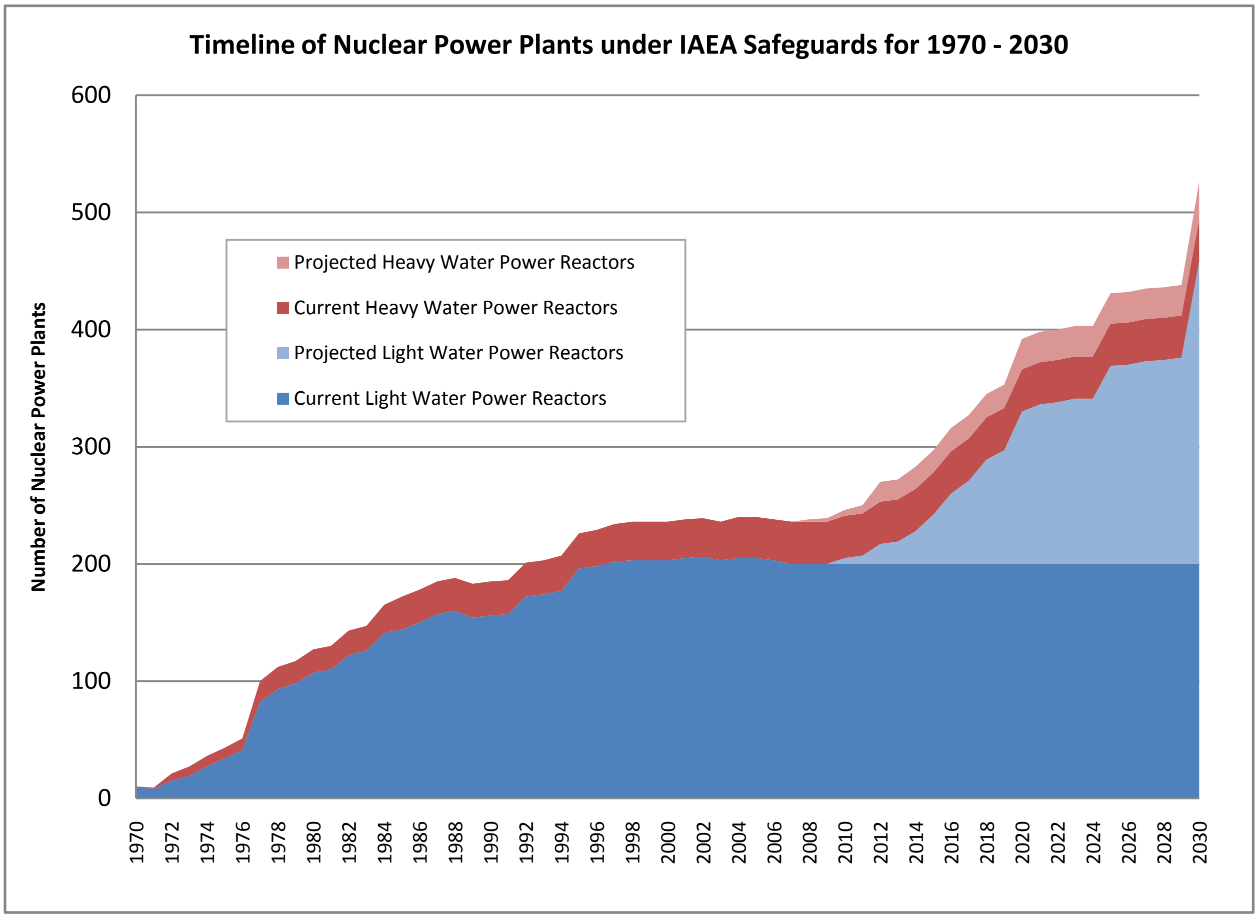

Figure 5: Past and present number of nuclear power plants under IAEA safeguards[10] and projected number of LWR and HWR plants under IAEA safeguards until 2030.[11]

[10] Source for years 1970-2007: IAEA Annual Reports, 1970-2007: www.iaea.org/About/Policy/GC/GC51/Agenda/
[11] Source for years 2008-2030: World Nuclear Association, Country Briefings, 2009, www.world-nuclear.org/info/default.aspx

In order to support the expansion of nuclear power, new fuel cycle facilities will also add to the number of facilities eligible for IAEA safeguards in the future. The nuclear weapons states (NWS) are heavily planning to upgrade current plants and build new conversion, enrichment, and fuel fabrication plants to match the world-wide expansion of nuclear power.[12] Therefore, a list of current and planned facilities in NNWS eligible for IAEA safeguards is used for future projections, as shown in Table 1. An operation date of 2030 is assumed as the latest if no other information is given. Pakistan is included in these projections because it has the potential to be under safeguards. Also, there have been no new plans to built reprocessing plants by NNWS. These facilities[13], along with the projected number of plants in Figure 5 are combined to show the total growth in number of safeguarded facilities from 1970 to 2030 in Figure 6. Once again, the number of facilities under IAEA safeguards is expected to double in the next 20 years.

Table 1: List of current and projected nuclear facilities eligible for IAEA Safeguards until 2030[14, 15, 16]

Country	Facility Name	Facility Type	Facility Status	Operation
Australia	Uranium Enrichment Facility	Enrichment Plant	Planned	2015
Azerbaijan	Research Reactor	Research Reactor	Planned	2012
Brazil	Fabrica de Combustivel Nuclear	Conversion to UO2	In operation	Current
Iran	Isfahan Nuclear Fuel Plant	Fuel Fabrication	Commissioning	2010
Kazakhstan	Ulba Conversion Plant	Conversion to UF6	Planned	2030
Kazakhstan	Ulba Fuel Fabrication Plant	Fuel Fabrication	Planned	2030
Pakistan	Islamabad	Conversion to UO2	In operation	Current
Pakistan	Uranium Enrichment Facility	Conversion to UF7	Planned	2013
Pakistan	Kahuta	Enrichment Plant	In operation	Current
Pakistan	Uranium Enrichment Facility	Enrichment Plant	Planned	2013
Pakistan	Fuel Fabrication Facility	Fuel Fabrication	Planned	2013
South Africa	Enrichment Plant	Enrichment Plant	Planned	2017
Turkey	Enrichment Plant	Enrichment Plant	Planned	2030

12 Source: WISE Uranium Project, "Uranium Enrichment and Fuel Fabrication," 2009, www.wise-uranium.org/indexe.html
13 Facilities in Figure 6 do not include research reactors because the future increase is insignificant.
14 Source: WISE Uranium Project, "Uranium Enrichment and Fuel Fabrication," 2009, www.wise-uranium.org/indexe.html
15 Source: IAEA Nuclear Fuel Cycle Information System, 2007, www-nfcis.iaea.org/NFCIS/NFCISMain.asp?Order=1&RPage=1&Page=1&RightP=List
16 Source: World Nuclear Association, Country Briefings, 2009, www.world-nuclear.org/info/default.aspx

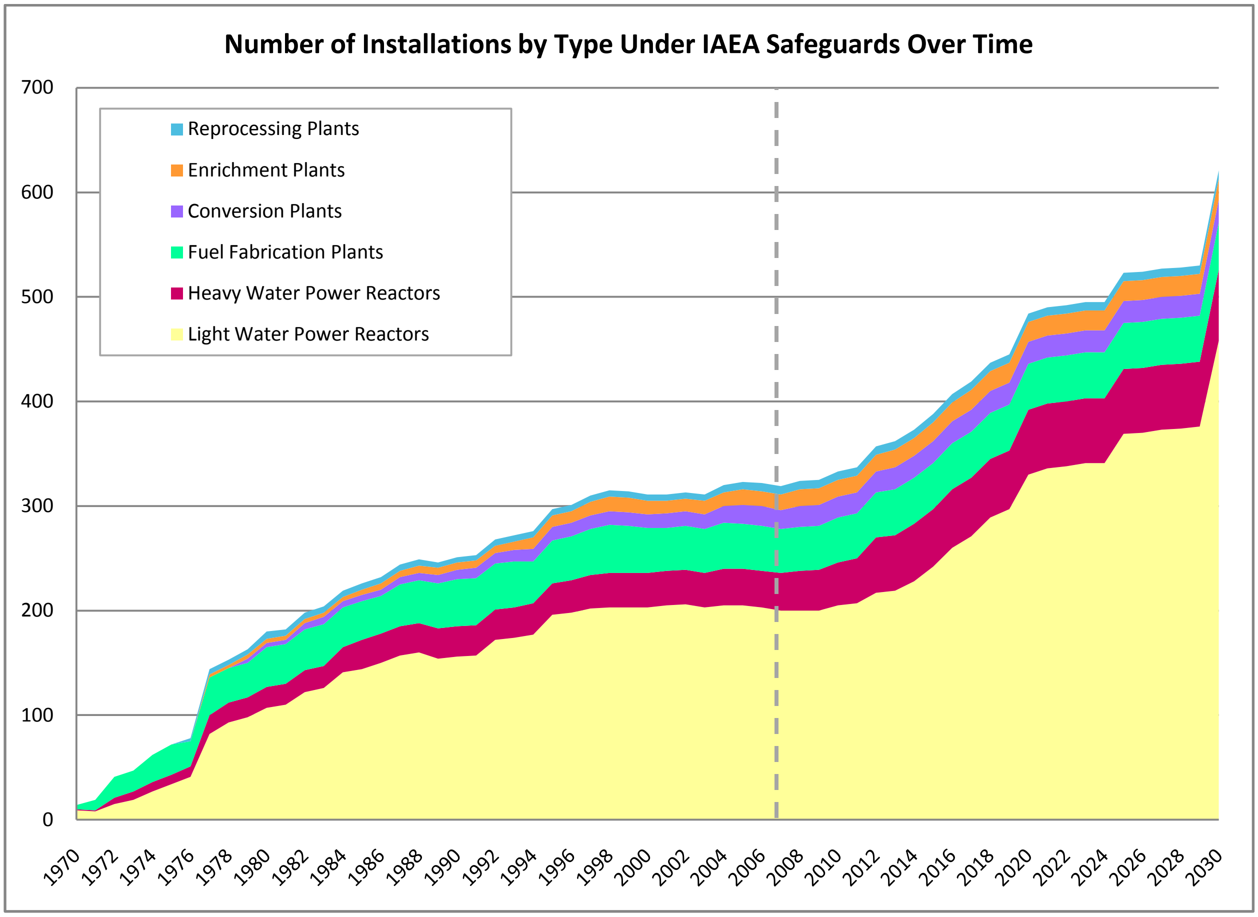

Figure 6: Past and present numbers of different types of installations under safeguards for 1970 to 2007[17] *and projected numbers of nuclear facilities until 2030.*[18,19,20] *The past and future projections are separated by the dotted line.*

In order to estimate the amount of nuclear material that will be under IAEA safeguards to support the growing nuclear industry, a projection of the nuclear energy electric capacity must be estimated. While documenting the planned power plants from the World Nuclear Association, the planned capacity was also calculated. If there was no planned capacity available, then it was assumed that each new unit in a plant would be 1 GWe capacity for LWRs and 500 MWe capacity for HWRs, which are rough average capacities for the new LWR and HWR plants being constructed. This information was then used to create Figure 7, which expands the projected capacity from the current nuclear capacity under safeguards. The nuclear capacity for safeguarded power plants is expected to nearly triple.

[17] Source: IAEA Annual Reports, 1970-2007: www.iaea.org/About/Policy/GC/GC51/Agenda/
[18] Source: World Nuclear Association, Country Briefings, 2009, www.world-nuclear.org/info/default.aspx
[19] Source: IAEA Nuclear Fuel Cycle Information System, 2007, www-nfcis.iaea.org/NFCIS/NFCISMain.asp?Order=1&RPage=1&Page=1&RightP=List
[20] Source: WISE Uranium Project, "Uranium Enrichment and Fuel Fabrication," 2009, www.wise-uranium.org/indexe.html

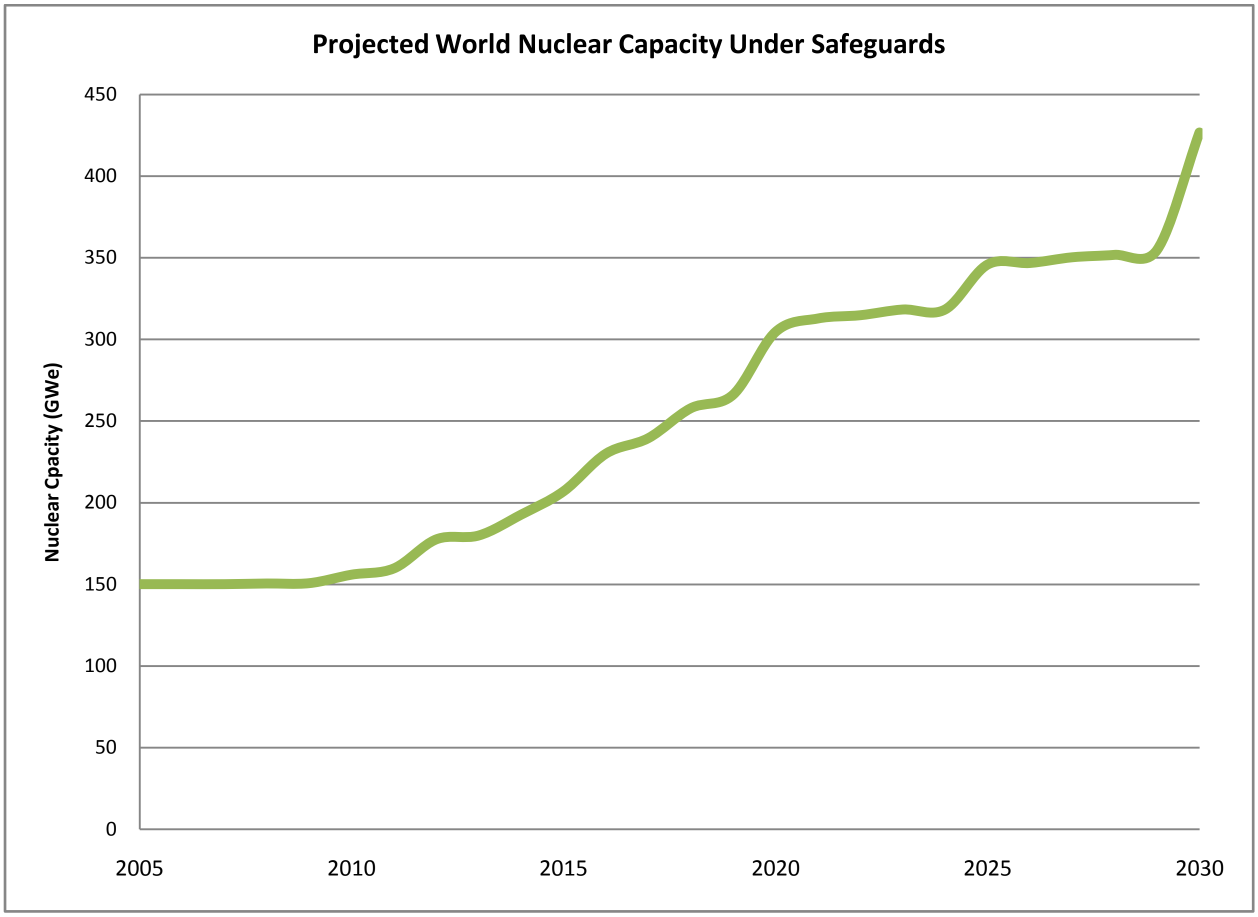

Figure 7: Projected world electric capacity for planned nuclear power plants in NNWS eligible for safeguards[21,22]

With the projected capacities of nuclear power in Figure 7, the amount of nuclear material to support it can now be calculated. 245 tons of yellow cake is needed per year to supply the fuel for 1 GWe capacity of a nuclear reactor, which is equal to 208 tons of the element uranium.[23] Table 2 shows the assumed parameters for SQs and concentrations of U-235 and Pu at the various points in the fuel cycle. Table 3 shows the SQs per 1 GWe capacity of LWR and HWR plants used in the once-through fuel cycle. It is assumed that eventually all nuclear material under safeguards in the fuel cycle will result as the U-235 in tails from conversion, enrichment, and fuel fabrication or as U-235 and Pu in spent fuel. As seen in Table 3, 208 tons of uranium per 1 GWe turns into about 41 SQs for LWRs and 13 SQs for HWRs per GWe per year. More SQs are used for LWRs because there is a large amount of enrichment tail assays that are not present in the HWR fuel cycle since it uses natural uranium. These numbers are used to calculate the number of SQs needed to support the capacity of the projected safeguarded power plants until 2030, as shown in Figure 8. The SQs of material under safeguards is, once again,

[21] Source for year 2005 – 2007: IAEA Annual Reports for 2005 to 2007, www.iaea.org/Publications/Reports/Anrep2007/index.html
[22] Source for years 2008 – 2030: World Nuclear Association, Country Briefings, 2009, www.world-nuclear.org/info/default.aspx
[23] Source: WISE Uranium Project, "Nuclear Fuel Material Balance Calculator," 2003, www.wise-uranium.org/nfcm.html

estimated to almost triple in 20 years. Also, the projected numbers do not include fissile material that will be needed for research facilities in the future.

Table 2: Assumed parameters used for projection of nuclear material needed to sustain projected nuclear power capacity under safeguards.[24, 25, 26]

SQ of Pu (total element) in tons	0.008
SQ of U-235 in LEU (total isotope) in tons	0.075
Percent of U-235 in Natural U	0.07%
Percent of U-235 in Enriched U	4%
Percent of U-235 in Enriched U Tails	0.25%
Percent of U-235 in LWR Spent Fuel	1%
Percent of Pu in LWR Spent Fuel	1%
Percent of U-235 in HWR Spent Fuel	0.2%
Percent of Pu in HWR Spent Fuel	0.4%

Table 3: Significant quantities of nuclear material needed to sustain 1 GWe of capacity for LWR and HWR power plants per year, using parameters from Table 2.

	Tons of HM[27]	SQs for LWR	SQs for HWR
Conversion Tails (U)	1.04	0.010	0.010
Enrichment Tails (U)	181.04	6.035	-
Fuel Fabrication Tails (U)	0.26	0.137	0.002
Spent Fuel (U and Pu)	25.43	35.175	12.858
Total	**207.77**	**41.356**	**12.870**

[24] Source: World Nuclear Association, "Plutonium," 2009, www.world-nuclear.org/info/inf15.html
[25] "Reprocessing versus Direct Disposal of Spent CANDU Nuclear Fuel:
A Possible Application of Fluoride Volatility" By D. Rozon and D. Lister, 2008
[26] "The Evolution of International Safeguards" - Presentation by Jim Tape, June 2009
[27] Source: WISE Uranium Project, "Nuclear Fuel Material Balance Calculator," 2003, www.wise-uranium.org/nfcm.html

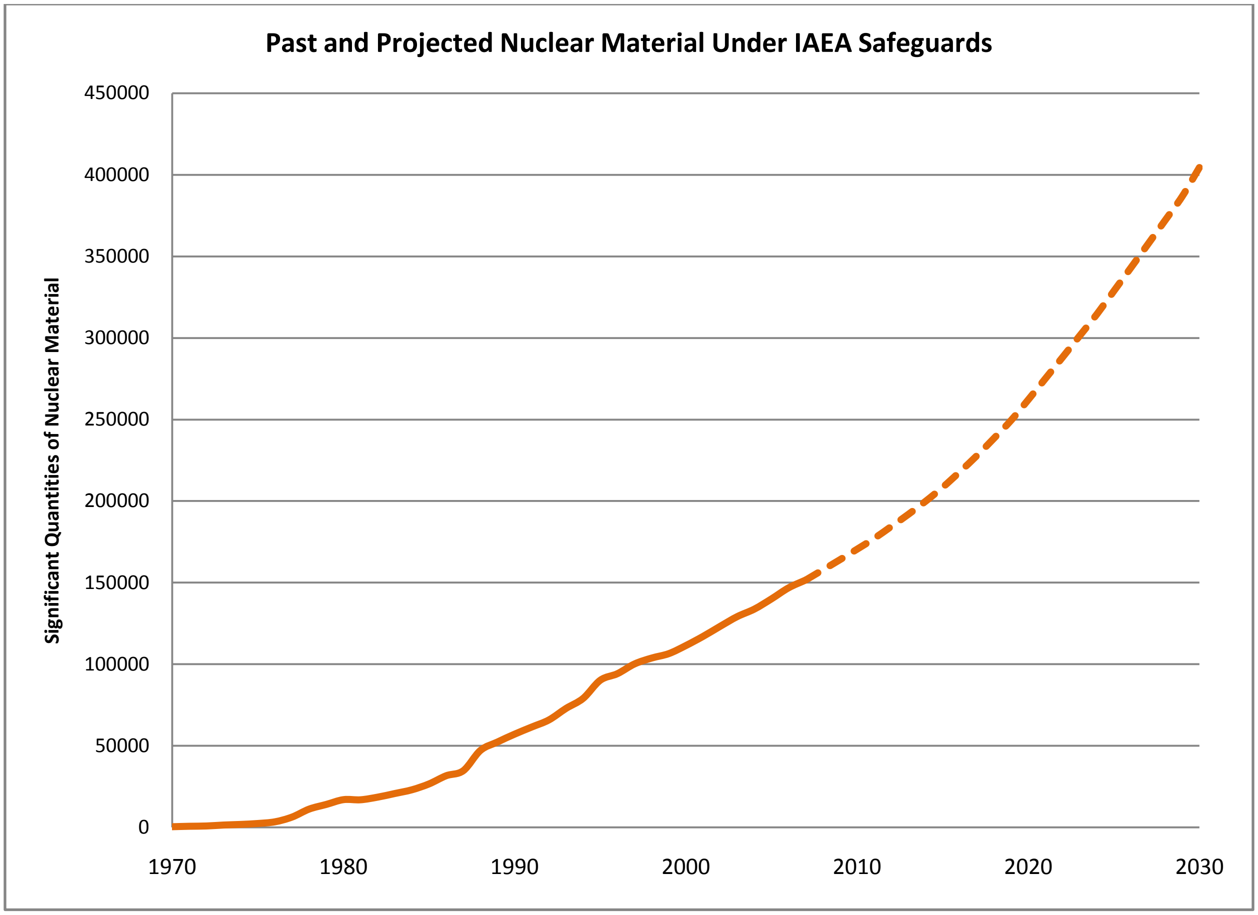

Figure 8: Projected significant quantities[28,29] added to past significant quantities of nuclear material[30] under IAEA safeguards for 1970 to 2030[31].

Safeguards Budget

While the IAEA safeguards budget has significantly increased since 1970, the IAEA has expressed concern that its budget may experience zero real growth over the foreseeable future.[32] Figure 9 shows the IAEA budget in 2008 dollars from 1970 to 2009. The dotted line represents when the IAEA found clandestine nuclear activities in Iraq in 1991. The AP came soon thereafter and the IAEA was taking extra effort to verify states' peaceful nuclear programs, thus resulting in a modest budget increase. Another budget increase came in the mid-2000's when the United States led an effort to provide an approximately 11% increase in the IAEA's overall budget. It can be seen that the safeguards budget has remained quite steady for the past few years and is not projected to grow.

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[28] Source: World Nuclear Association, Country Briefings, 2009, www.world-nuclear.org/info/default.aspx
[29] Source: WISE Uranium Project, "Nuclear Fuel Material Balance Calculator," 2003, www.wise-uranium.org/nfcm.html
[30] Source: IAEA Annual Reports, 1970-2007: www.iaea.org/About/Policy/GC/GC51/Agenda/
[31] Information for 1991 is unavailable, the graph shows an average of 1990 and 1992 for graphical purposes
[32] Source: "Reinforcing the Global Nuclear Order for Peace and Prosperity: The Role of the IAEA to 2020 and Beyond," International Atomic Energy Agency, May 2008

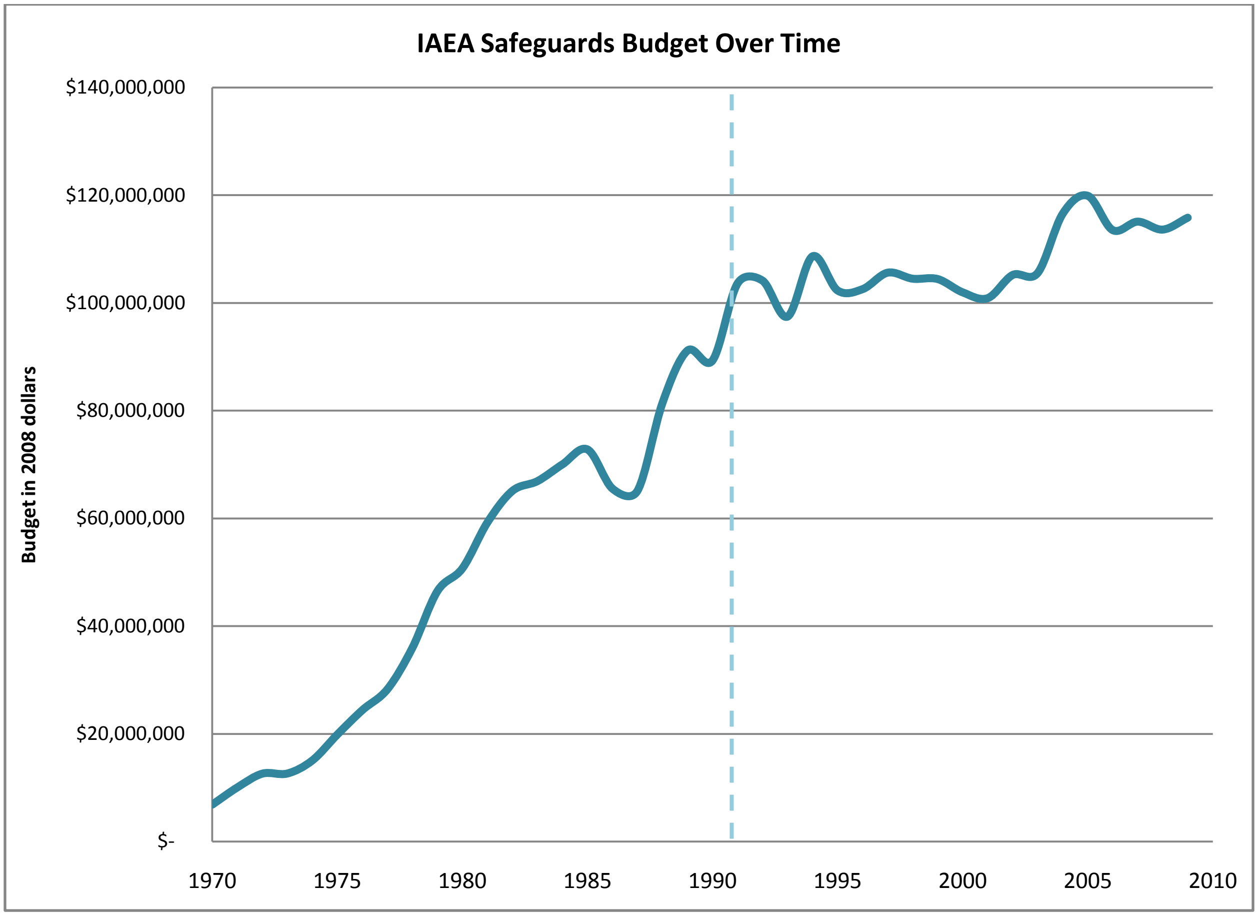

Figure 9: IAEA Safeguards budget from 1970 to 2009,[33,34] the dotted line represents when clandestine nuclear activities were found in Iraq in 1991.

Using the data from Figure 8 and Figure 9, a timeline of safeguards budget per significant quantity of material is composed. Figure 10 shows that there has been an extreme decline in the safeguards budget available per significant quantity of material under safeguards. The relation is only expected to decline to under $300 per SQ by 2030. A zero real growth budget for IAEA safeguards will not be sufficient to safeguard the future nuclear material needed to sustain the growing nuclear power demand.

[33] Source: IAEA Annual Reports and Budgets, 1970-2009: www.iaea.org/About/Policy/GC/GC51/Agenda/
[34] Source: Inflation Data .com, 1970-2008, www.inflationdata.com/Inflation/Inflation_Rate/HistoricalInflation.aspx

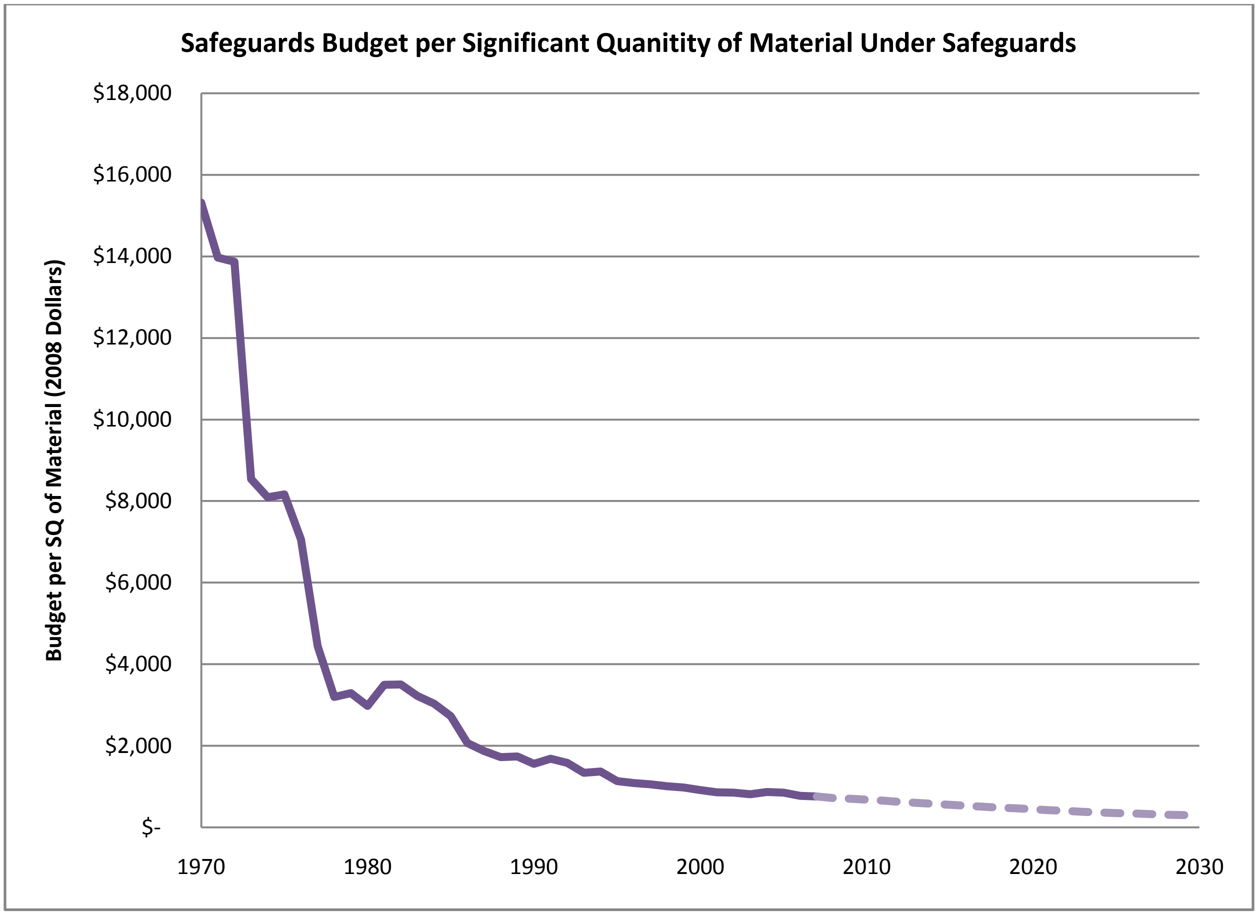

Figure 10: Timeline of safeguards budget per SQ of material for 1970 to 2007 and then projected to 2030 with zero real growth in budget[35]

[35] Data is taken from Figure 8 and Figure 9

Conclusion

The IAEA plays a crucial role in international nuclear security by safeguarding fissile material from diversion into non-peaceful uses. The scope of work of the IAEA has increased dramatically over its 50 year life due to increasing nuclear infrastructure and responding to the threat of clandestine nuclear weapons programs. There are currently 71 states with safeguarded nuclear activities, 18 of which are being inspected to reach the broader conclusion and achieve integrated safeguards. The majority of safeguarded nuclear facilities are now under integrated safeguards since the AP was first signed in 1997.

Since nuclear power is an attractive option to meet electric energy needs for both industrialized and developing countries, the safeguards scope of the IAEA is expected to increase rapidly in the coming years. The number of new nuclear power plants in NNWS will more than double by 2030, including a large increase in HWR plants, which are a greater proliferation concern. The total number of nuclear facilities eligible for safeguards will also nearly triple in the next 20 years. The nuclear electric capacity from these new plants will nearly triple the nuclear capacity under safeguards to about 425 GWe. As a result, the significant quantities of nuclear material under IAEA safeguards is expected to nearly triple by 2030 just from the material needed to sustain the new and existing power plants.

The IAEA safeguards budget is expected to see zero real growth in the near future. This would cause the budget to decline to under $300 per SQ by 2030. As new nuclear power plants and other nuclear facilities are constructed in NNWS, more and more nuclear material will need to be safeguarded by the IAEA. An increase in budget will be necessary for the future of international safeguards and nuclear security. This report has not evaluated the affect of added missions to the IAEA, but if they were to be asked to verify a new treaty or convention, such as a Fissile Material Cutoff Treaty or a Disarmament agreement, the budget pressures would worsen.

Appendix A

The table on the next pages shows the facilities under IAEA safeguards or containing safeguarded material by the end of the year 2007.[36]

[36] Source: IAEA Annual Report 2007: www.iaea.org/About/Policy/GC/GC51/Agenda/

Table A28. Facilities under Agency Safeguards or Containing Safeguarded Material on 31 December 2007

State[a]	Name of facility	Location[a]
Power reactors		
Argentina	Atucha	Lima
	Embalse	Embalse
Armenia	Armenia	Metsamor
Belgium	Tihange-1	Tihange
	Tihange-2	Tihange
	Tihange-3	Tihange
	Doel-1	Doel
	Doel-3	Doel
	Doel-4	Doel
Brazil	Angra-2	Angra dos Reis
	Angra-1	Angra dos Reis
Bulgaria	Kozloduy-I	Kozloduy
	Kozloduy-II	Kozloduy
	Kozloduy-III	Kozloduy
Canada	Bruce A	Tiverton
	Bruce B	Tiverton
	Gentilly-2	Gentilly
	Darlington	Bowmanville
	Pickering	Pickering
	Point Lepreau	Point Lepreau
China	Qin Shan	Hai Yan
Czech Republic	EDU-1	Dukovany
	EDU-2	Dukovany
	Temelin	Temelin
Finland	Loviisa	Loviisa
	TVO-I	Olkiluoto
	TVO-II	Olkiluoto
Germany	AVR	Jülich
	Brunsbüttel	Brunsbüttel
	Grohnde	Grohnde
	Neckarwestheim-II	Neckarwestheim
	Obrigheim	Obrigheim
	Biblis-A	Biblis
	Biblis-B	Biblis
	Emsland	Lingen
	Grafenrheinfeld	Grafenrheinfeld
	Greifswald-1 and 2	Lubmin
	Isar-2	Essenbach
	Isar-Ohu	Ohu bei Landshut
	Krümmel	Geesthacht
	Philippsburg-1	Philippsburg
	Philippsburg-2	Philippsburg
	Brokdorf	Brokdorf

State[a]	Name of facility	Location[a]
	Gundremmingen-B	Gundremmingen
	Gundremmingen-C	Gundremmingen
	Unterweser	Unterweser
	Neckarwestheim	Neckarwestheim
	Thorium Hochtemperatur Reaktor	Hamm
Hungary	Paks-I (units 1 and 2)	Paks
	Paks-II (units 3 and 4)	Paks
India	KKNP	Kudankulam
	RAPS	Rajasthan
	TAPS	Tarapur
Iran, Islamic Republic of	Bushehr	Halilem
Italy	ENEL-Trino	Trino-Vercellese
	ENEL-Caorso	Caorso
	ENEL-Latina	Borgo-Sabotino
Japan	Joyo	Higashi-gun, Ibaraki-ken
	Fukushima Dai-ichi-2	Futaba-gun, Fukushima-ken
	Fukushima Dai-ichi-3	Futaba-gun, Fukushima-ken
	Fukushima Dai-ichi-6	Futaba-gun, Fukushima-ken
	Fukushima Dai-ichi-1	Futaba-gun, Fukushima-ken
	Fukushima Dai-ichi-4	Futaba-gun, Fukushima-ken
	Fukushima Dai-ichi-5	Futaba-gun, Fukushima-ken
	Fukushima Dai-ni-1	Futaba-gun, Fukushima-ken
	Fukushima Dai-ni-2	Futaba-gun, Fukushima-ken
	Fukushima Dai-ni-3	Futaba-gun, Fukushima-ken
	Fukushima Dai-ni-4	Futaba-gun, Fukushima-ken
	Genkai-1	Higashimatsuura-gun, Saga-ken
	Genkai-2	Higashimatsuura-gun, Saga-ken
	Genkai-3	Higashimatsuura-gun, Saga-ken
	Genkai-4	Higashimatsuura-gun, Saga-ken
	Hamaoka-1	Ogasa-gun, Shizuoka-ken
	Hamaoka-2	Ogasa-gun, Shizuoka-ken
	Hamaoka-3	Ogasa-gun, Shizuoka-ken
	Hamaoka-4	Ogasa-gun, Shizuoka-ken
	Hamaoka-5	Ogasa-gun, Shizuoka-ken
	Higashidori-1	Shimokita-gun, Aomori-ken
	Ikata-1	Nishiuwa-gun, Ehime-ken
	Ikata-2	Nishiuwa-gun, Ehime-ken
	Ikata-3	Nishiuwa-gun, Ehime-ken
	Kashiwazaki-Kariwa-2	Kashiwazaki-shi, Niigata-ken
	Kashiwazaki-Kariwa-3	Kashiwazaki-shi, Niigata-ken
	Kashiwazaki-Kariwa-4	Kashiwazaki-shi, Niigata-ken
	Kashiwazaki-Kariwa-5	Kashiwazaki-shi, Niigata-ken
	Kashiwazaki-Kariwa-1	Kashiwazaki-shi, Niigata-ken
	Kashiwazaki-Kariwa-6	Kashiwazaki-shi, Niigata-ken
	Kashiwazaki-Kariwa-7	Kashiwazaki-shi, Niigata-ken
	Mihama-1	Mikata-gun, Fukui-ken
	Mihama-2	Mikata-gun, Fukui-ken
	Mihama-3	Mikata-gun, Fukui-ken
	Ohi-3	Ohi-gun, Fukui-ken
	Ohi-4	Ohi-gun, Fukui-ken
	Ohi-1 and 2	Ohi-gun, Fukui-ken
	Onagawa-1	Oshika-gun, Miyagi-ken

State[a]	Name of facility	Location[a]
	Onagawa-2	Oshika-gun, Miyagi-ken
	Onagawa-3	Oshika-gun, Miyagi-ken
	Fugen	Tsuruga-shi, Fukui-ken
	Monju	Tsuruga-shi, Fukui-ken
	Sendai-1	Sendai-shi, Kagoshima-ken
	Sendai-2	Sendai-shi, Kagoshima-ken
	Shika-1	Hakui-gun, Ishikawa-ken
	Shika-2	Hakui-gun, Ishikawa-ken
	Shimane-1	Yatsuka-gun, Shimane-ken
	Shimane-2	Yatsuka-gun, Shimane-ken
	Takahama-1	Ohi-gun, Fukui-ken
	Takahama-2	Ohi-gun, Fukui-ken
	Takahama-3	Ohi-gun, Fukui-ken
	Takahama-4	Ohi-gun, Fukui-ken
	Tokai-2	Tokai-mura, Ibaraki-ken
	Tomari-1	Furuu-gun, Hokkaido
	Tomari-2	Furuu-gun, Hokkaido
	Tsuruga-1	Tsuruga-shi, Fukui-ken
	Tsuruga-2	Tsuruga-shi, Fukui-ken
Kazakhstan	BN-350	Aktau
Korea, Republic of	Kori-1	Pusan
	Kori-2	Pusan
	Kori-3	Pusan
	Kori-4	Pusan
	Ulchin-1	Ulchin
	Ulchin-2	Ulchin
	Ulchin-3	Ulchin
	Ulchin-4	Ulchin
	Ulchin-5	Ulchin
	Ulchin-6	Ulchin
	Wolsong-1	Kyongju
	Wolsong-2	Kyongju
	Wolsong-3	Kyongju
	Wolsong-4	Kyongju
	Younggwang-1	Younggwang
	Younggwang-2	Younggwang
	Younggwang-3	Younggwang
	Younggwang-4	Younggwang
	Younggwang-5	Younggwang
	Younggwang-6	Younggwang
Lithuania	Ignalina	Visaginas
Mexico	Laguna Verde 1	Alto Lucero
	Laguna Verde 2	Alto Lucero
Netherlands	Borssele	Borssele
Pakistan	Chashma-1	Kundian
	Karachi	Karachi
Romania	Cernavoda-1	Cernavoda
	Cernavoda-2	Cernavoda

State[a]	Name of facility	Location[a]
Slovakia	Mochovce EM0-1	Mochovce
	Bohunice-1	Bohunice
	Bohunice-2	Bohunice
Slovenia	Krško	Krško
South Africa	Koeberg-1	Cape Town
	Koeberg-2	Cape Town
Spain	Santa María de Garona	Santa María de Garona
	José Cabrera	Almonacid de Zorita
	Almaraz-1	Almaraz
	Almaraz-2	Almaraz
	Cofrentes	Cofrentes
	Asco-1	Asco
	Asco-2	Asco
	Vandellòs-2	Vandellòs
	Trillo-1	Trillo
	Vandellòs-1	Vandellòs
Sweden	Forsmark-1	Östhammar
	Forsmark-2	Östhammar
	Forsmark-3	Östhammar
	Oskarshamn-1	Oskarshamn
	Oskarshamn-2	Oskarshamn
	Oskarshamn-3	Oskarshamn
	Ringhals-1	Ringhals
	Ringhals-2	Ringhals
	Ringhals-3	Ringhals
	Ringhals-4	Ringhals
Switzerland	Mühleberg	Mühleberg
	Beznau-I	Beznau
	Beznau-II	Beznau
	Gösgen	Gösgen-Däniken
	Leibstadt	Leibstadt
Ukraine	Chernobyl	Chernobyl
	Khmelnitski-1	Neteshin
	Khmelnitski-2	Neteshin
	Rovno-3	Kuznetsovsk
	Rovno-4	Kuznetsovsk
	Rovno-1 and 2	Kuznetsovsk
	South Ukraine 1	Yuzhnoukrainsk
	South Ukraine 2	Yuzhnoukrainsk
	South Ukraine 3	Yuzhnoukrainsk
	Zaporozhe-1	Energodar
	Zaporozhe-2	Energodar
	Zaporozhe-3	Energodar
	Zaporozhe-4	Energodar
	Zaporozhe-5	Energodar
	Zaporozhe-6	Energodar

State[a]	Name of facility	Location[a]
Research reactors and critical assemblies		
Algeria	Es Salam research reactor	Ain Oussera
	NUR research reactor	Wilaya de Tipaza
Argentina	Argentine reactor-8	Pilcaniyeu
	Argentine reactor-0	Córdoba
	Argentine reactor-1	Constituyentes
	Argentine reactor-3	Ezeiza
	Argentine reactor-4	Rosario
	Argentine reactor-6	Bariloche
Australia	HIFAR	Lucas Heights
	MOATA	Lucas Heights
	OPAL	Lucas Heights
Austria	Atominstitut der Österreichischen Universitäten	Vienna
Bangladesh	Atomic Energy Research Establishment	Dhaka
Belarus	Sosny	Minsk
Belgium	BR1-CEN	Mol
	BR2/BR02	Mol
	Venus	Mol
	Thetis	Gent
Brazil	Argonaut reactor	Rio de Janeiro
	Critical unit IPEN/MB-01	São Paulo
	IEA-R1	São Paulo
	IPR-R1 CDTN	Belo Horizonte
Bulgaria	IRT-2000	Sofia
Canada	Dalhousie University Slowpoke	Halifax
	DIF	Chalk River
	Health Sciences, Chemistry, Reactor Physics, Fuel Engineering and Manufacturing	Chalk River
	McMaster	Hamilton
	NRU	Chalk River
	NRX	Chalk River
	Slowpoke de l'École Polytechnique	Montreal
	Saskatckewan Slowpoke	Saskatoon
	Slowpoke-2 Facility at the Royal Military College of Canada	Kingston
	University of Alberta Slowpoke	Edmonton
Chile	La Reina	Santiago
	Lo Aguirre	Santiago
China	HTGR	Nankou
Colombia	IAN-R1	Bogotá

State[a]	Name of facility	Location[a]
Czech Republic	LR-O	Řež
	Research reactor	Řež
	University training reactor VR-1	Prague
Democratic Republic of the Congo	Triga-II	Kinshasa
Egypt	ET RR-1	Inshas
	MPR	Inshas
Finland	FIR 1	Espoo
Georgia	IRT-M	Tbilisi
Germany	AKR	Dresden
	FRJ-2	Jülich
	FRM	Garching
	GKSS	Geesthacht
	BER-II	Berlin
	FRM-II	Garching
	SUR-100	Furtwangen
	SUR-100	Kiel
	SUR-100	Ulm
	SUR-100	Berlin
	SUR-100	Aachen
	SUR-100	Hannover
	SUR-100	Stuttgart
	Triga	Mainz
Ghana	GHARR-1	Legon-Accra
Greece	GRR-1	Attiki
Hungary	Budapest research reactor	Budapest
	Training reactor	Budapest
Indonesia	Centre for Research and Development of Nuclear Techniques	Bandung
	Multipurpose reactor	Serpong
	Yogyakarta Nuclear Research Centre	Yogyakarta
Iran, Islamic Republic of	Esfahan miniature neutron source reactor	Esfahan
	Heavy water zero power reactor	Esfahan
	Light water subcritical reactor	Esfahan
	TRR	Tehran
Israel	IRR-1	Soreq
Italy	AGN-201	Palermo
	RTS-1	San Piero a Grado
	Tapiro	Santa Maria di Galeria
	Triga-II	Pavia
	Triga-RC1	Santa Maria di Galeria
Jamaica	Centre for Nuclear Sciences	Kingston

State[a]	Name of facility	Location[a]
Japan	DCA	Oarai-machi, Ibaraki-ken
	FCA	Tokai-mura, Ibaraki-ken
	HTTR	Higashi-gun, Ibaraki-ken
	HTR	Kawasaki-shi, Kanagawa-ken
	JMTR	Higashi-gun, Ibaraki-ken
	JMTRCF	Higashi-gun, Ibaraki-ken
	JRR-2	Tokai-mura, Ibaraki-ken
	JRR-3	Tokai-mura, Ibaraki-ken
	JRR-4	Tokai-mura, Ibaraki-ken
	Kinki University reactor	Higashiosaka-shi, Osaka-fu
	KUCA	Osaka
	KUR	Sennan-gun, Osaka
	Musashi reactor	Kawasaki-shi, Kanagawa-ken
	NSRR	Tokai-mura, Ibaraki-ken
	Rikkyo University research reactor	Nagasaka, Kanagawa-ken
	TTCA	Tokai-mura, Ibaraki-ken
	Tokyo University-Yayoi	Tokai-mura, Ibaraki-ken
	TNCA	Kawasaki-shi
	TTR	Kawasaki-shi, Kanagawa-ken
	VHTRCA	Tokai-mura, Ibaraki-ken
Kazakhstan	Kurchatov test reactor	Kurchatov
	WWR-K	Almaty
Korea, Republic of	HANARO	Taejon
	Triga-II and III	Seoul
	AGN-201	Suwoon
Latvia	IRT	Salapils
Libyan Arab Jamahiriya	IRT	Tajura
Malaysia	Puspati	Bangi, Selangor
Mexico	Triga-III	Ocoyoacac
Morocco	MA-R1	Rabat
Netherlands	HFR	Petten
	HOR	Delft
	LFR	Petten
Nigeria	Nigeria research reactor 1	Zaria
Norway	HBWR	Halden
	Jeep-II	Kjeller
Pakistan	PARR-1	Rawalpindi
	PARR-2	Rawalpindi
Peru	RP-10	Lima
	RP-0	Lima
Philippines	PRR	Quezon City, Diliman
Poland	Maria	Otwock-Swierk

State[a]	Name of facility	Location[a]
Portugal	RPI	Sacavem
Romania	Material testing facility	Pitesti Colibasi
	National Institute R&D for Physics and Nuclear Engineering 'Horia Hulubei'	Magurele
Serbia	Vinča Institute of Nuclear Sciences	Vinča
Slovenia	Triga-II	Ljubljana
South Africa	SAFARI-I	Pelindaba
Sweden	Studsvik	Studsvik
Switzerland	AGN 211P	Basel
	Crocus	Lausanne
	Proteus	Würenlingen
Syrian Arab Republic	MNSR	Damascus
Thailand	TRR	Bangkok
Turkey	Çekmece Nuclear Research and Training Centre	Istanbul
Turkey	ITU-TRR Triga-II	Istanbul
Ukraine	IR-100	Sevastopol
	WWR-M	Kiev
Uzbekistan	IIN-3M	Tashkent
	WWR-SM	Ulugbek
Venezuela	IVIC	Altos de Pipe
Vietnam	Da Lat research reactor	Da Lat, Lam Dong
Conversion plants		
Algeria	Pilot uranium concentration purification unit	Draria nuclear site
Argentina	UF_6 production plant	Pilcaniyeu
	UO_2 conversion plant	Córdoba
Canada	Cameco Corporation Blind River refinery	Blind River
	Cameco Corporation Port Hope conversion facility	Port Hope
Chile	Experimental conversion laboratory	Santiago
Iran, Islamic Republic of	Uranium chemistry laboratory	Esfahan
	UCF	Esfahan

State[a]	Name of facility	Location[a]
Japan	JCO	Tokai-mura, Ibaraki-ken
	JNC	Tomata-gun, Okayama-ken
	Plutonium conversion development facility	Tokai-mura, Ibaraki-ken
Korea, Republic of	DUF4 conversion plant	Taejon
Mexico	Fuel fabrication pilot plant	Salazar
Romania	Sinterable UO_2 powder processing plant	Feldiora
South Africa	Conversion plant	Pelindaba
	HEU and LEU conversion, alloy production, scrap recovery plant	Pelindaba
Sweden	Ranstad Mineral	Stenstorp
Fabrication plants		
Algeria	UDEC	Draria nuclear site
Argentina	Experimental plant	Constituyentes
	Fuel fabrication plant	Ezeiza
	Research reactors fuel elements fabrication plant	Constituyentes
	Research reactor fuel fabrication plant	Ezeiza
Belgium	BN-MOX	Dessel
	FBFC	Dessel
	FBFC MOX	Dessel
Brazil	Fuel fabrication plant	Resende
Canada	Fuel engineering, metallurgy, workshops, metallurgy and chemical operations	Chalk River
	Fuel fabrication facility	Chalk River
	General Electric Canada	Toronto
	General Electric Canada	Peterborough
	Zircatec Precision Industries	Port Hope
Chile	UMF	Santiago
Egypt	FMPP	Inshas
	Research and development nuclear fuel laboratory	Inshas
Germany	Advanced Nuclear Fuels	Lingen
India	CFFAA	Hyderabad
	NFC	Hyderabad
Indonesia	Experimental fuel element installation	Serpong
	Research reactor fuel element production installation	Serpong

State[a]	Name of facility	Location[a]
Iran, Islamic Republic of	Fuel fabrication laboratory	Esfahan
Italy	FN-Nuovo Technologie e Servizi Avanzati	Bosco Marengo
Japan	Global Nuclear Fuel	Yokosuka-shi, Kanagawa-ken
	Mitsubishi Nuclear Fuel	Tokai-mura, Ibaraki-ken
	NFI Kumatori-1	Sennan-gun, Osaka
	Tokai-1	Tokai-mura, Ibaraki-ken
	NFI Kumatori-2	Sennan-gun, Osaka
	Plutonium fuel production facility	Tokai-mura, Ibaraki-ken
	PFC plutonium fuel facility	Tokai-mura, Ibaraki-ken
Kazakhstan	Ulbinski metallurgical plant	Kamenogorsk
Korea, Republic of	Korea nuclear fuel fabrication plant	Taejon
Romania	NFP	Pitesti Colibasi
South Africa	BEVA	Pelindaba
Spain	ENUSA fuel fabrication plant	Juzbado
Sweden	ABB	Västeras
Turkey	Nuclear fuel pilot plant	Istanbul
Reprocessing plants		
Germany	WAK	Eggenstein-Leopoldshafen
India	PREFRE	Tarapur
Italy	Eurex	Saluggia
	ITREC	Rotondella
Japan	Chemical processing facility (JAEA Tokai research and development)	Tokai-mura, Ibaraki-ken
	Rokkasho reprocessing plant	Kamikita-gun, Aomori-ken
	Solution critical facility of NUCEF	Tokai-mura, Ibaraki-ken
	Tokai reprocessing plant	Tokai-mura, Ibaraki-ken
Enrichment plants		
Argentina	Uranium enrichment plant	Pilcaniyeu
Brazil	Isotopic enrichment laboratory	Iperó
	Laser spectroscopy laboratory	São José dos Campos
	U-235 centrifuge enrichment plant	Resende
	Uranium enrichment pilot plant	Iperó
China	Shaanxi uranium enrichment plant	Han Zhang
Germany	UTA-1	Gronau
Iran, Islamic Republic of	Fuel enrichment plant	Natanz
	Pilot fuel enrichment plant	Natanz

State[a]	Name of facility	Location[a]
Japan	Rokkasho enrichment and disposal office centrifuge test facility	Kitakami-gun, Aomori-ken
	Rokkasho uranium enrichment plant	Kamikita-gun, Aamori-ken
	Uranium enrichment plant	Tomata-gun, Okayama-ken
Netherlands	URENCO SP4, SP5	Almelo
United Kingdom	URENCO A3, E22 and E23	Capenhurst
Separate storage facilities		
Argentina	Central store	Ezeiza
	Central store	Constituyentes
	DUE	Ezeiza
	Nuclear material storage	Constituyentes
	Storage bunker	Ezeiza
Armenia	Dry spent fuel storage	Metsamor
Australia	Vault storage	Lucas Heights
Belgium	Belgoprocess dry storage	Dessel
	Belgoprocess	Dessel
	Electrabel Doel Droge Stockage	Beveren
	Zone de production nucléaire de Tihange	Tihange
Brazil	Aramar store	Iperó
	UF_6 production	São Paulo
Bulgaria	AFRS	Kozloduy
Canada	AECL Research	Pinawa
	CRL spent fuel storage facility	Chalk River
	Douglas Point dry irradiated fuel storage	Tiverton
	Gentilly-I dry irradiated fuel storage facility	Gentilly
	Nuclear material storage facility	Chalk River
	Pickering used fuel dry storage facility	Pickering
	Spent fuel dry canister storage facility	Chalk River
	Spent fuel storage facility	Chalk River
	Western used fuel dry storage facility	Tiverton
Czech Republic	High level radioactive waste storage	Řež
	Dukovany interim spent fuel storage	Dukovany
	Skoda Plzen-Bolevec storage	Bolevec
Denmark	Risø store	Roskilde
	Danish decommissioning waste treatment plant	Roskilde
Finland	TVO-KPA store	Olkiluoto
France	COGEMA UP2 and UP3	La Hague

State[a]	Name of facility	Location[a]
Germany	AVR-Behaelterlager für Bestrahlte Brennelementkugeln	Jülich
	Brennelementbehaelterlager Grafenrheinfeld	Grafenrheinfeld
	Brennelemente-Zwischenlager Biblis	Biblis
	Brennelemente-Zwischenlager Gundremmingen	Gundremmingen
	Brennelementlager Isar	Essenbach
	Brennelement-Zwischenlager Ahaus	Ahaus
	Gemeinschaftskernkraftwerk Neckar, Zwischenlager	Neckarwestheim
	Kernmateriallager Gebaeude 87	Rossendorf
	Lager der Kernforschungsanlage Jülich für Bestr Ahlte Avr Brennelement-Kugeln	Jülich
	NCS, Lagerhalle Hanau, Geb. 15	Hanau
	Staatliches Spaltstofflager für Plutonium und hochangereichertes Uran	Hanau
	Standort Zwischenlager Kruemmel	Geesthacht
	Standort Zwischenlager Philippsburg	Philipsburg
	Standort-Zwischenlager Lingen	Lingen
	Standortzwischenlager Brunsbuettel	Brunsbuettel
	Transportbehaelterlager Gorleben	Gorleben
	Zwischenlager Kernkraftwerk Grohnde	Emmerthal
	Zwischenlager Nord	Lubmin
	Zwischenlager-Kernkraftwerk Brokdorf	Brokdorf
	Zwischenlager-Kernkraftwerk Unterweser	Stadland
Hungary	Central isotope storage	Budapest
	MVDS	Paks
India	AFR	Tarapur
Indonesia	Transfer channel and interim storage for spent fuel	Serpong
Iran, Islamic Republic of	Karaj radioactive waste storage	Karaj
Iraq	Tuwaitha, location C	Tuwaitha
Italy	Deposito Avogadro	Turin
	INE, non-irradiated nuclear material	Ispra
	Essor storage pond	Ispra
	Nucleco	Rome
	Research centre	Ispra
Japan	Fukushima Dai-ichi common spent fuel storage facility	Futaba-gun, Fukushima-ken
	Kyoto University fresh fuel storage	Sennan-gun, Osaka
Kazakhstan	Ulba thorium storage	Kamenogorsk
Korea, Republic of	Nuclear material storage facility	Taejon

State[a]	Name of facility	Location[a]
Lithuania	Ignalina spent fuel dry storage	Visaginas
Netherlands	COVRA	Vlissingen
	COVRA – Habog	Vlissingen
Pakistan	Hawks Bay depot	Karachi
Poland	Radioactive waste management plant	Swierk
Portugal	Instalacao de Armazenagem	Sacavem
Romania	Interim dry spent fuel storage	Cernavoda
Slovakia	Bohunice interim store	Bohunice
Slovenia	CSRAO, ARAO	Brinje
South Africa	Bulk storage facility	Pelindaba
	Decommissioned pilot enrichment plant	Pelindaba
	E building storage facility	Valindaba
	HEU storage vault	Pelindaba
	Koeberg Castor storage facility	Cape Town
	Thabana pipe store	Pelindaba
	Waste storage facility	Pelindaba
	Z plant storage facility	Pelindaba
Spain	Intermediate dry spent fuel storage	Trillo
Sweden	SKB clab store	Oskarshamn
Switzerland	Central interim storage facility	Würenlingen
	SAPHIR	Würenlingen
USA	K area materials storage facility	Savannah River Site
	Plutonium storage	Hanford
	Tube vault 16	Oak Ridge
Ukraine	Spent fuel storage	Chernobyl
	Fresh fuel storage Khmelnitski	Neteshin
	Fresh fuel storage	Kuznetsovsk
	Fresh fuel storage	Yuzhnoukrainsk
	Dry spent nuclear fuel storage facility	Energodar
	Fresh fuel storage	Energodar
United Kingdom	Special nuclear material store 9	Sellafield
	Thorp product store	Sellafield
Other facilities		
Algeria	AURES I	Ain Oussara
Argentina	Alpha laboratory	Constituyentes
	Enriched uranium recovery laboratory	Ezeiza
	Fission products division	Ezeiza
	Radiochemical facility laboratory	Ezeiza
	Post-irradiation testing laboratory	Ezeiza

State[a]	Name of facility	Location[a]
	LTA	Ezeiza
	Uranium powder fabrication plant	Constituyentes
Australia	Research and development laboratories	Lucas Heights
Belgium	CEN waste	Dessel
	IRMM	Geel
	IRE	Fleurus
	Laboratoires plutonium du CEN/SCK	Mol
	SCK-CEN laboratories	Mol
Brazil	Fuel development and technology coordination	São Paulo
	Isotope separation element development laboratory	São Paulo
	Nuclear fuel and instrumentation development laboratory	São Paulo
	Nuclear materials laboratory	Iperó
	Reprocessing project	São Paulo
Czech Republic	Nuclear fuel institute	Prague
	Radioactive waste repository	Litomerice
	Research laboratories	Řež
Georgia	Subcritical assembly	Tbilisi
	Sukhumi Institute	Sukhumi
Germany	Deutsches Elektronen-Synchrotron	Hamburg
	Heisse Zellen der Kernforschungsanlage	Jülich
	Laboratorien der Kernforschungsanlage	Jülich
	Transuran Institut	Leopoldshafen
Indonesia	Radiometallurgy installation	Serpong
Iran, Islamic Republic of	Jabr Ibn Hayan multipurpose laboratory	Tehran
Italy	Laboratorio plutonio	Santa Maria di Galeria
Japan	JAERI Oarai research establishment	Higashi, Ibaraki-ken
	JAERI Tokai research establishment	Tokai-mura, Ibaraki-ken
	JNC fuel monitoring facility	Higashi, Ibaraki-ken
	JNC irradiation rig assembling facility	Higashi-gun, Ibaraki-ken
	JNC Oarai research and development facility	Higashi, Ibaraki-ken
	JNC Tokai research and development	Tokai-mura, Ibaraki-ken
	Kyoto University, Kumatori	Sennan-gun, Osaka
	Neutron radiation facility	Tsukuba-shi, Ibaraki-ken
	NDC fuel hot laboratory	Tokai-mura, Ibaraki-ken
	NERL, University of Tokyo	Tokai-mura, Ibaraki-ken
	NFI Tokai-2	Tokai-mura, Ibaraki-ken
	NFD research facility	Higashi, Ibaraki-ken
	Uranium material laboratory	Higashi, Ibaraki-ken

State[a]	Name of facility	Location[a]
Korea, Republic of	Advanced spent fuel conditioning process demonstration facility	Taejon
	DUPIC fuel development facility	Taejon
	HANARO fuel fabrication laboratory	Taejon
	Irradiation material examination facility	Taejon
	Nuclear fuel cycle related R&D facility	Taejon
	Post-irradiation examination facility	Taejon
	Acrylonitrile plant	Ulsan
Libyan Arab Jamahiriya	Tajura uranium R&D facility	Tajura
Netherlands	ECN and JRC	Petten
Norway	Research laboratories	Kjeller
South Africa	Hot cell complex	Pelindaba
	Decontamination and waste recovery plant	Pelindaba
	NU and DU metals plant	Pelindaba
Spain	ENRESA	El Cabril
Switzerland	CERN	Geneva
	EIR	Würenlingen
Ukraine	Chernobyl unit 4 shelter	Chernobyl
	National Science Center–Kharkov Institute of Physics and Technology	Kharkov
	Subcritical uranium water assembly	Sevastopol
United States of America	BWX Technologies facility	Lynchburg

[a] An entry in this column does not imply the expression of any opinion whatsoever on the part of the Agency concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers.

Note: The Agency was also applying safeguards in Taiwan, China, at eight power reactors, three research reactors/critical assemblies, one uranium pilot conversion plant, one fuel fabrication plant, one storage facility and one R&D facility.

Note: Additionally under Agency safeguards there were more than 300 locations outside facilities in 45 States.