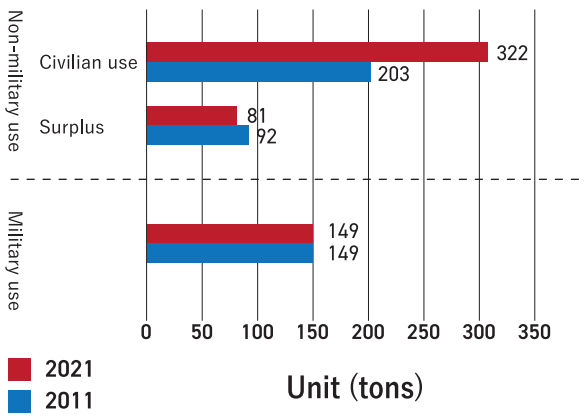
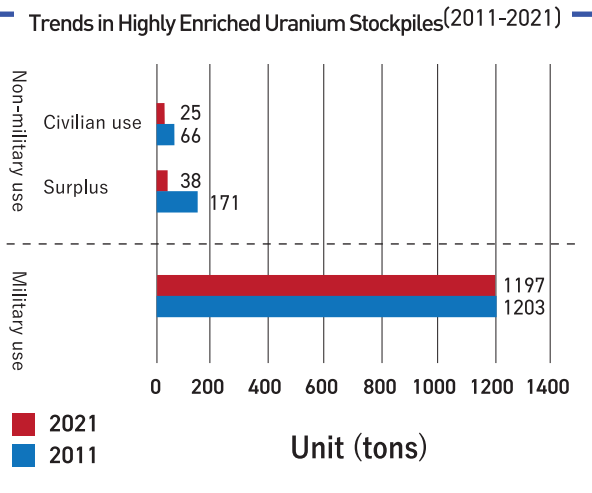
Overview of the 2023 Edition

The special feature of this year is that the total fissile material inventory, which decreased last year, has once again increased due to an increase in the amount of separated plutonium. The total inventory of the Highly Enriched Uranium (HEU) increased, but this is due to a difference in the way the figures for "Other Non-nuclear Weapon Countries" are treated, and is not a substantial increase. On the other hand, the overall rising trend in separated plutonium continues. With regard to military-use plutonium, only India has seen an increase, while the inventory of non-military use plutonium recovered from civilian nuclear power plants increased this year mainly due to higher inventories in France.

Trends in Separated Plutonium Stockpiles (2011-2021)



Trends in Highly Enriched Uranium Stockpiles (2011-2021)



Separated Plutonium around the World

(as of the end of 2021)

Country	Military use (tons)	Non-military use (tons)	Total (tons)
Russia	88.0	103.5	191.5
United States	38.4	49.4	87.8
France	6.0	85.0	91.0
China	2.9	0.04	2.94
United Kingdom	3.2	116.5	119.7
Israel	0.8		0.8
Pakistan	0.5		0.5
India	9.2	0.4	9.6
North Korea	0.04		0.04
Japan		45.8	45.8
Other non-nuclear weapon states*		2.5	2.5
Subtotal	149	403	
Total	552		

*The Netherlands, Italy, Spain, Germany, Switzerland

NB: The stockpile of fissile materials includes estimated ones with different isotopic composition and with large uncertainties, and thus total quantities are expressed in rounded numbers.

Plutonium that remains in spent nuclear fuel but is not separated cannot be directly reused in nuclear weapons and therefore is not included. Estimates for military plutonium except those for the U.S. and U.K. contain large uncertainties. It is estimated that the Nagasaki bomb contained 6 kg of plutonium.

All of the five major nuclear powers (the U.S., Russia, China, France, the U.K.) have closed their military reprocessing facilities. However, India, Pakistan, Israel, and North Korea have small-scale military reprocessing facilities.

Three nuclear powers, namely the U.K., Russia, and France, operate large-scale reprocessing facilities for civilian use, and China plans to import this technology from France. Non-nuclear weapon states such as Germany and Belgium have operated research facilities in the past. Currently, only Japan has a large-scale reprocessing facility, which is scheduled to be completed in 2024. Other non-nuclear weapon states are terminating reprocessing activities and reducing plutonium quantities to virtually zero. However, South Korea is currently negotiating with the U.S. for the right to carry out reprocessing.

Highly Enriched Uranium around the World

(as of the end of 2021)

Country	Military use (tons)	Non-military use (tons)	Total (tons)
Russia	672.0	8.0	680.0
United States	453.2	33.9	487.1
France	25.0	5.3	30.3
China	14.0	0.0※※	14.0
United Kingdom	21.9	0.7	22.6
Israel	0.3	0.02	0.32
Pakistan	4.9	0.02	4.92
India	4.5	0.0※※	4.5
North Korea	0.7		0.7
Non-nuclear weapon states*		15.0	15.0
Subtotal	1,197	63	
Total	1,260		

*13 non-nuclear weapon states are estimated to have at least 1 kg of HEU (Japan, Kazakhstan, Germany, Canada, the Netherlands, Belgium, South Africa, Italy, Belarus, Norway, Iran, Australia, and Syria).

**The amount held is less than 100 kilograms, but the details are unknown.

NB: The stockpile of fissile materials includes estimated ones with different isotopic composition and with large uncertainties, and thus total quantities are expressed in rounded numbers. Uranium that could potentially be used to produce nuclear weapons is HEU that has a concentration of 20% or higher. In reality, it is estimated that virtually all HEU used for nuclear weapons has a concentration of 90% or higher, but some use low-concentration HEU and details have not been disclosed. Therefore, the converted values based on the atomic bomb dropped on Hiroshima are given only as a guide.

Estimates for military HEU (Highly Enriched Uranium) except those for the U.S. and U.K. contain large uncertainties. It is estimated that the Hiroshima atomic bomb contained 64 kg of HEU with an average concentration of 80%.

All five of the major nuclear powers (the U.S., Russia, China, France, the U.K.) have ceased producing military-use highly enriched uranium (HEU). However, India and Pakistan's production facilities continue to be operational. Israel possesses some military-use HEU acquired from other countries, but has no enrichment facilities of its own.

France, Germany, the Netherlands, Russia, the U.K., China, Japan, the U.S., Iran, Argentina, and Brazil have enrichment facilities for civilian use. The U.S. has plans to build new non-military enrichment facilities.

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June 2023
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"The World' s Fissile Material Inventory" poster is an illustration of the materials which can be used for nuclear weapons (namely highly enriched uranium and separated plutonium), with the information organized by country and by purpose for easier understanding. This poster was made by the Nagasaki Council for Nuclear Weapons Abolition (PCU-NC) and the Research Center for Nuclear Weapons Abolition, Nagasaki University (RECNA) for all audiences, from elementary school students to adults. As part of the peace education efforts carried out every August at Hiroshima' s and Nagasaki' s Atomic Bomb Memorials, we present annual updates on the latest information every June. The detailed data of this poster, which was compiled by the Fissile Material Data Monitoring Team, including RECNA staff, has been published on our website (http://www.recna.nagasaki-u.ac.jp/recna/en-fmdata). Please see the website for further details.

We hope this guide will aid those using the poster in understanding background information and terminology in simple, plain terms. It should be especially useful in the education field, particularly in schools.

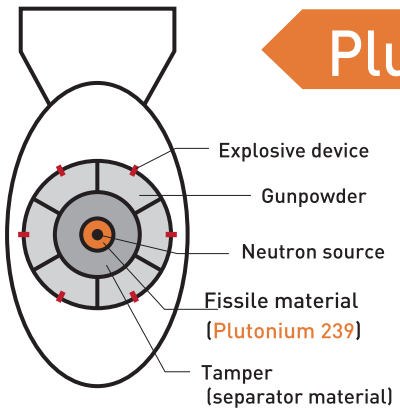
INTRODUCTION

The World' s Fissile Material Inventory

Poster & Guide

The Raw Materials Used in Making Nuclear Weapons

Plutonium



Plutonium is an artificial radioactive element that does not exist in nature and is generated from the operation of a nuclear reactor. For example, spent nuclear fuel discharged from a light water reactor—which is the type most commonly used around the world—contains about 1% plutonium by weight. Plutonium can be recovered from spent nuclear fuel through so-called "reprocessing", which separates plutonium leaving uranium and fission products.

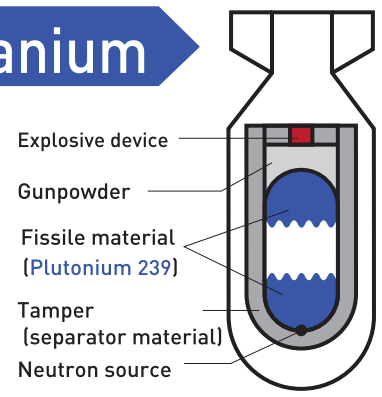
The temperature of the fissile plutonium recovered from usual nuclear power plants is low. For this reason, there are people who claim that this plutonium is "unsuitable" for use in the manufacturing of nuclear weapons, but this is not accurate. Even if nuclear weapons are made with this sort of plutonium, they still have an explosive power that far surpasses that of conventional weapons. Moreover, if even more advanced design technology is applied, it is possible to build nuclear weapons using reactor-grade plutonium that have the same reliability and destructiveness as weapons built using weapons-grade plutonium.

Length: 3.25 m; Diameter: 1.52 m;
Weight: 4.5 tons
Nicknamed "Fat Man"

Nagasaki atomic bomb: Implosion-type bomb made with plutonium. Deemed to require nuclear weapons testing because of its complex design.

Uranium

Uranium is a natural radioactive element. In nature, most uranium is found as the less fissionable uranium-238 (99.3%). Only 0.7% of uranium is the fissile uranium-235. Therefore the concentration of uranium-235 needs to be increased in a process known as "uranium enrichment". Uranium enriched to 20% or more is believed to be usable for weapons, and is referred to as "Highly Enriched Uranium (HEU)." Typical nuclear weapons use uranium enriched to 90% or higher. On the other hand, nuclear fuel used in a nuclear power plant typically has a 3–5% concentration, and is referred to as "low-enriched uranium (LEU)." It is still possible to produce highly enriched uranium, even in low-enriched uranium facilities for civilian use. However, even though this is technically simple the clandestine production of HEU in non-nuclear weapon countries is not easy if reactors are under the surveillance of the International Atomic Energy Agency (IAEA).



Length: 3.0 m; Diameter: 0.7 m;
Weight: 4.0 tons
Explosive force: equivalent to 16,000 ton of TNT
icknamed "Little Boy"

Hiroshima atomic bomb: Gun barrel-type bomb made with Highly Enriched Uranium (HEU). Deemed to not require nuclear weapons testing because of its comparatively simple design.

Highly enriched uranium (HEU) or plutonium are essential raw materials for producing nuclear weapons. Modern nuclear weapons are made using both HEU and plutonium, and uranium enrichment or reprocessing facilities are required for obtaining these fissile materials. There are countries that are equipped with the above two facilities as "nuclear fuel cycle" facilities for nuclear power production. Having even small-scale nuclear fuel cycle facilities gives a country the capability to produce fissile materials for military purposes. Subsequently, if nuclear fuel cycle capabilities spread throughout the world the risk of nuclear weapons proliferations will also significantly increase. In fact, the increasing stockpile of plutonium recovered through reprocessing for civilian use is becoming a serious issue in terms of international security.

Military and Non-military
Plutonium

Military: Plutonium used in nuclear warheads or stored for use in weapons; plutonium that is reserved for possible military uses in the future

Non-military: Plutonium separated from spent nuclear fuel from a nuclear reactor for non-military purposes; plutonium declared as "excess" for nuclear weapons

Military and Non-military
Uranium (HEU)

Military: HEU used in nuclear warheads or stored for use in weapons; HEU used in reactor fuel for naval nuclear propulsion (including spent fuel)

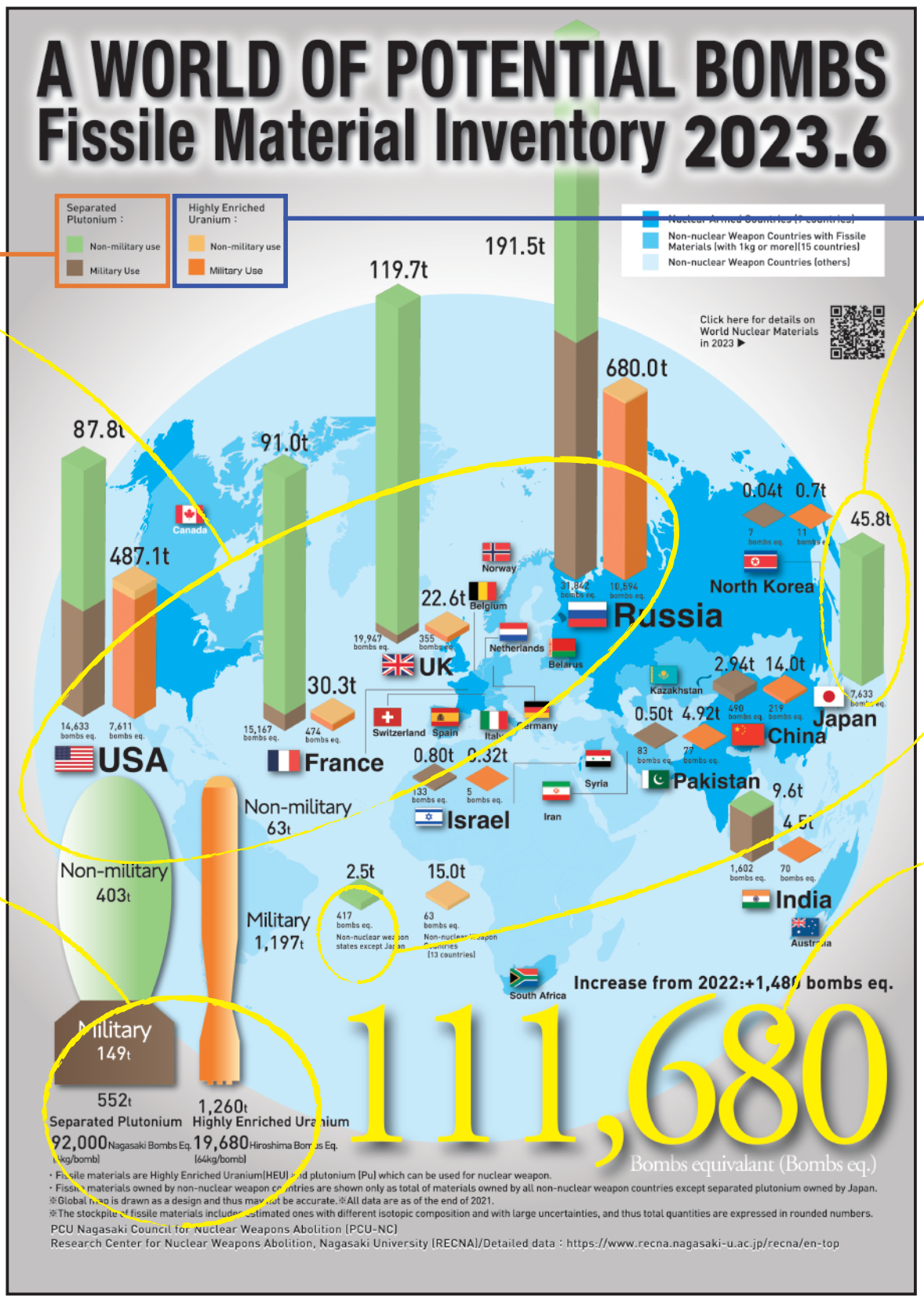
Non-military: HEU used in fuel for research and testing reactors; HEU declared as "excess" for military purposes

Existing Raw Materials Can Create Many Atomic Bombs

It is estimated that the Hiroshima bomb contained 64 kg of HEU with an average enrichment of 80%, and that the Nagasaki bomb had 6 kg of plutonium. The International Atomic Energy Agency (IAEA) deems it possible to build one implosion-type nuclear weapon with 25 kg of uranium-235 or 8 kg of plutonium. The graph shown conversions for the Hiroshima bomb (64 kg) and the Nagasaki bomb (6 kg). In reality, there are many variables, and so the values shown are approximate.

Downward Trend in HEU and Upward Trend in Plutonium

Military-use HEU accounts for 95% of all HEU. Since 2011, 6 tons of military HEU and 174 tons of non-military-use HEU have been eliminated. In contrast, non-military-use plutonium accounts for 73% of all plutonium. Since 2011, the amount of military-use plutonium has remained unchanged, but there has been an increase in non-military-use plutonium of 108 tons.



Japan is as the Largest Stockpile owner of Plutonium as a Non-Nuclear Weapon State

Japan has as much as 8% of the world's separated plutonium, possessing the fifth largest amount of separated plutonium after Russia, the United Kingdom, the United States, and France. In contrast, the other non-nuclear weapon states combined possess only 0.5 or less of the world's separated plutonium. From this one can tell that Japan is a very unique outlier.

Reducing Fissile Materials is Also a Huge Challenge

All of the global fissile materials combined are equivalent to more than 110,000 of the Hiroshima and Nagasaki bombs. It is estimated that there are 12,520 nuclear warheads in the world. In other words, the world is capable of developing many times more nuclear weapons than it currently possesses. Fissile materials will remain even if all of the world's nuclear weapons are dismantled. They must therefore be processed and disposed of to ensure that they are never again used to make nuclear warheads.