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SYNOPSIS

As small modular reactors are increasingly deployed worldwide, more countries are requesting access to enrichment capabilities to ensure a more stable supply chain of nuclear fuel. The safeguards mechanism imposed by the International Atomic Energy Agency will need to be reviewed as more countries acquire nuclear latency.

COMMENTARY

The International Atomic Energy Agency (IAEA) forecast that global nuclear capacity will triple to 1000 GW by 2050, driven by the need for sustainable baseload power to support data centres in a more digitalised world. In its most optimistic scenario, small modular reactors (SMRs) could supply 25 per cent of this new projected capacity.

The growth in nuclear energy deployment will lead to a surge in demand for enriched uranium – the essential fuel for nuclear reactors. North America remains the largest market for enriched uranium as the United States currently has the largest nuclear reactor fleet. However, the Asia-Pacific region is emerging as the fastest-growing market for enriched uranium due to rising energy demands. The Middle East is also in contention, with several countries in the region planning to switch to nuclear energy to decarbonise their economies.

Presently, Russia dominates the supply of enriched uranium, accounting for more than 40 per cent of global enrichment capacity. The US has been a major importer of Russia's enriched uranium since the post-Cold War *Megatons to Megawatts Agreement* and had ceased its domestic enrichment capacity for its civilian nuclear power plants in 2013.

Due to Russia's invasion of Ukraine, the US has passed a law to ban the import of Russia's enriched uranium from 2028. As a result, countries are considering

acquiring indigenous enrichment capabilities as a hedge against possible global supply shocks in the nuclear fuel cycle.

Nuclear Latency is Not Necessarily Proliferation

The capability to enrich uranium (enrichment) or to extract plutonium (reprocessing of spent fuel) is a tightly controlled process in fabrication because it can put a country on the path towards weaponisation. Once a country acquires the technical expertise and infrastructure for enrichment, it is considered to have nuclear latency, i.e., the ability to quickly develop a bomb. To preserve the principles of the Non-Proliferation Treaty (NPT), all non-nuclear-weapon states (NNWS) are discouraged from taking the irreversible path of acquiring nuclear latency.

However, nuclear latency does not equate to the proliferation of nuclear weapons. Article IV of the NPT specifies that signatories to the treaty have the inalienable right to develop, research, and use nuclear energy for peaceful purposes, which technically means that enrichment activities are allowed for NNWS as long as they are meant for civilian applications.

Other than the five nuclear-weapons states (NWS) of the NPT, enrichment is also carried out in Argentina, Brazil, Germany, the Netherlands and Japan, all of which are considered nuclear latent but have no intention to develop nuclear weapons. Japan even operates a reprocessing plant at its Rokkasho facility, where plutonium has been extracted from its spent fuels. In addition, these countries comply with the IAEA safeguards protocol, under which stockpiles of sensitive fissile materials are monitored by the nuclear watchdog.

Assessing Breakout Time

The IAEA uses the metric quantity, known as the “breakout time”, to assess a country’s proliferation risks. Based on the declared enriched uranium stockpile and the capacity of enrichment facilities, the breakout time is the estimated time required for that country to produce 25 kg of Uranium-235 enriched to 90 per cent purity, which is considered weapons-grade.

The threshold for uranium enrichment is set at 20 per cent purity, below which it is technically infeasible to construct a bomb. The implementation of the enrichment limits in the 2015 Joint Comprehensive Plan of Action (JCPOA) signed between Iran and the US, UK, France, Russia, China, Germany and the EU was intended to set Iran’s breakout time at one year, giving the international community ample time to resolve a crisis through diplomacy. Currently, Iran is assessed to have a much-reduced breakout time, i.e., less than one year, as it has already enriched uranium up to a 60 per cent level.

Typically, a conventional light water reactor operates with Lowly-Enriched Uranium (LEU) with enrichment levels of 3 to 5 per cent. However, future SMRs, which are smaller in capacity but designed to operate longer, will require High-Assay Low-Enriched Uranium (HALEU), which is fuel enriched to 5-20 per cent. With more countries capable of producing and stockpiling HALEU, the breakout time to produce

a nuclear weapon will be significantly reduced. Therefore, the IAEA will need to develop a more stringent or effective safeguard mechanism against proliferation.

The Intent to Develop Nuclear Weapons

One proposal to strengthen the non-proliferation regime is to confine enrichment and reprocessing activities within the five NWS, as these countries have different safeguards protocols with the IAEA. However, this proposal will further worsen the unequal status between the NWS and the NNWS, deepening the current over-dependence on Russia for enriched uranium. Moreover, several NNWS like Japan already possess nuclear latency. It would not be justifiable to deny newcomer countries their right to pursue enrichment to enhance their energy resilience.

It is inadequate for the IAEA to rely on technical data acquired through its safeguards verification process to determine a country's breakout time. One criterion for better assessing the proliferation risk profile is whether there is an intent to develop a weapon. Such a criterion can be ascertained through intelligence gathering and a good understanding of political ideologies and the regional geopolitical environment. The IAEA can work with organisations such as the Nuclear Threat Initiative to develop the metrics to complement its existing safeguards framework and to assess a country's risk profile better.

Conclusion

The ubiquitous deployment of nuclear energy for civilian purposes will inevitably mean an increase in nuclear latent states. However, nuclear latency does not necessarily lead to weapons proliferation, as exemplified in the case of Japan. It is more critical to dampen a country's intention to develop nuclear weapons than to curb its nuclear latency.

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