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Addressing the Challenges of Nuclear Submarine Proliferation to the IAEA's Comprehensive Safeguards System

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Tariq Rauf

INTRODUCTION: AND THEN THERE WERE THREE!

In October-November 2025, South Korea became the third country after Australia and Brazil seeking nuclear-powered submarines besides the nuclear-armed states.[1] The naval nuclear propulsion programmes in these three non-nuclear-weapon States (NNWS) parties to the nuclear Non-Proliferation Treaty (NPT)[2] will exploit critical weaknesses in the NPT and its associated verification and monitoring (safeguards)[3] system developed and implemented by the International Atomic Energy Agency (IAEA).[4]

The end result will be that several thousands of kilogrammes (kg) of both weapons-grade highly-enriched uranium (HEU) at 93% to 97.3% U235, and low-enriched uranium (below 20%), will be completely outside the safeguards and accountability system of the IAEA, designed to prevent and forestall the further proliferation of nuclear weapons. Recall that the IAEA considers 25kg of weapon-grade HEU or 8kg of separated plutonium as sufficient for the fabrication of one nuclear explosive device (weapon) – a significant quantity (SQ) for one nuclear weapon.[5]

At the time of this writing, it is not evident that in November last year the IAEA Board of Governors considered the South Korean nuclear submarine programme, or that South Korea officially has communicated to the IAEA its early plans for the acquisition of nuclear-powered, conventionally armed, general-purpose attack submarines (SSNs). South Korea is legally obliged to officially report these developments to the IAEA, pursuant to the modified code 3.1 of the subsidiary arrangements[6] to its NPT comprehensive safeguards agreement (CSA).[7] And, it is obligated to provide relevant information to the IAEA under article 8 of the CSA[8] and article 2 of the additional

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[1] Ethan Gossrow, "USA gives South Korea Green Light to Build Nuclear Submarines," *Naval News,* October 31, 2025, https://www.navalnews.com/naval-news/2025/10/usa-gives-south-korea-green-light-to-build-nuclear-submarines/

[2] IAEA Information Circular, TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS, *INFCIRC/140, International Atomic Energy Agency,* April 22, 1970, https://www.iaea.org/sites/default/files/publications/documents/infcircs/1970/infcirc140.pdf

[3] International Atomic Energy Agency, "Basics of IAEA Safeguards," IAEA Website, https://www.iaea.org/topics/basics-of-iaea-safeguards

[4] International Atomic Energy Agency, "History," IAEA Website, https://www.iaea.org/about/overview/history

[5] International Atomic Energy Agency, *IAEA Safeguards Glossary : 2022 Edition*, INTERNATIONAL NUCLEAR VERIFICATION SERIES No. 3 (Rev. 1), Vienna, Austria: IAEA, October 2022, p.30, https://www-pub.iaea.org/MTCD/Publications/PDF/PUB2003_web.pdf

[6] Ibid.p.14.

[7] IAEA Information Circular, "Text of the Agreement of 31 October 1975 Between the Republic of Korea and the Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons" *INFCIRC/236,* October 31, 1975, https://www.iaea.org/publications/documents/infcircs/text-agreement-31-october-1975-between-republic-korea-and-agency-application-safeguards-connection-treaty-non-proliferation-nuclear-weapons

[8] Ibid.

protocol,[9] with the IAEA. In this context, one might recall that the IAEA Director General reported in November 2004 that "starting in 1982 and continuing until 2000, South Korea conducted experiments and activities involving uranium conversion, uranium enrichment and plutonium separation, which it failed to report to the Agency in accordance with its obligations under its Safeguards Agreement", and that the failure to report these activities were "a matter of serious concern".[10]

In September 2021, Australia informed the IAEA that it had reached an agreement with the United Kingdom and the United States to acquire a fleet of eight SSNs[11] for the Royal Australian Navy (AUKUS),[12] and would seek to exempt[13] the naval nuclear propulsion reactor and HEU from Agency safeguards[14] as provided for in the loophole in the Agency's comprehensive safeguards system (described below). After more than four years there is scant evidence that the Agency's Board of Governors, or the Agency's Member States, and likely also the IAEA Secretariat, have any clarity and specificity about the technical details of the SSN reactors and HEU fuel as well as related other relevant information. In this context, not much is known about technical safeguards parameters, other than early pious claims by the three AUKUS partner states that they unilaterally would define and interpret the safeguards exemption procedures

[9] Information Circular INFCIRC/236/Add.1, "Protocol Additional to the Agreement of 31 October 1975 between the Government of the Republic of Korea and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons," June 18, 2004, https://www.iaea.org/sites/default/files/publications/documents/infcircs/1976/infcirc236a1.pdf

[10] IAEA Board of Governors, "Implementation of the NPT Safeguards Agreement in the Republic of Korea," *GOV/2004/84,* November 11, 2024, https://www.iaea.org/sites/default/files/documents/gov2004-84.pdf ; "IAEA Board Concludes Consideration of Safeguards in South Korea," IAEA Website, November 26, 2004, https://www.iaea.org/newscenter/news/iaea-board-concludes-consideration-safeguards-south-korea; IAEA Information Circular, "Text of the Agreement of 31 October 1975 Between the Republic of Korea and the Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons," *INFCIRC/236,* October 31, 1975, https://www.iaea.org/publications/documents/infcircs/text-agreement-31-october-1975-between-republic-korea-and-agency-application-safeguards-connection-treaty-non-proliferation-nuclear-weapons

[11] Australian Submarine Agency, "Australia's nuclear-powered submarines," *Australian Government,* October 2, 2024, https://www.asa.gov.au/aukus/australias-nuclear-powered-submarines

[12] Lana Lam, "What is Aukus, the submarine deal between Australia, the UK and US?," *BBC,* October 21, 2025, https://www.bbc.com/news/articles/cgr589k5yleo

[13] IAEA Information Circular, "Communication Dated 14 March 2023 Received from the Permanent Mission of Australia to the Agency," *INFCIRC/1079,* March 14, 2023, https://www.iaea.org/sites/default/files/publications/documents/infcircs/2023/infcirc1079.pdf

[14] IAEA Information Circular, "The Text of the Agreement Between Australia and the Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons," *INFCIRC/217,* December 13, 1974, https://www.iaea.org/publications/documents/infcircs/text-agreement-between-australia-and-agency-application-safeguards-connection-treaty-non-proliferation-nuclear-weapons

and set the highest non-proliferation standard[15] for all other IAEA and NPT member states in consultation with the IAEA Secretariat. Following opposition and push back to these claims from some states (notably China), the AUKUS partners retreated and elaborated that they themselves would define the exemption standard and procedures solely for their AUKUS SSN programme.

Brazil has a longstanding domestic programme to develop SSNs (PROSUB),[16] with some assistance from Germany in uranium enrichment and from France in submarine construction technology.[17] Unlike Australia and South Korea, Brazil's programme relies on "indigenous" development and construction of SSNs fuelled with low-enriched uranium. Nuclear verification and monitoring, safeguards, in Brazil[18] and Argentina are implemented separately and in parallel by the IAEA and Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC).[19] Brazil also has invoked the exemption from safeguards[20] of its naval nuclear propulsion programme, as did Australia before it. Reportedly, discussions involving the IAEA Secretariat, Brazil and ABACC have made more initial progress than the AUKUS programme. Nevertheless, IAEA Member States still do not have a clear picture of the practices and procedures involved.

This paper builds on several previous assessments by the author on the problems and risks of exempting naval nuclear propulsion programmes in NNWS from IAEA

[15] IAEA Information Circular, "Communication dated 14 September 2022 received from the Permanent Mission of Australia to the Agency," *INFCIRC/1037,* September 14, 2022, https://www.iaea.org/sites/default/files/publications/documents/infcircs/2022/infcirc1037.pdf

[16] João Paulo Moralez, "Brazil's nuclear submarine program advances with new contract for Naval Group," *Naval News,* September 5, 2025, https://www.navalnews.com/naval-news/2025/09/brazils-nuclear-submarine-program-advances-with-new-contract-for-naval-group/

[17] News Wires, "France will help Brazil develop nuclear-powered submarines, Macron says," *France24,* March 27, 2024, https://www.france24.com/en/americas/20240327-france-to-help-brazil-develop-nuclear-technology-for-submarines

[18] IAEA Information Circular, "AGREEMENT OF 13 DECEMBER 1991 BETWEEN THE REPUBLIC OF ARGENTINA, THE FEDERATIVE REPUBLIC OF BRAZIL, THE BRAZILIANARGENTINE AGENCY FOR ACCOUNTING AND CONTROL OF NUCLEAR MATERIALS AND THE INTERNATIONAL ATOMIC ENERGY AGENCY FOR THE APPLICATION OF SAFEGUARDS," *INFCIRC/435,* March 1994, https://www.iaea.org/sites/default/files/infcirc435.pdf

[19] ABACC, "Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials: Verifying the peaceful use of nuclear energy in Argentina and Brazil" https://www.abacc.org.br/es/

[20] IAEA Board of Governors, "Naval nuclear propulsion: Brazil", *GOV/INF/2024/13*, November 15, 2024, https://www.iaea.org/sites/default/files/24/11/govinf2024-13.pdf

safeguards[21] and IAEA Information Circulars (INFCIRCs) 1091[22] and 1293.[23] This assessment suggests some possible ways in outline form, to minimise the proliferation risks and related aspects of procedures with a view to building transparency and accountability, especially since the IAEA Board of Governors, being mired down in politicisation of technical matters, continues to fail in its statutory obligations[24] of oversight of the Agency's and the NPT's safeguards system.

The Safeguards "Loop hole"

The spread of SSN acquisition programmes in NPT NNWS – specifically Australia, Brazil, and South Korea – already has created a major challenge to the integrity and effectiveness of the implementation of the IAEA safeguards system.

Following the entry into force of the NPT in 1970, the negotiations between 1970 and 1972 at the IAEA on the comprehensive safeguards' agreement (INFCIRC/153)[25] created a 'loop hole' by including paragraph 14 on the "non-application of safeguards to nuclear material to be used in non-peaceful activities"[26] (IAEA Safeguards Glossary

[21] Tariq Rauf, "Naval Nuclear Propulsion: A Two-Track Solution for IAEA Safeguards Integrity," *IDN InDepth News,* November 19, 2025, https://indepthnews.net/naval-nuclear-propulsion-a-two-track-solution-for-iaea-safeguards-integrity/ ; Tariq Rauf, "Nuclear Submarines and The Non-Proliferation Treaty: Brazil Gets a Jump on Australia?" *IDN InDepth News,* August 8, 2022, https://indepthnews.net/nuclear-submarines-and-the-non-proliferation-treaty-brazil-gets-a-jump-on-australia/; Tarir Rauf, "Driving Nuclear Submarines Through IAEA Safeguards!" *IDN InDepth News,* July 22, 2022, https://www.researchgate.net/publication/362582806_Driving_Nuclear_Submarines_Through_IAEA_Safeguards; Tariq Rauf, "Crashing Nuclear Submarines Through IAEA Safeguards," Policy Brief 122, *Toda Peace Institute,* January 2022, https://toda.org/assets/files/resources/policy-briefs/t-pb-122_crashing-nuclear-submarines-through-iaea-safeguards_rauf.pdf; Marie-France Desjardins and Tariq Rauf, *Opening Pandora's box? : nuclear-powered submarines and the spread of nuclear weapons,* Ottawa : Canadian Centre for Arms Control and Disarmament, 1988, https://www.researchgate.net/publication/350017528_Opening_Pandora's_Box_Nuclear_Powered_Submarines_and_the_Spread_of_Nuclear_Weapons_The_Canadian_Centre_for_Arms_Control_and_Disarmament_Aurora_Papers_8_1988

[22] IAEA Information Circular, "Communication dated 1 June 2023 received from the Permanent Mission of the People's Republic of China to the Agency," *INFCIRC/1091,* June 1, 2023, https://www.iaea.org/sites/default/files/publications/documents/infcircs/2023/infcirc1091.pdf

[23] IAEA Information Circular, "Communication from the Permanent Mission of the People's Republic of China to the Agency," *INFCIRC/1293,* May 27, 2025, https://www.iaea.org/sites/default/files/publications/documents/infcircs/2025/infcirc1293.pdf

[24] International Atomic Energy Agency, "Statue of the IAEA*,"* IAEA Website, https://www.iaea.org/about/statute

[25] IAEA Information Circular, "THE STRUCTURE AND CONTENT OF AGREEMENTS BETWEEN THE AGENCY AND STATES REQUIRED IN CONNECTION WITH THE TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS," *INFCIRC/153 (Corrected),* June 1972, https://www.iaea.org/sites/default/files/publications/documents/infcircs/1972/infcirc153.pdf

[26] Ibid.p.5.

2022, Section 2.15)[27]. This applies to SSNs using either LEU or weapon-grade HEU – the latter is characterised by the IAEA as "direct use material"[28] for nuclear weapons. Such an exemption creates a "safeguards gap" and thereby a potential "diversion risk" of enriched uranium fuel (IAEA Safeguards Glossary 2022, Section 2.5).[29] The key impacts of this gap have included the "loss of continuity of knowledge" over safeguarded direct-use nuclear material, possible elevated proliferation risks, and the negative precedents set for other NNWS.

COMPREHENSIVE SAFEGUARDS APPROACHES FOR NUCLEAR SUBMARINE ACQUISITION PROGRAMMES: AUKUS, PROSUB AND SOUTH KOREA

This paper proposes an outline for differentiated yet robust safeguards approaches for Australia's AUKUS, Brazil's PROSUB, and South Korea's projected nuclear submarine acquisition programme under their respective Article 14[30] (with reference to AUKUS and South Korea regarding non-application of safeguards) and Article 13[31] (with reference to "special procedures" in Brazil's PROSUB) safeguards arrangements. The basic provisions of Australia's and Brazil's respective safeguards agreements are essentially the same in scope and mandate, but there is a difference in the sequential numbering of the relevant paragraph covering the non-application of Agency safeguards. The proposed approaches refer to reporting and transparency measures, monitoring and accountability, and attempt to balance protection of classified military information with the IAEA's need to verify non-diversion of nuclear material, while setting high standards that discourage future proliferation risks.

Case 1: AUKUS SAFEGUARDS APPROACH (AUSTRALIA)

SSN Programme Characteristics

[27] International Atomic Energy Agency, *IAEA Safeguards Glossary : 2022 Edition*, INTERNATIONAL NUCLEAR VERIFICATION SERIES No. 3 (Rev. 1), Vienna, Austria: IAEA, October 2022, p.30, https://www-pub.iaea.org/MTCD/Publications/PDF/PUB2003_web.pdf

[28] Victor Bragin, John Carlson and Russell Leslie, "The categorisation of nuclear material in the context of integrated safeguards," Australian Safeguards and Non-Proliferation Office, Canberra, N.D, https://www.dfat.gov.au/sites/default/files/categ_numat_intsfgrds.pdf

[29] International Atomic Energy Agency, *IAEA Safeguards Glossary : 2022 Edition*, INTERNATIONAL NUCLEAR VERIFICATION SERIES No. 3 (Rev. 1), Vienna, Austria: IAEA, October 2022, p.30, https://www-pub.iaea.org/MTCD/Publications/PDF/PUB2003_web.pdf

[30] IAEA Information Circular, "THE STRUCTURE AND CONTENT OF AGREEMENTS BETWEEN THE AGENCY AND STATES REQUIRED IN CONNECTION WITH THE TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS," *INFCIRC/153 (Corrected),* June 1972, https://www.iaea.org/sites/default/files/publications/documents/infcircs/1972/infcirc153.pdf

[31] IAEA Information Circular, "AGREEMENT OF 13 DECEMBER 1991 BETWEEN THE REPUBLIC OF ARGENTINA, THE FEDERATIVE REPUBLIC OF BRAZIL, THE BRAZILIANARGENTINE AGENCY FOR ACCOUNTING AND CONTROL OF NUCLEAR MATERIALS AND THE INTERNATIONAL ATOMIC ENERGY AGENCY FOR THE APPLICATION OF SAFEGUARDS," *INFCIRC/435,* March 1994, https://www.iaea.org/sites/default/files/infcirc435.pdf

- **Fuel Type**: Highly enriched uranium (HEU) at weapon-grade (~93% to 97.3% U-235).
- **Reactor Design**: Sealed, lifetime-core S9G reactors (no refueling required).
- **Supply Chain**: Complete welded propulsion units from the United States and/or United Kingdom.
- **Timeline**: First US Navy *Virginia*-class submarines from early 2030s; UK's SSN-AUKUS from late 2030s.
- **Key Feature**: Australia committed to not enrich uranium, reprocess fuel, or to access reactor cores – but the question is whether such commitments can be reversed in the future?

A. Safeguards for the Pre-Transfer Phase (2025-2030s)

Material Accountability at Source

Objective: For the IAEA to establish baseline accounting before HEU nuclear fuel leaves US/UK custody and is loaded into the naval nuclear propulsion reactors that are then sealed – by the supplier (and by the IAEA?).

Proposed Measures to be Implemented by the IAEA:

- IAEA verification of HEU isotopic composition and quantities in reactor cores before sealing at reactor/SSN construction facilities.
- Non-destructive assay (NDA) measurements where technically feasible without compromising classified design.
- Photography and unique identification marking of sealed reactor units (by the IAEA would be desirable).
- Chain-of-custody documentation to be maintained from manufacture through transfer and installation.
- Environmental sampling at naval nuclear fuel manufacturing and assembly facilities (by the IAEA?).

Transfer Verification

Objective: For the IAEA to maintain continuity of knowledge during international transfer from nuclear-weapon state (NWS) supplier (US, UK) to NNWS recipient (Australia).

Measures:

- IAEA presence at loading and unloading operations of nuclear fuel and reactors.
- Verification of sealed reactor identification markers by the IAEA?

- Transport container seals applied jointly by supplier State and the IAEA?
- Real-time notification to the IAEA of transfer completion of nuclear fuel and reactors.
- Australia to declare to the IAEA receipt, jurisdiction and control of fuelled sealed naval nuclear propulsion reactor units under its Comprehensive Safeguards Agreement (CSA).
- Supplier State to declare to the IAEA transfer of fuelled sealed naval nuclear propulsion reactor units to Australia, pursuant it is Voluntary Offer Safeguards Agreement (US,32 UK33), and the IAEA voluntary reporting scheme (VRS).[34]

B. Safeguards for the SSN Operational Phase (30+ years)

Containment and Surveillance System

Objective: IAEA to verify that the reactor cores have remained sealed and no material diversion has occurred during the scheduled SSN maintenance and crew change port calls.

Measures:

- **Multi-layer seal system**: Application by the IAEA of tamper-indicating seals at multiple points on the reactor compartment?
- **Advanced seal technology**: Use of fibre-optic seals or electronic surveillance with encrypted data transmission by the IAEA?
- **Remote monitoring**: Installation of radiation monitors and environmental sensors at naval bases that transmit data continuously to IAEA (with appropriate time delays to protect operational information)?
- **Regular verification**: IAEA visual inspection of seals during scheduled maintenance and crew change port calls periods – minimum annually?

[32] IAEA Information Circular, "The Text of the Agreement of 18 November 1977 Between the United States of America and the Agency for the Application of Safeguards in the United States of America," *INFCIRC/288,* December 1, 1981, https://www.iaea.org/publications/documents/infcircs/text-agreement-18-november-1977-between-united-states-america-and-agency-application-safeguards-united-states-america

[33] IAEA Information Circular, "THE TEXT OF AN AGREEMENT BETWEEN THE AGENCY AND THE UNITED KINGDOM FOR THE APPLICATION OF SAFEGUARDS," *INFCIRC/175,* February 6, 1973, https://www.iaea.org/sites/default/files/publications/documents/infcircs/1973/infcirc175.pdf

[34] International Atomic Energy Agency, *IAEA Safeguards Glossary : 2022 Edition*, INTERNATIONAL NUCLEAR VERIFICATION SERIES No. 3 (Rev. 1), Vienna, Austria: IAEA, October 2022, p.15, https://www-pub.iaea.org/MTCD/Publications/PDF/PUB2003_web.pdf

Design Information Verification (DIV)

Objective: IAEA to confirm naval nuclear propulsion reactor design with information barrier to deter and prevent access to HEU without detection?

Measures:

- IAEA review of classified design with information barrier, data access at IAEA headquarters on a "need to know" basis at the Safeguards Department?
- Verification that accessing nuclear fuel would require cutting through hull and extensive SSN disablement?
- Confirmation that no refueling capability exists or would be set up in Australian facilities without prior communication to the IAEA and subject to Agency verification/monitoring?
- IAEA access to and review of SSN construction progress at Australian shipyards (for SSN-AUKUS) with appropriate information protection.

Facility Monitoring

Objective: Ensure that no undeclared activities related to fuel extraction or reprocessing are present in Australia.

Measures:

- **Naval base access**: Periodic complementary access given to IAEA to inspect HMAS *Stirling* and future Osborne Naval Shipyard under Australia's Additional Protocol (already occurring).
- **Environmental sampling**: IAEA collection of swipe samples during base visits to detect any fuel handling or enrichment activities.
- **No-notice inspections**: IAEA right to conduct short-notice inspections if concerns arise regarding facility misuse.
- **Spent fuel storage facilities**: Full IAEA access to any facilities designed for long-term storage of returned SSN reactor cores and spent nuclear fuel.

Declaration and Reporting

Objective: Maintain transparency and early warning of any programme changes – modified code 3.1 and related measures.

Measures:

- Advance declaration to the IAEA of submarine locations when in Australian territory.

- Notification of extended maintenance periods (>30 days) when seals could be verified by the IAEA.
- Annual reporting to the IAEA by Australia on submarine operational status and nuclear material accounting?
- Immediate notification to the Agency of any accidents, damage, or circumstances that could affect SSN reactor integrity.
- Declaration by Australia of all facilities related to SSN maintenance and support.

C. Safeguards for the Post-Operational Phase (End of Life)

Return and Disposal Verification

Objective: IAEA accountancy for all HEU through complete life cycle (up to or exceeding 33 years).

Measures:

- IAEA presence during SSN decommissioning preparations.
- IAEA verification of sealed reactor units before return for disposal to the US/UK.
- Re-verification by the IAEA of SSN reactor identification markers against original documentation.
- If SSN reactor disposal occurs in Australia: full pro-active IAEA oversight of spent fuel storage facilities with regular and short-notice inspections.
- Long-term IAEA monitoring arrangements for any radioactive waste repositories.

D. Institutional Arrangements

Information Protection Regime

Objective: Enable verification while protecting classified information – classification subject to discussion and agreement with the IAEA.

Measures:

- Establishment of a secure IAEA facility in Australia for handling classified design information.
- Security-cleared IAEA inspectors with appropriate security background checks – three-person access rule at all times, with different nationalities.

- Managed access procedures that allow verification without revealing SSN performance characteristics (speed, depth, acoustic signature, endurance).
- "Black box" approach: Agency focus on material accounting and seal integrity rather than on operational performance data.

Transparency and Confidence Building

Objective: Address international concerns and set a good example.

Measures:

- **Public reporting framework**: annual unclassified reports submitted by Australia to IAEA Board of Governors, supplemented by technical briefings, on safeguards implementation on SSN related activities.
- **Voluntary transparency measures**: Australia's continued engagement with regional partners through ASEAN Regional Forum and Pacific Islands Forum, including reporting during the NPT review process,
- **Peer review**: consider inviting independent technical experts to review safeguards approach adequacy – supplementary to SAGSI (IAEA Safeguards Advisory Group on Safeguards Implementation).
- Commitment that SSN reactor cores will never be opened in Australian territory.

Case 2: PROSUB SAFEGUARDS APPROACH (BRAZIL)

Programme Characteristics

- **Fuel Type**: Low enriched uranium (LEU) <20% U-235, potentially uranium metal.
- **Reactor Design**: Indigenous design requiring refueling (approximately 7-10 year or less cycles).
- **Supply Chain**: Entirely indigenous fuel cycle including enrichment and fuel fabrication.
- **Timeline**: Land-based prototype (*Labgene*)[35] under construction; Conventionally Armed Nuclear-Powered Submarine (SCPN) (Álvaro Alberto) expected 2030s.[36]

[35] Andre Magalhaes, "Amazul and Nuclep sign a contract to build a nuclear reactor," *Aeroflap,* October 17, 2019, https://www.aeroflap.com.br/en/amazul-and-nuclep-sign-a-contract-for-the-construction-of-a-nuclear-reactor/

[36] "Brazil's Nuclear-Powered Submarine Project Reaches New Milestone," *Naval News,* October 10, 2023, https://www.navalnews.com/naval-news/2023/10/brazils-nuclear-powered-submarine-project-reaches-new-milestone/

- **Key Challenge**: Indigenous enrichment creates greater proliferation pathway risks and safeguards implementation challenges for the IAEA and ABACC.

A. Safeguards for the Fuel Cycle Front-End Phase

Uranium Enrichment Facility Safeguards

Objective: IAEA (and ABACC) to verify that enrichment remains below 20% and to prevent HEU production capability.

Measures:

- **Enhanced monitoring at enrichment facilities, including**:
    - Continuous enrichment monitoring using online enrichment monitors (OLEM).[37]
    - Unattended monitoring systems with encrypted data transmission.
    - Environmental sampling at all enrichment locations.
    - Material balance verification at frequent intervals (monthly rather than annual).
- **Design information verification**: Full IAEA and ABACC access to centrifuge cascade designs and halls to verify technical inability to produce HEU at declared enrichment facilities.
- **Feed and product accountability**: Strict accounting of uranium hexafluoride (UF6) feed and LEU product with frequent PIV (physical inventory verification).
- **Limitation declarations**: Brazil to declare maximum enrichment capacity and submit to verification that enrichment above 20% would require facility modifications detectable by IAEA (and ABACC).

Fuel Fabrication Verification

Objective: IAEA (and ABACC) to confirm that LEU is converted to SSN fuel elements and accountancy for all nuclear material.

Measures:

- Safeguards on uranium metal or ceramic fuel production facilities (if metallic/ceramic fuel is used).
- Non-destructive assay of fuel elements before assembly.

[37] "IAEA, PNNL test new uranium enrichment monitor," *Nuclear Newswire,* January 16, 2026, https://www.ans.org/news/2026-01-16/article-7680/iaea-pnnl-test-new-uranium-enrichment-monitor/

- Unique serialization and identification of each fuel element.
- Full material accounting from enrichment through fuel fabrication.
- Video surveillance and containment/surveillance measures at fuel fabrication facilities.

B. Safeguards for the Land-Based Prototype Reactor Phase

Labgene (Land-Based Prototype) Safeguards

Objective: IAEA (and ABACC) to establish and implement verification procedures before SSN deployment.

Measures:

- **Design Information Verification**: IAEA and ABACC joint verification of SSN reactor design, already underway:
    - Review of classified reactor design in secure facilities.
    - Verification of fuel loading/unloading arrangements.
    - Confirmation of reactor operating parameters.
- **Fuel loading and unloading verification:**
    - IAEA/ABACC continuous presence during all fuel loading/unloading operations.
    - Item counting and identification verification of fuel elements.
    - Application of seals on SSN reactor vessel during operation.
    - Monitoring during all refueling operations with fuel element accountability.
- **Operational monitoring**:
    - Radiation monitors at facility perimeter.
    - Regular environmental sampling to verify no undeclared fuel cycle activities.
    - Unannounced inspections during prototype testing phase.
- **Safeguards by Design**: Incorporation of inspection provisions into *Labgene* construction plans (windows, access points, instrumentation ports, etc.).

C. Safeguards for the Submarine Construction Phase

Shipyard Safeguards

Objective: IAEA (and ABACC) to verify the design of the submarine construction while protecting classified design information.

Measures:

- IAEA/ABACC observation of submarine construction at intervals that verify design with information barrier.
- Verification that submarine design includes accessible reactor compartment hatch (critical for future inspections).
- Environmental sampling at construction facilities.
- Review of submarine design to confirm safeguard-ability (managed access approach).

D. Safeguards for the Submarine Operational Phase

Fuel Loading Verification

Objective: IAEA (and ABACC) accountancy for all LEU fuel entering submarine reactor unit.

Measures:

- IAEA/ABACC presence during initial fuel loading of submarine reactor.
- Verification of fuel element serial numbers against declared inventory.
- Item counting of all fuel elements.
- Photography and sealing of reactor compartment after loading.
- Documentation of fuel configuration in reactor core.

At-Sea and In-Port Verification

Objective: IAEA (and ABACC) to maintain continuity of knowledge without compromising submarine operations and performance.

Measures:

- **Seal system**:
    - Application of tamper-indicating seals on reactor compartment hatch when submarine is in port.
    - Electronic seals with data logging for periods between inspections.
    - Seal verification during every port call exceeding 7 days.

- **Periodic verification:**
    - IAEA/ABACC inspection of seals during routine maintenance periods.
    - Minimum quarterly verification when submarine is in Brazilian waters.
    - Annual comprehensive inspection including environmental sampling.
- **Radiation monitoring:**
    - Fixed radiation monitors at naval bases to detect any fuel removal or reprocessing activities.
    - Environmental sampling around submarine support facilities.
- **Operational declarations:**
    - Brazil to declare submarine location when in territorial waters (with appropriate time lag to protect operational security).
    - Notification of extended maintenance periods >30 days.
    - Advance notification of any refueling operations.

Refueling Operations Safeguards

Objective: IAEA (and ABACC) to account for spent fuel removal and fresh fuel insertion.

Measures:

- IAEA/ABACC mandatory continuous presence during all refueling operations.
- Verification of reactor hatch seal removal.
- Item counting and identification of spent fuel elements removed.
- Non-destructive assay of spent fuel where technically feasible.
- Verification of new fuel elements by serial number.
- Item counting of fresh fuel loaded.
- Re-sealing of reactor compartment after refueling completion.
- Chain of custody documentation for spent fuel transfer to storage.

E. Safeguards for the Spent Fuel Management

Spent Fuel Verification

Objective: Prevention of spent fuel reprocessing and plutonium extraction.

Measures:

- Spent fuel transferred to dedicated storage facility under full IAEA/ABACC safeguards.
- Continuous surveillance by IAEA/ABACC of spent fuel storage pool.
- Regular verification of spent fuel inventory.
- Seal and item counting verification for all spent fuel assemblies.
- Unannounced inspection right at spent fuel facilities.
- Brazil to declare it will not reprocess spent fuel (already committed).
- Environmental sampling to verify no reprocessing activities.

F. Additional Protocol Implementation

Addressing the Additional Protocol Gap

Objective: Provide IAEA with tools to detect undeclared activities.

Critical Recommendation: Brazil should ratify the Additional Protocol to its IAEA safeguards agreement.

Measures (under Additional Protocol):

- Expanded declaration of nuclear-related activities, facilities, and locations.
- IAEA complementary access to any location to resolve questions about undeclared material or activities.
- Enhanced information on nuclear fuel cycle research and development.
- Information on uranium mining and processing.
- Manufacturing and export of specified equipment and non-nuclear material.

Alternative (if Additional Protocol *not* adopted):

- Expanded subsidiary arrangements with specific provisions for:
    - IAEA access to any facility related to submarine programme.
    - Environmental sampling at any location where nuclear activities might occur.
    - Brazil's declaration of all uranium mining, processing, and enrichment activities.
    - Export controls verification in cooperation with Nuclear Suppliers Group commitments.

Case III. REPUBLIC OF KOREA: NAVAL NUCLEAR PROPULSION

On 29 October 2025, US President Donald J. Trump in a post announced that he had authorised that the Republic of Korea (ROK) would be constructing nuclear-powered submarines in the Philadelphia Shipyards in the United States which were acquired by the South Korean defence firm Hanwha late in 2024.[38]

A White House Joint Fact Sheet of 13 November 2025, *inter alia* stated: "Consistent with the bilateral 123 agreement and subject to US legal requirements, the United States supports the process that will lead to the ROK's civil uranium enrichment and spent fuel reprocessing for peaceful uses".[39] Later in November 2025,[40] South Korea's government announced that it had finalised an agreement to build nuclear-powered submarines in partnership with the United States.[41]

While President Trump's announcement referenced nuclear propulsion technology sharing, South Korea may not acquire *Virginia*-class submarines directly but may adapt South Korea's existing KSS-III diesel-electric submarine platform for nuclear propulsion – the Jang Yeong-sil Batch II variant of the *Dosan Ahn Chang-ho* class.[42] South Korea claims to have launched a conventionally-armed ballistic missile from a Batch I boat, and Batch II boats reportedly also will have this capability.[43]

A nuclear-powered *KSS-III* variant[44] would displace at least 5,000 tons according to Admiral Kang Dong-il, Chief of Naval Operations of South Korea's navy, making it comparable in size to France's *Suffren*-class[45] (5,300 tons) but smaller than the UK's Astute-class (7,400 tons). The *KSS-III* platform's existing 89-metre hull provides

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[38] "Donald Trump says South Korea can build nuclear-powered submarines in US," *Financial Times,* October 29, 2025, https://www.ft.com/content/a6ee6741-5a66-41b1-80b6-5e01e4a823a5

[39] The White House, "Joint Fact Sheet on President Donald J. Trump's Meeting with President Lee Jae Myung," November 13, 2025, https://www.whitehouse.gov/fact-sheets/2025/11/joint-fact-sheet-on-president-donald-j-trumps-meeting-with-president-lee-jae-myung/

[40] "South Korea has reached an agreement with the U.S. to begin the future development of its new nuclear submarines" *Zona Militar,* November 17, 2025, https://www.zona-militar.com/en/2025/11/17/south-korea-has-reached-an-agreement-with-the-u-s-to-begin-the-future-development-of-its-new-nuclear-submarines/

[41] Richard Thomas, "Is South Korea going to get a Virginia-class nuclear submarine?" *Naval Technology,* October 30, 2025, https://www.naval-technology.com/news/is-south-korea-going-to-get-a-virginia-class-nuclear-submarine/

[42] Thomas Newdick, "South Korea Has Launched Its Most Advanced Submarine Ever," *The TWZ Newsletter,* October 23, 2025, https://www.twz.com/air/south-korea-has-launched-its-most-advanced-submarine-ever

[43] Thomas Newdick, "South Korea Successfully Launches Ballistic Missile From Its New Submarine: Report," *The TWZ Newsletter,* September 7, 2021, https://www.twz.com/42272/south-korea-successfully-launches-ballistic-missile-from-its-new-submarine-report

[44] "The construction of the first of the South Korean Navy's new KSS-III Batch-III nuclear-powered submarines would begin in 2028," *Zona Militar,* February 12, 2026, https://www.zona-militar.com/en/2026/02/12/the-construction-of-the-first-of-the-south-korean-navys-new-kss-iii-batch-iii-nuclear-powered-submarines-would-begin-in-2028/

[45] NTI Factsheet, "France Submarine Capabilities," *Nuclear Threat Initiative,* November 14, 2025, https://www.nti.org/analysis/articles/france-submarine-capabilities/

sufficient space for reactor installation, similar to how France's *Rubis*-class[46] achieved nuclear propulsion in a compact 74-metre, 2,600-ton design, fuelled with low enriched uranium (estimated 6% to 7.5% LEU).

Admiral Kang Dong-il has indicated South Korean submarines will use low-enriched uranium (20% or lower) to power vessels of at least 5,000 tons displacement.[47] Defence Minister Ahn Gyu-back confirmed plans call for South Korea to build its own submarines and modular reactors and receive a supply of enriched uranium fuel from the United States.[48] However, this is easily said than done, as is shown by Brazil's nearly three decade long endeavour to develop and launch a nuclear-powered submarine.

This approach potentially offers some strategic advantages. LEU/HALEU[49] (high-assay LEU) fuel avoids the proliferation concerns associated with weapon-grade HEU and aligns with France's proven model of successful LEU-fueled naval reactors operating for over 30 years with interval refuelling. Periodic refueling (every 7-10 years or less), increases lifecycle costs and maintenance downtime, and has adverse effects on the submarine's acoustic signature. HALEU (5% to 19.9% high-assay LEU) commercial supply chain of the US CENTRUS facility delivered 900 kg of HALEU to the Department of Energy in 2025.[50]

The following discussion covers the required desired elements for South Korea's acquisition programme concerning the design, construction, and operation of nuclear-powered attack/missile submarines (SSNs/SSGNs).

[46] "SSN Rubis Amethyste Class," *Naval Technology,* May 3, 2001, https://www.naval-technology.com/projects/rubis/

[47] Robert McKinnon, "Seoul's Nuclear Submarine Breakthrough," *GMF,* November 4, 2025, https://www.gmfus.org/news/seouls-nuclear-submarine-breakthrough; "S. Korea likely needs 10 years to build nuclear-powered sub: Navy chief," *Yonhap,* October 30, 2025, https://www.koreatimes.co.kr/southkorea/defense/20251030/s-korea-likely-needs-10-years-to-build-nuclear-powered-sub-navy-chief

[48] Josh Smith, David Brunnstrom and Costas Pitas, "Trump says South Korea has approval to build nuclear-powered submarine," *Reuters,* October 30, 2025, https://www.reuters.com/world/china/trump-says-south-korea-has-approval-build-nuclear-powered-submarine-2025-10-29/

[49] "High-Assay Low-Enriched Uranium," *Centrus Energy Corp,* N.D, https://www.centrusenergy.com/what-we-do/nuclear-fuel/high-assay-low-enriched-uranium/

[50] Centrus Energy Corp, "Centrus Achieves Key Production Milestone with Delivery of 900 Kilograms of HALEU to the Department of Energy," June 25, 2025, https://www.centrusenergy.com/news/centrus-achieves-key-production-milestone-with-delivery-of-900-kilograms-of-haleu-to-the-department-of-energy/

Programme Objectives

1. Establish joint production capacity for nuclear-powered attack submarines at US shipyards for both US Navy (USN) and ROK Navy (ROKN) requirements.
2. US transfer of naval nuclear propulsion technology to South Korea under strict non-proliferation safeguards and/or indigenous development of naval nuclear propulsion reactor and fuel.
3. Develop South Korean indigenous SSN/SSGN construction capability.
4. Maintain highest standards of nuclear safety, security, and non-proliferation compliance.

Proposed Programme Structure (US-based)

Phase I: US Construction Programme (Years 1-8)

Initial Construction Phase

Construction of nuclear-powered attack submarines by South Korean naval constructors at designated US shipyards (Electric Boat Corporation, Groton, Connecticut, General Dynamics NASSCO, with potential expansion to Huntington Ingalls Industries, Newport News Shipbuilding, and Hanwha Philly Shipyard)[51]:

- Three (3) Virginia-class Block VI submarines for the US Navy.
- Two (2) modified *Virginia*-class submarines for Republic of Korea Navy, incorporating Korean-specific systems and requirements.
- Estimated timeline: 30-36 months per boat, with staggered construction schedule.
- Technology transfer protocols for SSN sensitive information.

Technology Transfer and Capability Development (Years 5-15)

Nuclear Propulsion Technology Package

Transfer of naval nuclear propulsion technology, including:

- S9G naval nuclear reactor design specifications and operational parameters (classified transfer).
- Highly enriched uranium (HEU at 93% to 97.3%) fuel assembly technology and manufacturing processes.

[51] "Donald Trump says South Korea can build nuclear-powered submarines in US," *Financial Times,* October 29, 2025, https://www.ft.com/content/a6ee6741-5a66-41b1-80b6-5e01e4a823a5

- Naval nuclear reactor safety systems, control mechanisms, and emergency protocols.
- Radiation shielding and containment technologies.
- Maintenance, refueling, and lifecycle management protocols.

SSN/SSGN Infrastructure Development in South Korea

- Construction of specialised nuclear submarine maintenance and support facility at designated ROKN base (proposed location: Jeju Naval Base or expansion of existing facilities).[52]
- Establishment of Korean Naval Nuclear Reactor Programme administrative and oversight organisation.
- Development of naval nuclear fuel handling, storage, and security infrastructure.

South Korean Indigenous Construction (Years 10-25)

- Construction of nuclear-powered submarines at South Korean shipyards (Hyundai Heavy Industries, or Hanwha Ocean).
- Initial SSNs incorporating US-manufactured naval nuclear reactors with South Korean-built hull and control systems and/or indigenous development of naval nuclear propulsion reactor and fuel.
- Progressive integration of South Korean-manufactured naval nuclear reactor components under US Naval Reactors quality assurance programme.
- Target: Four (4) additional nuclear-powered submarines for ROKN, bringing total fleet to six (6) SSNs by 2045 or later.

[52] Joshua Namtae Park, "South Korea's New Naval Base Throws a Jab, But Should Train for a Haymaker," *War on the Rocks,* July 17, 2025, https://warontherocks.com/2025/07/south-koreas-new-naval-base-throws-a-jab-but-should-train-for-a-haymaker/

Safeguards Arrangements

Nuclear Material Accountability

- All enriched uranium (LEU/HALEU/HEU) for naval propulsion purposes shall be removed from IAEA safeguards for the duration of its use in naval nuclear propulsion, consistent with Article 14 provisions of South Korea's NPT comprehensive safeguards agreement.[53]
- Comprehensive accounting and reporting to IAEA of quantities and enrichment levels of all nuclear material designated for naval propulsion.
- Nuclear material for naval nuclear propulsion shall be clearly identified, measured, and tracked through the lifecycle from production to fuel assemblies, and after end of life of SSNs/SSGNs for disposition.
- Spent fuel management protocols ensuring return to safeguards upon removal from SSNs/SSGNs or suitable disposition under IAEA safeguards.

Verification and Inspection Protocols

- **Baseline Declaration:** South Korea shall provide comprehensive initial declaration to IAEA including isotopic composition and total quantities of nuclear material to be removed from safeguards, enrichment specifications, projected timelines, and intended uses.
- **Annual Reporting:** Submission of detailed annual reports on status of nuclear material in naval propulsion programme, current inventory, and projections.
- Supplier State to declare to the IAEA transfer of naval nuclear fuel to South Korea, pursuant it is Voluntary Offer Safeguards Agreement (US)[54], and the IAEA voluntary reporting scheme (VRS).[55]

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[53] IAEA Information Circular, "Text of the Agreement of 31 October 1975 Between the Republic of Korea and the Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons" *INFCIRC/236,* October 31, 1975, https://www.iaea.org/publications/documents/infcircs/text-agreement-31-october-1975-between-republic-korea-and-agency-application-safeguards-connection-treaty-non-proliferation-nuclear-weapons

[54] IAEA Information Circular, "The Text of the Agreement of 18 November 1977 Between the United States of America and the Agency for the Application of Safeguards in the United States of America," *INFCIRC/288,* December 1, 1981, https://www.iaea.org/publications/documents/infcircs/text-agreement-18-november-1977-between-united-states-america-and-agency-application-safeguards-united-states-america

[55] International Atomic Energy Agency, *IAEA Safeguards Glossary : 2022 Edition*, INTERNATIONAL NUCLEAR VERIFICATION SERIES No. 3 (Rev. 1), Vienna, Austria: IAEA, October 2022, p.15, https://www-pub.iaea.org/MTCD/Publications/PDF/PUB2003_web.pdf

- **Design Information Verification:** Provision of design information for facilities involved in naval nuclear fuel fabrication, storage, and handling to enable IAEA verification activities.
- **Complementary Access:** IAEA shall maintain right to complementary and managed access to relevant facilities and locations to verify consistency with peaceful naval propulsion purposes.
- **Environmental Sampling:** IAEA environmental sampling at designated locations to ensure non-diversion of nuclear material.

Non-Diversion Assurances

The Republic of Korea to provide the following binding commitments:

- Nuclear material removed from safeguards shall be used exclusively for naval nuclear propulsion and no other purpose.
- No nuclear material designated for naval propulsion shall be diverted for nuclear weapons or other nuclear explosive devices.
- Upon decommissioning or removal from service of SSNs/SSGNs, nuclear material shall be returned to IAEA safeguards or disposed of under international verification.

Legal Frameworks for AUKUS, PROSUB and South Korea

- **Nuclear-Powered Submarine Cooperation Framework Agreements:** Comprehensive treaty between suppliers and recipients (AUKUS and South Korea respectively) establishing programme scope, responsibilities, governance structures, involvement with the IAEA, and general provisions
- **Nuclear Technology Transfer Agreements:** Specific agreements under Section 123 of US Atomic Energy Act covering terms and conditions for transfer of naval nuclear propulsion technology and nuclear fuel (AUKUS and South Korea).
- **IAEA Safeguards Arrangements:** Establishment of clear, specific, and transparent foundational arrangements on interpretation and implementation of the "loop hole" in the IAEA comprehensive safeguards framework (INFCIRC/153[56] and INFCIRC/435[57]) on non-application of safeguards to naval

[56] IAEA Information Circular, "THE STRUCTURE AND CONTENT OF AGREEMENTS BETWEEN THE AGENCY AND STATES REQUIRED IN CONNECTION WITH THE TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS," *INFCIRC/153 (Corrected),* June 1972, https://www.iaea.org/sites/default/files/publications/documents/infcircs/1972/infcirc153.pdf

[57] IAEA Information Circular, "AGREEMENT OF 13 DECEMBER 1991 BETWEEN THE REPUBLIC OF ARGENTINA, THE FEDERATIVE REPUBLIC OF BRAZIL, THE BRAZILIANARGENTINE AGENCY FOR ACCOUNTING AND CONTROL OF NUCLEAR MATERIALS AND THE INTERNATIONAL ATOMIC ENERGY

nuclear propulsion that have been developed and agreed in advance by IAEA Member States and specific umbrella safeguards procedures authorised by the Agency's Board of Governors. Respective subsidiary and facility attachment arrangements covering naval nuclear propulsion to be concluded between the IAEA and respectively Australia,[58] Brazil[59] and South Korea[60] that would remain safeguards confidential.

AGENCY FOR THE APPLICATION OF SAFEGUARDS," *INFCIRC/435,* March 1994, https://www.iaea.org/sites/default/files/infcirc435.pdf

[58] IAEA Information Circular, "The Text of the Agreement Between Australia and the Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons," *INFCIRC/217,* December 13, 1074, https://www.iaea.org/publications/documents/infcircs/text-agreement-between-australia-and-agency-application-safeguards-connection-treaty-non-proliferation-nuclear-weapons

[59] IAEA Information Circular, "AGREEMENT OF 13 DECEMBER 1991 BETWEEN THE REPUBLIC OF ARGENTINA, THE FEDERATIVE REPUBLIC OF BRAZIL, THE BRAZILIANARGENTINE AGENCY FOR ACCOUNTING AND CONTROL OF NUCLEAR MATERIALS AND THE INTERNATIONAL ATOMIC ENERGY AGENCY FOR THE APPLICATION OF SAFEGUARDS," *INFCIRC/435,* March 1994, https://www.iaea.org/sites/default/files/infcirc435.pdf

[60] IAEA Information Circular, "Text of the Agreement of 31 October 1975 Between the Republic of Korea and the Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons" *INFCIRC/236,* October 31, 1975, https://www.iaea.org/publications/documents/infcircs/text-agreement-31-october-1975-between-republic-korea-and-agency-application-safeguards-connection-treaty-non-proliferation-nuclear-weapons

ANNEXES

Annex A: Technical Specifications Summary (AUKUS and South Korea)

Submarine Class: Modified *Virginia*-class Block VI (US vessels) / AUKUS / ROK-*Virginia* variant (South Korean boats) and/or *Jang Yeong-sil* Batch II boats.

Propulsion: *Virginia*-class**:** S9G pressurised water reactor, high density HEU reactor core, ~500 MWt (about 165 MWe); *Jang Yeong-sil* Batch II (estimates based on French naval nuclear reactor technology)[61] LEU/HALEU reactor core?, ~48MWt-150 MWt (~14.4 MWe to ~48M MWe).

Nuclear Fuel: *Virginia*-class: **HEU ~2000 kg per boat** (up to 93% to 97.3% U235) life time core (~33 years); *Jang Yeong-sil* Batch II (estimates based on French naval nuclear reactor technology) **LEU ~180 kg to 300 kg per boat**? (~6% to -7% LEU, HALEU?

Armament: *Virginia*-class**:** Mk 48 heavyweight torpedoes, Tomahawk cruise missiles (subject to bilateral agreement), vertical launch system (VLS); *Jang Yeong-sil* Batch II VLS cruise and ballistic missiles.

Annex B: Safeguards Declaration Template

Article 1: Scope of Declaration

The Republic of Korea declares its intention to remove from IAEA safeguards specified quantities of nuclear material for use in naval nuclear propulsion in accordance with Article 14 of its Comprehensive Safeguards Agreement.

Article 2: Material Specifications

Total quantity of highly enriched uranium: [Specified in sealed annex] Enrichment level: [93% to 97.3%, and/or 6% to 19.9%] [Specified in sealed annex] Physical form: Reactor fuel assemblies Intended use: Naval nuclear propulsion exclusively

Article 3: Non-Diversion Commitments

The Republic of Korea commits that nuclear material removed from safeguards shall be used only for naval nuclear propulsion and shall not be diverted for nuclear weapons or other nuclear explosive devices or for any other military purpose.

Article 4: Return to Safeguards

Upon removal from submarines or cessation of use for naval propulsion, nuclear material shall be returned to IAEA safeguards or disposed of under appropriate international verification measures.

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[61] NTI Factsheet, "France Submarine Capabilities," *Nuclear Threat Initiative,* November 14, 2025, https://www.nti.org/analysis/articles/france-submarine-capabilities/

Annex C: Safety and Security Standards Matrix

Detailed safety and security standards incorporating IAEA Safety Standards, US Naval Reactors requirements, Korean national regulations, and international best practices (detailed technical specifications to be developed during implementation phase).

Annex D: Training and Qualification Requirements

Comprehensive training curriculum for nuclear-qualified officers, engineering personnel, and crew members. Programmes include academic instruction in nuclear engineering, reactor operations training at prototype facilities, operational training aboard US submarines, simulator training for emergency procedures, and continuous professional development throughout career.

Annex E: Environmental Impact Assessment Framework

Framework for comprehensive environmental impact assessments covering facility construction, operational impacts, radioactive waste management, decommissioning planning, and public health protection measures.

About the Author

Tariq Rauf is former Head of Verification and Security Policy, reporting to the Director General, at the International Atomic Energy Agency. He has been following the matter of naval nuclear propulsion and its impact on IAEA safeguards since 1987.

ABOUT APLN

The Asia-Pacific Leadership Network (APLN) is an independent, not-for-profit organisation and network of over 170 former, serving and emerging political, military, diplomatic and academic leaders from 24 countries across the Asia-Pacific, registered and headquartered in Seoul, South Korea. APLN's work addresses regional defence and security challenges with a particular focus on reducing nuclear weapons risks.

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