

Technical Review of Fuel Assurance Proposals

Presentation at the

**IAEA Special Event on: “New Framework for the
Utilization of Nuclear Energy in the 21st Century:
Assurance of Supply and Nonproliferation”**

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| | Multilateral Approaches INFCIRC/640 | Russian Nuclear Centers | U.S. GNEP Initiative | WNA Proposal | Six Countries Proposal |
|-----------------------------|--|---|--|--|---|
| Problem to be Solved | Replacing National Facilities with Regional Fuel Center Facilities | Giving Up Sensitive National Fuel Cycle Facilities | Giving Up Sensitive National Fuel Cycle Facilities | Disrupted Enrichment, Reprocessing Contracts | Disrupted Enrichment Contracts |
| What is Assured | Spent Fuel Storage, Front End Supply | Front End Supply, possibly Back End Services | Front End Supply, Ultimately Spent Fuel Take-Back | Enrichment Services, Access to Reprocessing | Enrichment Services (Reprocessing) |
| Assurance Mechanism | Multilateral Nuclear Fuel Cycle Centers | Russian Enrichment Facilities | U.S. Provided Diluted HEU – Fuel Bank | Collective Suppliers Guarantee, IAEA Stockpile | Backup Commercial Contracts |
| Eligibility | Regional States Agreeing to Participate in Regional Center | NWS- Designated - IAEA Approved | NWS- Designated - IAEA Approved | IAEA Approved Meeting All NPT Obligations | IAEA Approved Meeting All NPT, Obligations |
| Practical Aspects | Defining Functional Role, Facilities to be Used | Solution to Iran Problem as Model for Center Implementation | Depends on Future Administration, Tie-in with Tech. Programs | Implementing Suppliers Collective Guarantee, IAEA Stockpile Back-up of Last Resort | Switch Commercial Contracts to Other Willing Enrichers, |
| Role of IAEA | Fostering Regional Fuel Cycle Center Agreements, Safeguards | Management, Approvals, Safeguards | Approvals, Safeguards | Approve Triggering of Collective Suppliers Guarantee, Manage Backup Stockpile | Approve Transfer of Commercial Contracts to Other Enrichers |
| Role of Industry | Managing, Operating Centers | Performing Fuel Services at Designated Center | Perform Fuel Services per USG Instructions | Perform Enrichment, Reprocessing Contracts | Perform Enrichment Contracts |

What “Problems” are being Addressed by Establishment of Assurance of Supply Mechanism?

- **Three types of problems could be solved:**
 - **Provision of additional measures of nuclear supply assurance, ‘Supply of Last Resort’, to countries seeking incremental new supply guarantees**
 - **Measures of compensation to countries willing to give up sensitive fuel cycle facilities**
 - **Guaranteed fuel Reloads held in escrow by IAEA for specific ‘crisis’ countries (e.g. Iran, DPRK) as part of comprehensive nonproliferation resolution of conflicts**
- **In each case there exist different motivations for, sponsors of, IAEA fostered fuel assurance programs**
- **Different emphasis IAEA assurance programs may be tailored for three different user country groups**
- **Basic question – who is interested in implementing supply assurance proposals: suppliers or prospective users?**

What Type of Nuclear Fuel is being Assured?

- **Reactor fuel elements vary in terms of pellet, rod, assembly, design, fuel composition, position within reactor core**
- **It might be costly, impractical, for suppliers, IAEA, to maintain stockpiles of fabricated fuel assemblies due to design variations**
- **Stockpile of natural Uranium oxide – U_3O_8 or UO_2 might represent inadequate assurance for users, as it still requires conversion, enrichment, fabrication – steps that could also be disrupted**
- **Low Enriched Uranium (LEU) in UF_6 or UO_2 forms, coupled with IAEA ‘Fabrication Credits’ Promissory Notes Guarantee provides flexible assurance**
- **Useful assurance mechanism – Six Countries proposal, backed-up with IAEA Physical supply of LEU, coupled with IAEA-issued ‘Fabrication Credits’**
- **IAEA-controlled LEU stockpile, fabrication services obligations, could be managed in Russian Center, in U.S. GNEP program site**

Modalities of Possible Fuel Assurance Mechanisms – Virtual Supplies

- **Different types of fuel supplies could be made available for IAEA-managed supply assurance programs as Virtual or Physical Supplies**
- **Under Virtual Supply Assurance programs IAEA will issue ‘Nuclear Fuel Credits’ (NFCs) Promissory Notes, patterned after Special Drawing Rights (SDRs)**
- **Each ‘Credit’ Note gives holders right to obtain specified amounts (MTHM?) of particular type of fuel service, at commercial prices, from suppliers designated by the IAEA**
- **IAEA could issue three different types of NFC Promissory Notes:**
 - **Enrichment Credits**
 - **Conversion Credits**
 - **Fabrication Credits**
- **Implementation of ‘Credits’ notes program depends on users preferences, suppliers willingness, as communicated to IAEA**

Possible Fuel Assurance Mechanisms – Virtual Supplies – Nuclear Fuel Credits

- **‘Nuclear Fuel Credits’ system be backed up by extensive set of agreements between IAEA, NSG, corporate suppliers, suppliers’ host countries**
- **Fuel, services, to be provided based on IAEA NFC Note will be delivered to user at a time agreed upon between user, IAEA, designated supplier, at commercial prices**
- **Who has legal obligation to supply fuel, services, promised under NFCs fuel assurance programs?**
 - **IAEA which issues NFC Notes**
 - **Nuclear fuel suppliers under basic ordering agreements with IAEA**

Modalities of Possible Fuel Assurance Mechanisms –Physical Supplies

- **Most flexible nuclear fuel form to be held under IAEA control is LEU in UF₆ or UO₂ forms**
- **LEU to be provided from diluted HEU promised by U.S. with matching promise by Russia – Suffice for ~ 10 ALWRs for 6 reloads**
- **Physical inventory, under IAEA control could be held:**
 - **In provider countries' sites under IAEA safeguards**
 - **In sites located at neutral 'Third Party' nuclear countries, e.g. Switzerland, Sweden, Finland**
- **Inventory to be held in 'Third Party' countries could be located in secured sites such as national nuclear research center sites (Similar to Korean Nuclear Fuel Services (KNFS) plant located at KAERI site in Taejon)**
- **Since different reactors might require different enrichment levels, it may be impractical to keep separate inventories at all possible enrichment levels**

Possible Fuel Assurance Mechanisms – Physical Supplies – Fuel Blending

- **LEU might be kept at baseline enrichment level, & specific amounts further blended, to meet user requirements**
- **Two Baseline enrichment ranges possible:**
 - **High LEU – Baseline supply at about 10 Percent U-235 - to be down-blended to user specifications**
 - **Low LEU – Baseline supply at about 3 Percent U-235 – to be up-blended to user specifications**
- **High LEU supply easier to further down-blend, however may not be acceptable on nonproliferation concerns**
- **Low-LEU supply acceptable on nonproliferation grounds, however represents significant entropy waste, higher costs**
- **Up-blending of Low-LEU could be accomplished in ‘Third Party’ country facilities, with small amount of required HEU flown in from supplier country just prior to blending**

Nuclear Fuel Supply Assurance Mechanisms – Need for Users Inputs

- **Nuclear fuel supply assurance proposals reviewed here seem to be made by suppliers, presumably for the benefit of various users communities**
- **No information on users perspectives regarding these proposals is available**
- **Industrializing countries contemplating nuclear power seem more interested in building their own domestic fuel cycle facilities**
- **Perceptions, strengthened by Iran's nuclear crisis, that supply assurance measures are guise for facilities, technologies, denial in contravention of NPT Article IV, are meant to maintain current suppliers' monopolistic positions for political, commercial, purposes**
- **Potential 'crisis of confidence' between users and suppliers states might emerge. Half-hearted nuclear fuel supply assurance measures might not be sufficient to counteract such concerns**
- **To dispel such perceptions it is important to:**
 - **Involve prospective users in decisions on types of proposed programs**
 - **Implement near-term proposals that will demonstrate realizable, significant, supply assurance benefits to users**
 - **Reliability of supply has political dimensions that extends beyond backup commercial contracts. These will have to be addressed**

Nuclear Fuel supply Assurance Mechanisms

– Three Tiers of Problems and Solutions

Problems

Solutions

Nonproliferation

UNSC, IAEA, NSG



Political

State to IAEA Agreements

State to State Agreements



Commercial →

Supplier to Supplier

Supplier to Utility

Nuclear Fuel Supply Assurance - Sequence of Implementation

- **Possible sequence of implementation includes:**
 - **Start with Six Countries Proposal for IAEA-managed mechanism for contracts transfers among suppliers in case of specific contract disruption**
 - **Launch Russian enrichment/fabrication center for countries approved by IAEA**
 - **U.S./IAEA define, demonstrate in practice, benefits package to be handed, in part under IAEA control, to user country giving up national fuel cycle facility – international element of GNEP – funded by U.S.**
 - **Develop IAEA role as controller of ‘Nuclear Fuel Bank’ supplier of last resort, based on LEU contributed by NWS**
 - **Evolve IAEA role as provider of Nuclear Fuel Credits back-up supply guarantees**
 - **Encourage tie-in of reactor order and fuel cycle supply packages coupled with IAEA back-up assurance mechanism**
 - **Encourage suppliers (besides Russia) to implement spent fuel take-back programs**
 - **Seek opportunities for implementing regional fuel cycle centers providing back-end services (Spent fuel storage) with guaranteed suppliers’ fuel transfer consent**
- **Consult with user country groups on implementation of the above**

What might Assuring Access to Reactor Technology Entail in Practice?

- **Should IAEA wish to actively control nuclear fuel supply assurance programs, then IAEA might have to function like a supplier. To that purpose, the IAEA should establish separate Corporation, in order to:**
 - **Manage the entire operation (Assuming greater management experience than in IAEA)**
 - **Provide fuel assurance guarantees, if applicable**
 - **Issue ‘Nuclear Fuel Credit’ Notes, if applicable**
 - **Provide on-time performance warranties, if appropriate**
 - **Negotiate supply terms with various industrial corporations, host countries, NSG, etc.**
 - **Manage escrow inventories of fabricated fuel assemblies for special case countries (Possibly to be held in ‘Third Party’ country sites)**
 - **Manage financial resources required to:**
 - **Pay for suppliers’ incremental inventory shares**
 - **Establish financial escrow accounts as additional guarantee of performance**
 - **Pay performance damages, if accrued**
 - **Shield the IAEA from legal damages (disgruntled suppliers, damaged users)**

What Would Be the Role of the IAEA?

- **IAEA prospective role in nuclear fuel supply assurance will depend on following factors:**
 - **Actual revival of nuclear power & worldwide growth**
 - **User countries interest in IAEA assuming proactive role in fuel supply assurance on their behalf**
 - **Authority & control of physical supplies ceded to IAEA by NWS**
 - **IAEA willingness to assume active role in supply assurance matters, acting as ‘supplier of last resort’**
 - **IAEA managerial/technical capabilities in controlling such enterprise (Handing over management role to Corporation?)**
 - **Adequate financial resources allocated to this IAEA function**
- **Time will tell if this window of opportunity has been effectively used**