# Non-Proliferation Challenges in Connection with Magnetic Fusion Power

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**Richard Kamendje**

IAEA

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# OUTLINE

- Background
- Objectives
- Findings & Recommendations

# BACKGROUND SITUATION ANALYSIS

- ITER construction is on-going
- Worldwide magnetic fusion programme is in a transition to one increasingly focused on the production of fusion energy on an industrial, power plant scale
- Many countries are independently developing programme plans and initiating new R&D activities leading to a demonstration of fusion energy's readiness for commercialization
- Advances in the understanding of non-proliferation aspects of magnetic fusion energy have resulted in the need for further analysis and dialogue

# PROLIFERATION RISKS OF MAGNETIC FUSION

- The nuclear weapons proliferation risks associated with magnetic fusion power plants are real but are likely to be controllable
- These risks fall into three categories:
  - Knowledge transfer
  - Fissile Material production
  - Tritium diversion
- Research facilities are likely to be a greater proliferation concern than power plants
- There is scope to add value by considering international engagement

# CANDIDATE PROLIFERATION SCENARIOS

1. Covert diversion of weapons-usable material from a fusion (power) plant, including their covert production in the case of fissile materials
2. Clandestine operation of a fusion system for production of weapons materials
3. Rapid turnaround of a fusion (power) plant for production of weapons materials

# KEY STRATEGIC ISSUES

a) How and whether to evaluate or consider measures on ITER Test Blanket Modules, taking into account both scenarios 1) and 3)

b) Tritium accountability issues for fusion power plants: economic, loss or theft, quality control, might safeguards ever be necessary?

c) The possibility of small-scale, potentially clandestine, fusion-based technologies for the production of weapons materials.

d) The Treaty on the Non-Proliferation of Nuclear Weapons.

# OBJECTIVES OF THE CONSULTANCY

- Bring together a group of fusion scientists and engineers and non-proliferation experts to meet with members of the IAEA Safeguards Department, and discuss non-proliferation aspects of magnetic fusion energy
- Elaborate experts' views on ideas and opportunities in the key strategic issues including coordinated approaches
- Contribute to improving the understanding of non-proliferation
- Contribute to improving the understanding of capabilities of fusion systems (existing and projected)

# PARTICIPANTS

| | | | |
|---|---|---|---|
| **Englert** | Matthias | Germany | IANUS |
| **Franceschini** | Giorgio | Germany | Peace Research Institute |
| **Glaser** | Alexander | USA | Princeton University |
| **Glugla** | Manfred | ITER | ITER Organization |
| **Goldston** | Robert | USA | PPPL |
| **How** | John | France | |
| **Konishi** | Satoshi | Japan | Institute of Advanced Energy, Kyoto University |
| **Liebert** | Wolfgang | Austria | Institute of Safety/Security and Risk Sciences (ISR) |
| **Wallace** | Richard | USA | LANL |
| **Catton** | Andrew | IAEA | |
| **Kamendje** | Richard | IAEA | |
| **Sprinkle Jr** | James Kent | IAEA | |
| **Suseanu** | Ionut | IAEA | |
| **Tuley** | John Neil | IAEA | |
| **Venkatesh** | Meera | IAEA | |
| **Whichello** | Julian | IAEA | |

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# EXECUTIVE SUMMARY

- As a Consultative Group, the fusion scientists and engineers and non-proliferation experts came to unanimously agreed high-level findings and recommendations that are hoped to be useful to the IAEA in its forward planning, and give rise to practical near-term actions

# KEY POINTS – I : COMMUNICATION

- Allowed fusion community to gain a better understanding of the IAEA safeguards regime.
- Allowed IAEA safeguards community to gain a better understanding of the properties of magnetic fusion systems.
- Facilitated broad discussion of key non-proliferation issues associated with magnetic fusion.
- It is recommended that this kind of cross-fertilization continues through the forum of the annual IAEA DEMO Programme Workshops.
- This could evolve into discussions of how to integrate appropriate monitoring strategies most effectively into future fusion power systems.

# KEY POINTS – II : LEGAL FRAMEWORK

- While fusion power plants produce significant amounts of neutrons which could in principle be used to produce special fissionable material, pure fusion power plants do not contain source material, and this should be straightforwardly verifiable.
  - The absence of source material means that the energetic neutrons from fusion cannot be used to produce special fissionable material.
  - It also means that even small amounts of source or special fissionable material should be easily detectable.
  - On the other hand, it means that the framework for inclusion of fusion power plants into verification regimes is unclear, but verification will be needed to confirm the absence of source materials.
  - It is recommended that the IAEA consider means to achieve this verification.

# KEY POINTS – III : R&D, TRITIUM

- There are R&D opportunities to advance the non-proliferation aspects of fusion, for example by testing methods to assure that fusion blanket modules do not contain source materials.
  - It is recommended that reports on such activities be included in the IAEA DEMO Programme Workshops.
  - Collaboration with the IAEA could be productive in this regard.
- Pure fusion power plants will produce the tritium required for their own operation, and for start-up of future power plants.
  - ITER will provide very valuable, relevant experience with tritium management and accountancy.
  - Tritium plays a role in advanced nuclear weapons systems.
  - The issue of tritium monitoring needs further consideration.

# KEY POINTS – IV : TECHNICAL CONCLUSIONS

- The ITER facility itself does not present proliferation risks.
  - ITER will produce a modest fluence of neutrons.
  - The operation of ITER is under extensive international oversight.
- The possibility of a clandestine magnetic fusion system for the production of special fissionable material is implausible due to size, power and environmental signatures.
  - A facility capable of producing 1/2 SQ/year would necessarily be large.
  - Such a facility would have very high power consumption.
  - Tritium would be a detectable environmental signature.

# OVERARCHING CONCLUSIONS

- This was a very valuable meeting, allowing detailed discussions between communities that need to develop closer links in the future
- There are R&D opportunities to advance the non-proliferation aspects of fusion, for example by testing methods to assure that fusion blanket modules do not contain source materials
- The framework for inclusion of fusion power plants into verification regimes is unclear
- The issue of tritium monitoring requires further consideration

# Thank you for your attention

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