Holistic Approach to Nuclear Safety, Security and Safeguards: Opportunities and Challenges

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Note: Unless otherwise indicated, words are used with their commonly understood meanings.

Advent of nuclear energy and its utilisation for the welfare of humankind brought along with it many opportunities and challenges. Peaceful utilisation of atomic energy should ensure that

(i) nuclear material and nuclear facilities, other radioactive materials and associated facilities are secured with adequate physical protection measures adhering to a well laid out and internationally acceptable safety and security culture, and

(ii)Nuclear material is safeguarded with adequate nuclear material & control (NMAC) measures adhering to a well laid out and internationally acceptable safeguards culture.

Nuclear safety and nuclear safeguards: Critical and indispensable

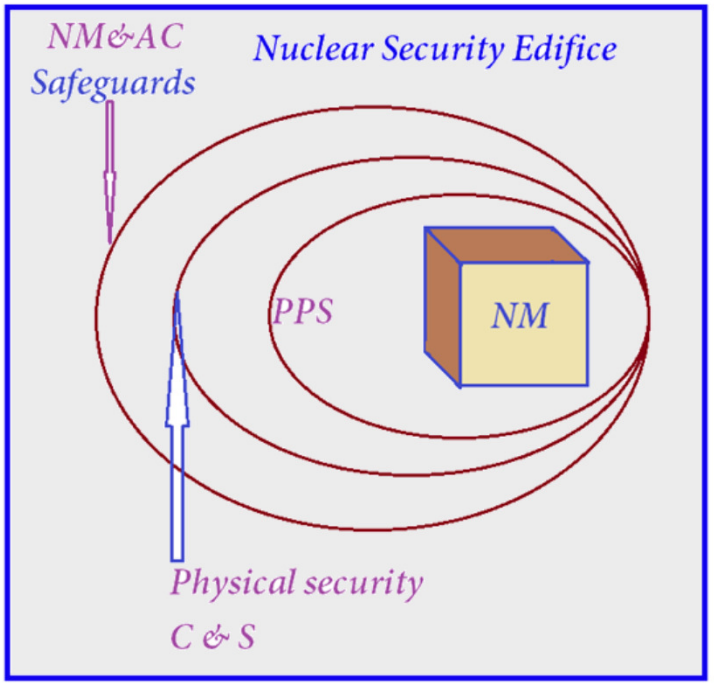
Nuclear security: An invisible but inalienable component

Abstract in nature and a concept

Its robustness inferred /assessed /judged only through physical attributes of nuclear safeguards and nuclear safety

Cannot be isolated from the other two "SS" namely nuclear safeguards and nuclear safety.

Inadequacy in implementation of any of these result in vulnerable situations necessitating corrective and remedial measures.



Holistic Approach to (Nuclear) Safeguards, Safety and Security

A holistic approach is desirable to understand the Triad of safeguards, safety and security

Tools for nuclear security culture: Safeguards and safety

Difference in implementation by IAEA
Safeguards – Legal mandate
Safety & Security – Responsibility of State (advisory and audit role on request)

Essential both from the point of view of Economics, Optimum use of technology and Human resources.

The best practices of each of the elements shall have to be pooled together to realise the wholesome advantage.

Technical challenges
Administrative /managerial challenges
Financial challenges
Political challenges

Nuclear Materials
Other radioactive materials
Holistic approach and post-nuclear security summit-2016 ("Central role" of IAEA)

Effect of Safeguards provisions on nuclear security(1/5)

Typical illustration

Objective of safeguards:

> **Timely detection of diversion of significant quantities of nuclear material to the *manufacture of nuclear weapons or of other nuclear explosive devices***

EI not same as the BI within the permitted statistics

Quantities of (special) nuclear material required for nuclear weapons or other nuclear explosive devices and also the time required for processing and assembling the device.

(Detection time < = Conversion time)

What about nuclear safety and security issues in such cases?

An issue arising out of safeguards verification may not be of concern from safeguards may become nuclear security concern. Quantities and the timelines suddenly become critical.

Effect of Safeguards provisions on nuclear security(2/5)

Exemptions (INFCIRC/153)

36. (a) Special fissionable material in gram quantities or less;
(c) Plutonium (plutonium-238 exceeding 80%)

37. N*uclear material* so exempted in the State may not at any time exceed:
(a) One kilogram in total of special fissionable material, which may consist of one of more of the following:
(i) Plutonium;
(ii) Uranium with an *enrichment* of 0.2 (20%) and above, taken account of by multiplying its weight by its *enrichment;* and -------

How to address nuclear security for these exempted materials?

Effect of Safeguards provisions on nuclear security(3/5)

The technical conclusion of the Agency's safeguards verification activities shall be a statement, in respect of each *material balance area,* of the amount of *material unaccounted for* over a ***specific period***, giving the ***limits of accuracy of the amounts stated***.

IAEA uses an absolute number – independent of the facility's throughput – more challenging for high throughput facilities even for safeguards verification.

Addressing nuclear security concerns is still more daunting. It is desirable that these standards will have to be revised and applied to have more confidence in ensuring nuclear security.

If the measurement technologies fall short of this expectation, administrative /managerial mechanism should be in place. Some sort of State Level Concept could be used for this purpose (?).

Effect of Safeguards provisions on nuclear security(4/5)

In the Agency's publication 25-G on Use of Nuclear Material Accounting and Control for Nuclear Security Purposes at Facilities, The term "control (of nuclear material)" has been defined by taking into nuclear security aspects into consideration.
Likely feeling: "State regulatory and/or operators shall be responsible for nuclear material control measures including Containment and surveillance, Nuclear material monitoring, and statistical evaluation of inputs/outputs, and measurement quality control."

IAEA uses material accountancy as a safeguards measure of fundamental importance, with *containment and surveillance* as important complementary measures.
(IAEA philosophy: "Trust but verify")

It is desirable that they continue to be important complementary measures under the 'control' of IAEA (independent verification)

Effect of Safeguards provisions on nuclear security(5/5)

This holistic approach helps, in case the Agency cannot draw satisfactory safeguards conclusions regarding possible diversion of nuclear material, one of the probable reasons could be inadequacy of C&S and hence physical protection measures with nuclear security implication, thus calling on the Member State to take appropriate measures based on safeguards conclusions which have legal basis.

It is a challenge but an opportunity for the Agency.

Further, nuclear security measures require smaller and more process-specific material balance areas than those defined for safeguards purposes. Similarly, member states are expected to record additional nuclear security information.

These are challenges not only for the Agency but also for Member States.

Securing other radioactive materials (1/3)

Protection of Nuclear material are limited to nuclear material and nuclear facilities only.

A non-binding code of conduct is available for radioactive sources.

Nuclear Security encompasses both nuclear material and nuclear facilities as well as *other radioactive material and associated facilities.*

Opportunity

There should be a mechanism to account for the other radioactive material in a State, similar to NMAC for realising nuclear security of these materials.

Some of the potentially relevant radioisotopes (2/3)

Isotope	Half life	Emission and energy	Used for
Am-241	≈ 432 y	α 5.6 MeV γ 50 keV	Smoke detectors, fuel gauges
Cf-252	≈ 3 y	α 6.2 MeV Spontaneous fission	Neutron source
Co-57	≈ 272 d	EC γ 136 keV	Gamma cameras
Co-60	≈ 5 y	γ 1.16 MeV, 1.33 MeV	Brachytherapy
Cr-51	≈ 28 d	EC γ 320 keV	Gastrointestinal bleeding diagnosis
Cs-137	≈ 30 y	γ 0.662 MeV	Brachytherapy
Er-169	≈ 9 d	β 0.35 MeV	Radiosynovectomy
Fe-59	≈ 45 d	β 1.099 and 1.29 MeV	Iron metabolism
I-125	≈ 60 d	γ 27.4 keV	Brachytherapy
I-131	≈ 8 d	β 0.16 MeV	Thyroid cancer
Ir-192	≈ 74 d	β 0.37 MeV	Brachytherapy
Pd-103	≈ 17 d	γ 21 keV	Brachytherapy
Pu-238	≈ 88 y	α 5.6 MeV	RTG
Ra-226	≈1600 y	α 4.9 MeV	Cancer treatment
Ru-106	≈1 y	β 3.54 MeV	Brachytherapy
Sc-46	≈84 d	β 0.16 MeV	Oil well logging
Se-75	≈ 120 d	EC 0.31 MeV	Gamma radiography
Sr-89	≈ 50 d	β 1.5 MeV	Bone pain palliation
Sr-90	≈ 29 y	β 0.55 MeV	Radiation therapy

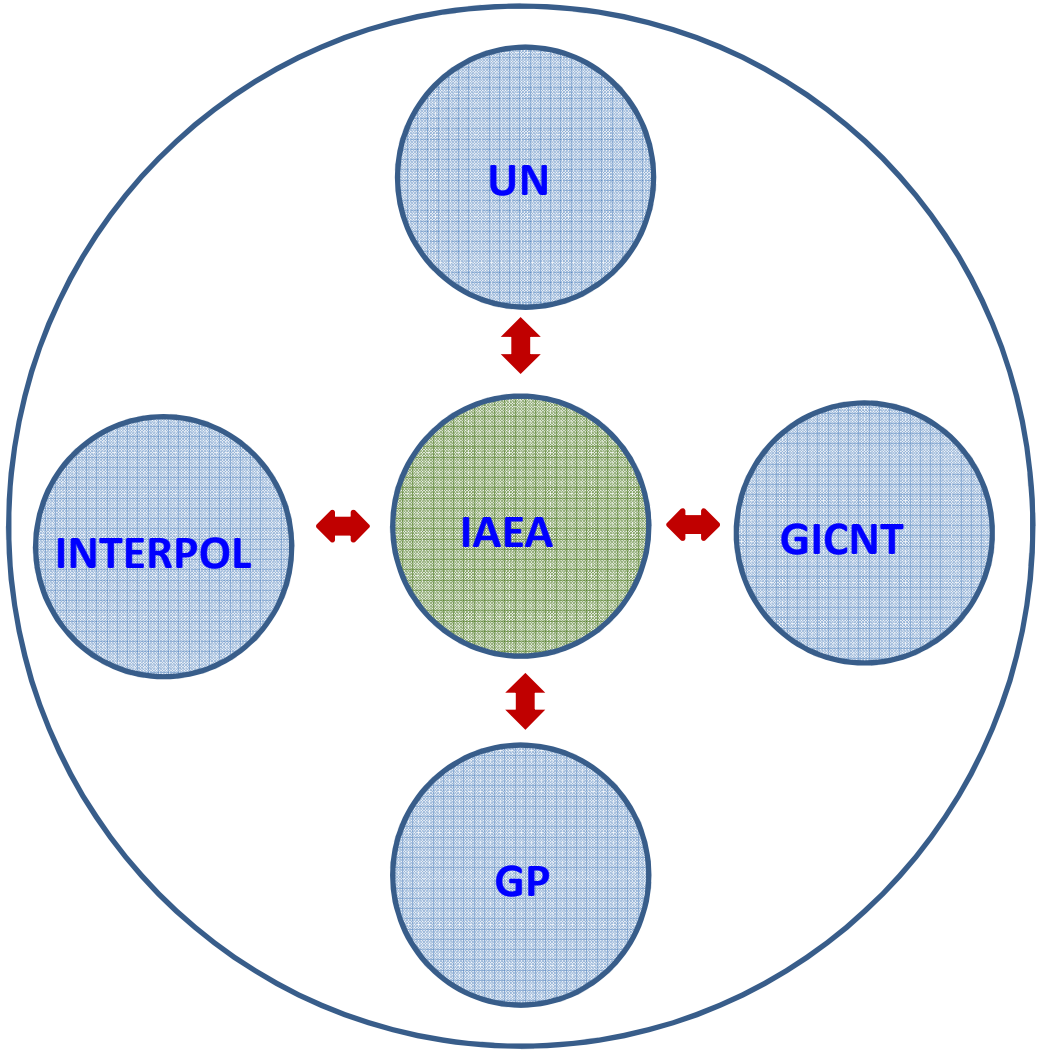
Securing other radioactive materials (3/3)

Too challenging a task to manage (weak legal security architecture)
Mainly used by industries and are not in immediate government control (like nuclear material)

Relook into exemptions provided in safeguards agreements
Plutonium with an isotopic concentration of Pu-238 exceeding 80%
Though nuclear materials, Pu-238 and Am-241 may better be treated as other radioactive materials for nuclear security purpose.

A mechanism to account for the other radioactive material in a State, similar to NMAC?
Legal mandate for IAEA to implement safeguards on such materials?
Or custodians to maintain their inventories certified by the regulatory agencies from the date of procurement and thereafter on annual basis.
Verification by the regulatory agencies at regular intervals
The information may be shared with the IAEA.

Post-Nuclear Security Summits and Directions for Nuclear Security



Nuclear Security Summit 2016 Communiqué

Reaffirms the essential responsibility and the central role of the International Atomic Energy Agency in

- strengthening the global nuclear security architecture,
- developing international guidance,
- its leading role in facilitating and coordinating nuclear security activities among international organisations and initiatives, and
- supporting the efforts of States to fulfill their nuclear security responsibilities

Broad expectations from the 5 Agencies in Nuclear Security

Conclusions

The triad of nuclear safety, security and safeguards is critical and indispensable in peaceful utilisation of atomic energy.
Inadequacy in implementation of any of the three result in vulnerable situations necessitating corrective and remedial measures.
A holistic approach is therefore desirable to take the cognizance of the fact that the triad organs are not independent of one another.
Such an exercise is essential both from the point of view of economics, optimum use of technology and human resources.

Equal attention should also be paid towards addressing security of other radioactive materials, identifying a mechanism for their accounting, and the responsible authorities for the same.
It may also be necessary to review the existing safeguards agreements with regard to exemptions for certain category of nuclear materials to bring them under other radioactive material category for effective accounting and control.

Post-Nuclear security summit, there is an urgent need to define the central role of the IAEA vis a vis other agencies entrusted with the responsibility of coordinating certain aspects of nuclear security.

Alfred Lord Tennyson
Morte d'Aurther

"The old order changeth yielding place to new

Lest one good custom should corrupt the world.
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Let there be a holistic new order enveloping the triad of Safety, Security and Safeguards for a better and safer world free from "Nuclear anxieties"

Thank you and Namaskar