Safeguards

Safeguards considerations for SMR fuel cycles

Technical Meeting on Back End of the Fuel Cycle Considerations for Small Modular Reactors – 20 September 2022

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Role of IAEA safeguards

IAEA Safeguards

…credible assurance that countries are honouring their international obligations (under the NPT) to use nuclear material and technology only for peaceful purposes.

Implications for SMRs

- Safeguards apply to **all nuclear material** in peaceful activities in non-nuclear-weapon States party to the NPT

- All SMRs and related nuclear fuel cycle facilities built in States under a CSA – even prototypes – **will need to be safeguarded**, regardless of the size, technology, or State of origin

Safeguards challenges for SMRs

IAEA Safeguards

- **New fuels and fuel cycles:** Th/U-233, RepU, MOX, TRU fuels, pebble bed, prismatic core, pyroprocessing, other new processes
- **New reactor designs:** molten salt, fast neutron, micro-sized, …
- **Longer operation cycles:** continuity of knowledge between refuelling, high excess reactivity of core (target accommodation)
- **New supply arrangements:** factory sealed cores, transportable power plants, transnational arrangements (need for design verification and sealing)

Safeguards challenges for advanced reactors (2)

IAEA Safeguards

- **New spent fuel management:** storage configurations, waste forms
- **Diverse operational roles:** district heating, desalination, hydrogen + electricity
- **Remote, distributed locations:** access issues, lack of "unannounced" visit deterrence, cost-benefit issues

IAEA independent verification capabilities must be ready

“Independent verification”

Nuclear Material Accountancy

- To verify State’s declaration of nuclear material **inventory and flow** (e.g. item counting, weighing, non-destructive assay)
- Can involve **unattended equipment with remote data transmission**

Containment and Surveillance

- To maintain **continuity-of-knowledge** (e.g. cameras, seals, measurements) between inspections
- Can involve **unattended equipment with remote data transmission**

Design Information Verification

- To verify State’s **declared facility design** (construction, operation, modification or decommissioning)

Environmental Sampling, and Complementary Access to other locations

- To assure **“completeness” of declaration**: i.e., absence of undeclared nuclear material or activities

Therefore… important future safeguards needs

- **Unattended monitoring systems** (UMS) and **remote data transmission** (RDT)
- **Digital connectivity:** e.g., coverage in remote areas (reliable, high bandwidth, secure)
- **Safeguards seals** on factory-sealed, transportable cores
- **Design verification**, particularly under transnational supply arrangements

Important future safeguards needs (2)

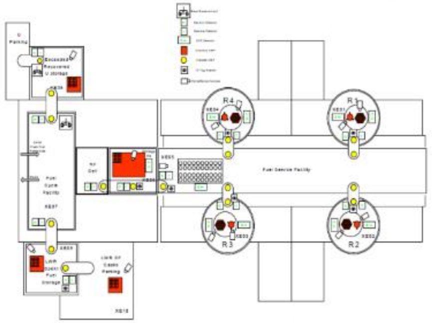
- **New safeguards approaches**, including (potentially) customized Agency or joint-use instrumentation (e.g., thermal power monitor for microreactors, process monitoring)
- **State-level issues:** e.g., managing effective/efficient safeguards for a fleet of small, remote facilities
- **Training** for safeguards authorities in emerging nuclear energy States

All of these need time for development:
"Safeguards by Design" is critical

What is safeguards by design? (SBD)

?

Conceptual design for new nuclear facility



Engineering design

Construction & commissioning

Operation

Safety

Codes and standards

Operational goals

Security

"Safeguards by design"

Safeguards

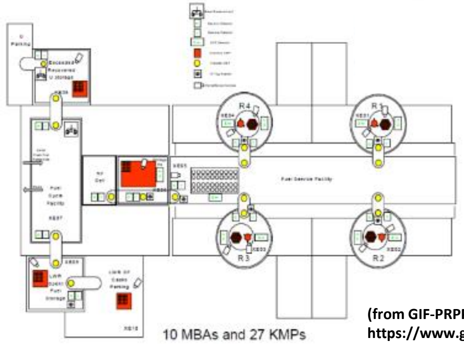
- ➢ Safeguards often implemented after design completed
- ➢ This works <u>if</u> designs don't evolve significantly
- ➢ This works <u>if</u> designers fully understand safeguards needs
- ➢ **Otherwise, safeguards by design is needed**

What is safeguards by design? (SBD)

- The **integration of safeguards considerations into the design process** (new or modified facility, at any stage of the nuclear fuel cycle), from initial planning through design, construction, operation, waste management and decommissioning

- **Awareness** by all stakeholders (State, designer, operator, regulator, other IAEA departments) of IAEA safeguards obligations, and opportunities for **early discussion with the IAEA Department of Safeguards**.

- A **voluntary process** that neither replaces a State's obligations for early provision of design information under its safeguards agreement, nor introduces new safeguards requirements.



(from GIF-PRPP ESFR Case Study, 2009: https://www.gen-4.org/gif/jcms/c_9365/pr-pp)

Benefits of safeguards by design

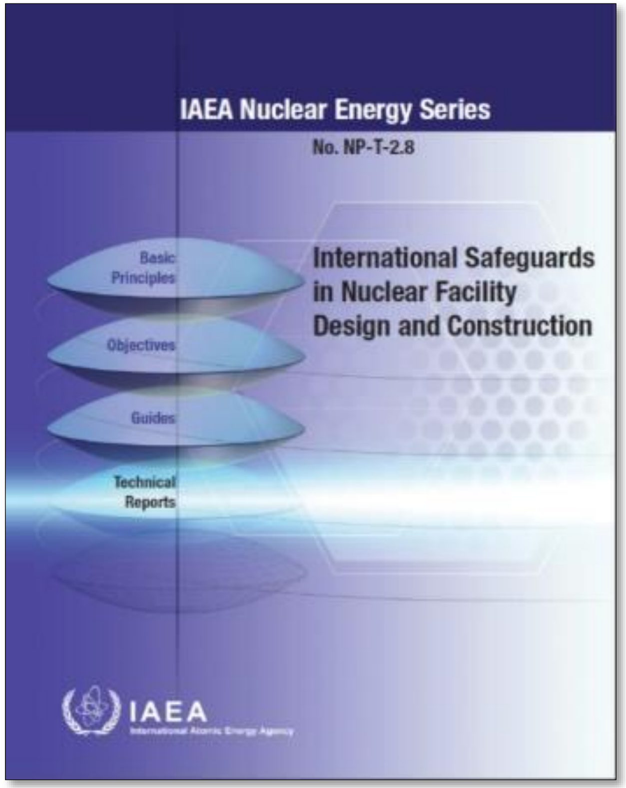
- Reduce **operator burden** by optimizing inspections
- Reduce need for **retrofitting**
- Facilitate **joint-use equipment**
- **Increase flexibility** for future safeguards equipment installation
- Enhance possibility to use facility design/operator **process info**
- **Reduce risk** to scope, schedule, budget, and licensing
- Possible **marketing advantages** for vendors?

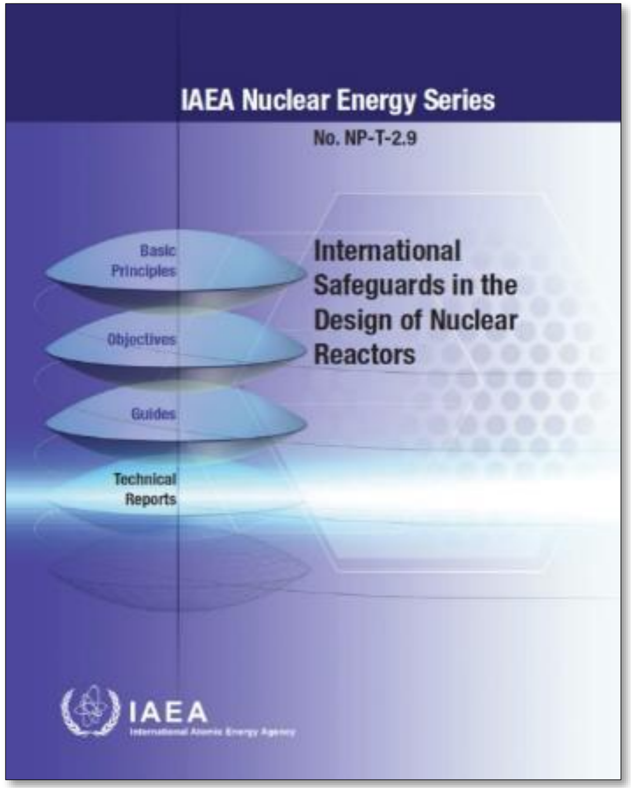
SBD benefits all parties involved, not just the IAEA

Challenges in implementing SBD

- IAEA lacks a **direct channel for initiating communication** with designers, particularly at the earliest stages of design when greatest SBD potential exists.
- Lack of an **'engineering requirements' document** for safeguards – only 'best practices'.
- Designers lack a **uniform understanding** of safeguards requirements.
  - Many nuclear designers are new to the industry, often relatively small with limited scope of capabilities
  - Many nuclear design companies are located in Nuclear-Weapon States, where IAEA safeguards are typically of concern when exports are anticipated (lack of "safeguards culture")
- Safety and economics are priority design drivers; safeguards **not seen as a design driver** at all – of relevance toward end of build process
- **Inconsistent licensing practice** in addressing safeguards requirements
- **Proprietary / commercial concerns** with early sharing of detailed design information

Safeguards by design (SBD) guidance





www.iaea.org/topics/assistance-for-states/safeguards-by-design-guidance

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Thank you for your attention!