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Dealing with Ignorance: Resilience for Nuclear Safety-Security

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Main Question

How could policymakers enhance existing fundamental nuclear safety principles to better deal with ignorance in building newer designs of NPPs?

Proposal

Ethical Risk Assessment (eRA) could enhance fundamental nuclear safety principles to deal with ignorance by specifying parties included and integrating fairness aspects, all while realising that ignorance ultimately remains.

Methods

- Literature research on IAEA documents on fundamental safety principles[1] and its application on new generations of NPPs.
- Applying Hermansson and Hansson's ethical Risk Assessment (eRA)[2] into ten fundamental safety principles and contextualise it into evolutionary and innovative design (EID) of NPPs.

eRA-enhanced fundamental nuclear safety principles for nuclear power plants

Fundamental Safety Principles[1]	Definition	eRA Enhanced Safety Principles
1. Responsibility for safety	The prime responsibility for safety must rest with the person or organisation responsible for facilities and activities that give rise to radiation risks	The prime responsibility for safety must rest with the person or organisation responsible benefitting from and deciding to initiate facilities and activities that give rise to radiation risks.
2. Role of government	An effective legal and governmental framework for safety, including an independent regulatory body, must be established and sustained	There has to be an effective legal and governmental framework for safety with an independent regulatory body assessing radioactive risk exposure, its distribution, and benefits related to it.
3. Leadership and management for safety	Effective leadership and management for safety must be established and sustained in organisations concerned with, and facilities and activities that give rise to, radiation risks	It is compulsory to establish and sustain leadership and management for safety in nuclear facilities which give rise to radioactive risks by, among others, ensuring knowledge accessibility and knowledge distribution about radioactive risks.
4. Justification of facilities and activities	Facilities and activities that give rise to radiation risks must yield an overall benefit	Facilities and activities which give rise to radiation risks must yield an overall benefit either monetarily or in-kind for the risk-exposed around the nuclear facilities.
5. Optimisation of protection	Protection must be optimised to provide the highest level of safety that can reasonably be achieved	Government and nuclear companies must provide the highest level of safety with fair radioactive risk distribution in mind.
6. Limitation of risks to individuals	Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm	Engineering, policy, and educational measures must ensure that no individuals bear unacceptable risks of harm.
7. Protection of present and future generations	People and the environment, present and future, must be protected against radiation risks	-
8. Prevention of accidents	All practical efforts must be made to prevent and mitigate nuclear or radiation accidents	All practical efforts must be made mainly by business entities in cooperation with the government to prevent and mitigate nuclear or radiation accidents.
9. Emergency preparedness and response	Arrangements must be made for emergency preparedness and response for nuclear or radiation incidents	Nuclear companies bear the most responsibility to ensure emergency preparedness and response for nuclear or radiation incidents.
10. Protective actions to reduce existing or unregulated radiation risks	Protective actions to reduce existing or unregulated radiation risks must be justified and optimised	Protective actions to reduce existing or unregulated radiation risks must be optimised without further exposing minority groups to risks.

Philosophical contribution: Integrating ethical Risk Assessment (eRA) to IAEA's fundamental safety principles to better deal with ignorance

The IAEA's Conceptualisation of NSS [3]

Nuclear safety: "the achievement of proper operating conditions, prevention of accidents and mitigation of accident consequences, resulting in protection of workers, the public and the environment from undue radiation risks."
Nuclear security: "the prevention and detection of, and response to, criminal, or intentional unauthorized acts involving or directed at nuclear material, other radioactive material, associated facilities or associated activities."

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Fairness aspects from ethical Risk Assessment (eRA)

- eRA introduces fairness aspects into existing fundamental safety principles
- in new NPPs such as Small Modular Reactors, eRA provides a map of risk-benefit relationships between relevant parties

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Enhanced NSS practices

From NSS Conceptualisation:
- Performing quantitative safety-security assessments for nuclear power plants (NPPs).
- Applying engineering strategies into NPPs design to prevent and mitigate radioactive hazards.

From ethical Risk Assessment:
- Constant and regular evaluation of safety-security measures in NPPs.
- Regularly updated, transparent public communication NPPs' safety-security features.

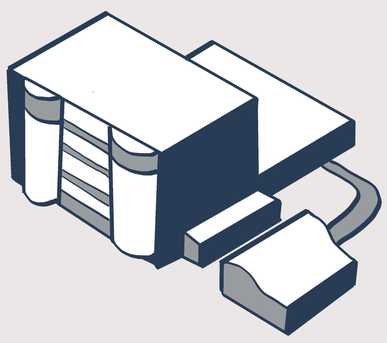
Nuclear policy relevance:

ignorance consideration enables policymakers to 1) visualise NSS states beyond numbers and 2) regularly enhancing accident mitigation strategies

1) Visualising NSS states beyond numbers:

- *Understanding the NPP's overall design*
- *Understanding the NSS features offered by the NPP*

*Example case: Small Modular Reactor**



2) Regularly enhancing accident mitigation strategies:

- *Regularly evaluating the NPP's preventive and mitigative features to deal with disruptions, both anthropogenic and non-anthropogenic*
- *Regularly updating the general public with the NPP's overall safety-security performance*

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[1] EUROPEAN ATOMIC ENERGY COMMUNITY, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, INTERNATIONAL MARITIME ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, WORLD HEALTH ORGANIZATION, Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1, IAEA, Vienna (2006), https://doi.org/10.61092/iaea.hmxn-vw0a
[2] H. Hermansson and S. O. Hansson, "A Three-Party Model Tool for Ethical Risk Analysis," Risk Manage., vol. 9, no. 3, pp. 129–144, Jul. 2007, doi: 10.1057/palgrave.rm.8250028.
[3] EUROPEAN ATOMIC ENERGY COMMUNITY, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, INTERNATIONAL MARITIME ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, WORLD HEALTH ORGANIZATION, Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1, IAEA, Vienna (2006), https://doi.org/10.61092/iaea.hmxn-vw0a

[*] Small Modular Reactor Technology icon by Carolus Astabrata. Instagram:**@bungcarol**