

# Strengthening Regulatory Capacity for Nuclear Safety in Cambodia

Uong Bunai

Tomsk Polytechnic University, Russia

## Abstract

This paper examines the current challenges and opportunities to strengthen Cambodia's regulatory capacity in the field of nuclear safety. Despite having a fundamental infrastructure, including the Department of Nuclear Science and Technology (DONST) under the Ministry of Mines and Energy (MME), Cambodia faces several challenges, such as a lack of qualified human resources, weak inspection and enforcement systems, and incomplete legislation. To address these challenges, a framework based on the recommendations of the International Atomic Energy Agency (IAEA) is proposed. The paper analyzes the gaps between Cambodia's current situation and the IAEA standards and proposes measures to improve human resources capacity, strengthen enforcement, upgrade infrastructure, and complete legislation. The proposed steps are aimed at ensuring the safe and sustainable use of nuclear technology in Cambodia.

## 1 Introduction

Cambodia's commitment to the safe and secure use of nuclear technology is evident in its ongoing efforts to enhance its nuclear security regime. In December 2023, [1] the International Atomic Energy Agency (IAEA) conducted an advisory service mission to assess the country's preparedness to prevent, detect, and respond to criminal or intentional unauthorized acts involving nuclear and other radioactive material out of regulatory control (MORC).

Building upon the findings of a previous mission, the IAEA team commended Cambodia's progress in implementing measures to address MORC-related risks. However, the mission also identified areas for improvement, particularly in terms of strengthening the country's legal and regulatory framework.

This paper will delve into the key challenges facing Cambodia's nuclear security regime and propose solutions based on the IAEA's recommendations. By examining the current state of nuclear security in the country and identifying specific areas for enhancement, this analysis aims to provide a roadmap for Cambodia to further strengthen its capabilities in preventing, detecting, and responding to MORC threats.

## 2. Current Regulatory Framework In Cambodia

Cambodia's regulatory framework for nuclear safety is still in the developmental stage, although notable progress has been made in recent years. The primary body responsible for overseeing

nuclear safety is the Department of Nuclear Science and Technology (DONST), which operates under the Ministry of Mines and Energy (MME). DONST's role includes regulating the use of nuclear and ionizing radiation technologies in medical, agricultural, industrial, and research sectors. The Organization Chart of DONST is shown in the Figure 1. From reference source [2] .

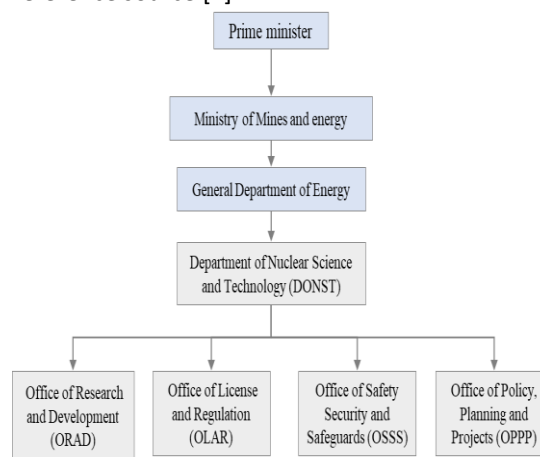


Figure 1. The department of nuclear science and technology

### 1.1 Legislative and Regulatory Foundations

At the core of Cambodia's regulatory framework is the 1993 Constitution, which explicitly prohibits the production, use, or storage of nuclear, chemical, or biological weapons. Additionally, Cambodia has enacted several laws to support nuclear safety:

- **Law on Environmental Protection and National Resources Management (1996):** Aimed at ensuring a healthy environment, this law indirectly contributes to radiation protection by requiring environmental impact assessments (EIAs) for

projects involving hazardous materials, including radioactive sources.

- **Law on Counter-Terrorism (2007):** Includes provisions to counter malicious use of radioactive materials, aligning with the UN Security Council Resolutions.

- **Draft Nuclear Law:** A comprehensive nuclear law is currently being developed with assistance from the International Atomic Energy Agency (IAEA). The law will address nuclear safety, security, and safeguards based on international norms and practices.

Despite these legislative efforts, Cambodia's nuclear safety framework remains incomplete, as key regulations are still in the drafting phase. Enforcement mechanisms, clear guidelines for radioactive waste management, and an independent regulatory body are among the essential components that need further development.

### 1.2 Institutional Framework

DONST serves as the primary regulatory authority. Its responsibilities include:

- Issuing licenses for the use and transport of radioactive materials.
- Conducting inspections of facilities using radioactive sources.
- Monitoring compliance with safety regulations.

The National Counter Terrorism Committee (NCTC) and the National Authority for the Prevention of Chemical, Nuclear, Biological, and Radiological Weapons (NACW) also contribute to the regulatory oversight of nuclear materials, particularly in the context of national security and counterterrorism efforts.

### 1.3 International Cooperation and Compliance

Cambodia's membership in the IAEA has facilitated significant technical cooperation. The IAEA has supported Cambodia through various projects aimed at building capacity in radiation safety infrastructure, including:

- KAM/9/001: Establishing a national radiation safety infrastructure.
- KAM/9/002: Capacity building in radioactive waste management.

- KAM/9/003: Supporting the Launching of a Nuclear Regulatory Authority.

Cambodia is also a signatory to several international treaties and agreements, such as:

- Convention on Nuclear Safety (CNS): Acceded in 2012, reflecting Cambodia's commitment to international standards for nuclear safety.

- Treaty on the Southeast Asia Nuclear Weapon-Free Zone (SEANWFZ): This reinforces Cambodia's stance on non-proliferation.

- Nuclear energy for peaceful purposes, with partnerships with Russia and China. Key agreements with Russia, starting in 2015, focus on cooperation in nuclear technology, public awareness, and infrastructure development, including joint projects and exploration of uranium deposits. Similarly, a 2017 agreement with China emphasizes human resource development, public education, and future nuclear energy capacity building. These efforts aim to ensure nuclear safety and support the country's socio-economic progress. [3]

## 2 CHALLENGES IN THE REGULATORY SYSTEM

Despite the progress made, Cambodia's regulatory system for nuclear safety faces several significant challenges. These obstacles must be addressed to ensure a robust and effective framework that meets both domestic and international safety standards. This section explores the main challenges in four key areas: legislation, enforcement, human resources, and infrastructure.

### 2.1 Incomplete Legislation

One of the most pressing challenges is the incomplete legislative framework governing nuclear safety in Cambodia. While the **draft nuclear law** has been developed with the support of the IAEA, it has yet to be fully enacted. Until this law is officially passed and implemented, Cambodia's regulatory framework lacks the legal authority needed to comprehensively manage nuclear safety, security, and safeguards. Specific gaps include:

- **Lack of Specific Regulations:** There are no clear regulations for critical areas such as radioactive waste management, transportation of nuclear materials, and emergency preparedness.
- **No Centralized Regulatory Authority:** The current regulatory responsibilities are fragmented

across different ministries, such as the Ministry of Mines and Energy (MME) and the Ministry of Health, with no central regulatory body to oversee all nuclear-related activities.

Without a complete legal framework, enforcing standards for the safe use of radioactive materials becomes difficult, and Cambodia remains reliant on international technical cooperation for guidance and regulation.

## **2.2 Weak Enforcement and Compliance Mechanisms**

Cambodia's capacity to enforce existing nuclear safety regulations is limited due to:

- **Inadequate Inspection Capacity:** DONST lacks sufficient resources and trained personnel to carry out regular inspections of facilities that use radioactive materials. As of 2018, only a small number of inspections were conducted on operators using radioactive sources, and several facilities remain unregulated.

- **Limited Monitoring and Reporting:** Current systems for tracking and reporting the use of radioactive materials are underdeveloped. Many operators do not submit timely reports on the status of radioactive sources or compliance with safety regulations.

- **Weak Penalty and Enforcement Provisions:** Even when violations are identified, the enforcement mechanisms are weak. Penalties for non-compliance are either insufficient or poorly enforced, which undermines the regulatory authority's ability to ensure compliance with safety standards.

These weaknesses in enforcement pose a serious risk to public safety, particularly in the event of unauthorized use or mishandling of radioactive materials.

## **2.3 Shortage of Qualified Human Resources**

The lack of skilled personnel is a critical issue that hampers the development and enforcement of nuclear safety regulations. Key challenges include:

- **Limited Expertise in Nuclear Safety:** Cambodia has a very small pool of professionals trained in nuclear safety, radiation protection, and emergency preparedness. The country's universities and technical institutes currently do not offer specialized programs to develop expertise in these fields.

- **Dependence on International Assistance:** Cambodia relies heavily on international technical cooperation, particularly with the IAEA, for training and capacity-building initiatives. While these programs have been beneficial, they are not enough to build a self-sustaining cadre of local experts in nuclear safety.

- **Retention of Skilled Personnel:** Even when professionals are trained, there is a high turnover rate, particularly in government agencies where salaries and career advancement opportunities are limited. This makes it difficult to maintain continuity in regulatory oversight and inspection activities.

As shown in [4], between 2012-2013 and 2017-2018, on average, nearly 80 percent of students chose the science track in upper secondary schools, but this trend dramatically reversed by 2020-2021, with 66% opting for social sciences despite efforts to promote STEM education. Also, data in [4] show from 2012-2013 to 2019-2020, the percentage of STEM students gradually increased from 18% to 30%, while the percentage of non-STEM students decreased from 82% to 70%. This shows a slow but steady shift towards STEM fields over the 8-year period, though non-STEM fields still significantly dominate enrollments.

In Cambodia, based on information from [5], the University of Battambang offers a Bachelor's Degree in Nuclear Engineering, with only 22 students enrolled. According to data from MME [reference], approximately 7 students, including both master's and bachelor's degree holders, graduate each year from programs in Russia, China, Korea, and other countries. Based on this data, it is estimated that fewer than 150 students have graduated in the past 10 years. Compare to Vietnam approximately 1,494 people were involved in Vietnam's nuclear program, including 344 students and 150 engineers trained by Russia, and around 1,000 staff committed for training by Japan. [6]

This is an evident that Cambodia needs to focus on developing its human resources through improved promotion of both high school and university education. Strengthening these educational foundations is essential to fostering the growth of skilled professionals, particularly in specialized fields like nuclear engineering.

#### **2.4 Inadequate Infrastructure**

Another significant challenge is Cambodia's lack of infrastructure to support nuclear safety, particularly in the following areas:

- **Radioactive Waste Management:** Cambodia currently lacks a centralized facility for storing and managing radioactive waste. This forces operators to repatriate disused radioactive sources to their country of origin, which is not always feasible or timely.
- **Emergency Preparedness:** The country has limited resources to handle nuclear emergencies. While some facilities have emergency plans, the overall preparedness of the country to respond to a radiological or nuclear incident is insufficient. The lack of a comprehensive emergency response framework presents a risk in the event of a nuclear accident or unauthorized use of radioactive materials.
- **Monitoring and Detection Systems:** There is a shortage of reliable detection systems at key points, such as ports and airports, to prevent the unauthorized transport of radioactive materials. While some measures have been taken in cooperation with international partners, the infrastructure remains inadequate for ensuring comprehensive monitoring.

#### **2.5 Public Awareness and Engagement**

A final challenge is the low level of public awareness regarding nuclear safety and the potential risks associated with the use of radioactive materials. Without widespread understanding of these risks, the public is less likely to support necessary regulatory reforms, and operators may be less inclined to prioritize safety measures. Additionally, insufficient communication between regulators and stakeholders (including operators and the general public) exacerbates the problem of regulatory compliance.

### **3 Proposed Solutions**

To enhance Cambodia's regulatory capacity for nuclear safety, it is essential to address the challenges identified in the previous section. The following measures, aligned with International Atomic Energy Agency (IAEA) recommendations and global best practices, are proposed to strengthen Cambodia's nuclear safety framework.

#### **3.1 Legislative Reforms**

A key priority for Cambodia is the completion and implementation of its comprehensive nuclear law. This law should cover all aspects of nuclear safety, security, and safeguards, including specific enforcement mechanisms and civil liability provisions.

- **Finalize the comprehensive nuclear law:** Accelerate the drafting and promulgation of the nuclear law with inputs from international nuclear safety experts, ensuring that it aligns with IAEA guidelines and covers safety, security, safeguards, and civil liability.
- **Establish legal frameworks for radioactive waste management:** Cambodia must develop national policies for the safe management of radioactive waste, including proper disposal, storage, and repatriation protocols.
- **Create a civil liability framework:** Establish legal provisions for civil liability and compensation in the event of nuclear or radiological accidents, ensuring protection for the public and the environment.

#### **3.2 Capacity Building and Human Resource Development**

A major challenge for Cambodia's nuclear regulatory system is the shortage of qualified personnel. [7] Developing human resources is critical to building a sustainable regulatory framework.

- **Increase training opportunities:** Collaborate with the IAEA and regional partners to offer specialized training programs for regulatory staff, radiation protection officers, and nuclear safety inspectors. These programs should focus on nuclear safety, security, emergency preparedness, and radiation protection.
- **Create educational pathways:** Establish partnerships with local and international universities to offer academic programs in nuclear science, safety, and regulatory affairs. Scholarships and internships could be developed to attract students into the field.
- **Retain and develop local expertise:** To reduce reliance on international experts, Cambodia should create incentives for retaining skilled professionals within the regulatory framework, including career advancement opportunities and competitive salaries.

### 3.3 Strengthening Enforcement and Inspection

Improving the enforcement of nuclear safety regulations and conducting effective inspections are critical for ensuring compliance and preventing unauthorized use of nuclear materials.

- **Enhance inspection capabilities:** Allocate more resources to the Department of Nuclear Science and Technology (DONST) to hire additional inspectors and improve their capacity to carry out routine inspections of facilities using radioactive sources.
- **Develop a national registry of radioactive sources:** Implement a centralized system for tracking all radioactive materials within Cambodia. This would ensure better oversight and reduce the risks of lost or unaccounted-for materials.
- **Establish stronger penalties for non-compliance:** Introduce a clear penalty structure in the upcoming nuclear law for entities that violate safety regulations, including fines, suspension of licenses, or criminal charges for serious offenses.

### 3.4 Infrastructure Development

Cambodia must invest in infrastructure to ensure the safe and effective management of nuclear and radioactive materials.

- **Establish a radioactive waste management facility:** Develop a national facility for the safe storage and processing of radioactive waste, thereby reducing the country's reliance on repatriation agreements with supplier countries.
- **Upgrade emergency preparedness:** Strengthen Cambodia's capacity to respond to nuclear and radiological emergencies by investing in necessary equipment, training first responders, and developing clear response protocols. This could include collaboration with regional partners to develop a joint emergency response framework.

### 3.5 Enhancing International and Regional Cooperation

International collaboration remains a cornerstone of Cambodia's efforts to improve nuclear safety. Continued cooperation with global and regional partners will be vital for achieving regulatory goals.

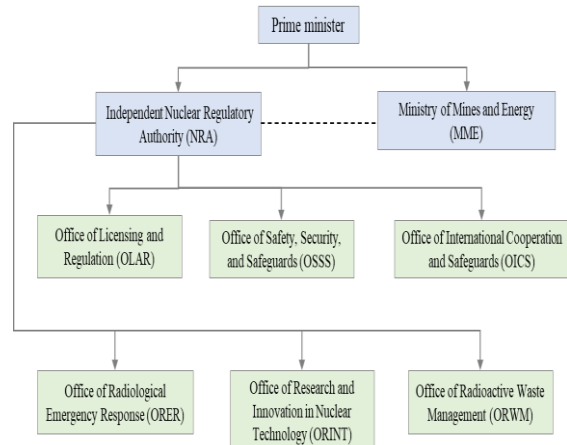
- **Strengthen collaboration with the IAEA:** Continue technical cooperation projects with the IAEA to support regulatory reforms, capacity building, and infrastructure development.

- **Foster regional cooperation:** Work more closely with neighboring countries and regional organizations to improve coordination on nuclear safety issues, including cross-border safety protocols, regional training initiatives, and shared resources for emergency response.

- **Join additional international conventions:** Cambodia should consider acceding to additional international agreements, such as the Amendment to the Convention on the Physical Protection of Nuclear Material, to further demonstrate its commitment to nuclear safety.

### 3.6 Structural Reform to Align with International Standards [8]

To strengthen Cambodia's nuclear regulatory framework and align it with international best practices, the following offices or modifications should be introduced:



**Figure 2. The department of nuclear science and technology**

#### 3.6.1 Establishment of an Independent Nuclear Regulatory Authority (NRA)

In line with IAEA recommendations and practices seen in China, Russia, and other advanced nuclear states, it is critical to establish an independent Nuclear Regulatory Authority (NRA). This body should operate independently from the Ministry of Mines and Energy (MME) to prevent conflicts of interest between regulation and promotion of nuclear activities. The NRA would oversee all aspects of nuclear safety, security, and safeguards, ensuring that Cambodia's nuclear industry complies with both national and international regulations.

#### 3.6.2 Creation of the Office of Radiological Emergency Response (ORER)

Cambodia lacks an official office dedicated to radiological or nuclear emergency preparedness, a

critical function outlined in IAEA standards and present in countries like China and Russia. This office would develop and implement national emergency response plans, coordinate with regional partners, and conduct regular drills to prepare for nuclear or radiological incidents.

### **3.6.3 Establishment of the Office of Radioactive Waste Management (ORWM)**

Compared to international frameworks, Cambodia lacks a dedicated office for managing radioactive waste, which is a key part of any nuclear safety framework, especially in countries with advanced nuclear programs. This office would handle the safe storage, transportation, and disposal of radioactive waste within Cambodia. It would also develop long-term strategies for dealing with spent fuel and radioactive sources, following the IAEA's safety guidelines.

### **3.6.4 Enhancement of the Office of Licensing and Regulation (OLAR)**

To match international best practices, the Office of License and Regulation (OLAR) should be strengthened. Countries like China and Russia have comprehensive licensing systems that cover all nuclear activities, from facility construction to decommissioning. This office would be responsible for issuing and renewing licenses for all nuclear activities, ensuring they meet strict safety and security standards. It should also be expanded to conduct routine inspections, enforce penalties for violations, and oversee compliance with international obligations.

### **3.6.5 Office of International Cooperation and Safeguards (OICS)**

To strengthen Cambodia's integration with global nuclear governance, a dedicated office for international cooperation should be established. In line with the IAEA framework and similar offices in Russia and China, this office would ensure that Cambodia adheres to international nuclear treaties and conventions. This office would manage Cambodia's commitments under international agreements, including the Non-Proliferation Treaty (NPT) and Comprehensive Safeguards Agreement. It would also coordinate with the IAEA for technical cooperation and reporting.

### **3.6.6 Establishment of the Office of Research and Innovation in Nuclear Technology (ORINT)**

Countries like China and Russia invest heavily in research and development (R&D) for the peaceful use of nuclear technology. Cambodia needs to follow suit to ensure that its nuclear program is sustainable and innovative. This office would focus on advancing nuclear technologies for peaceful purposes, such as energy production, medical uses, and agricultural applications. It would also work closely with universities and international research institutions to build local capacity in nuclear science.

### **3.6.7 Strengthening the Office of Safety, Security, and Safeguards (OSSS)**

While this office already exists, its scope should be expanded to include cybersecurity, physical security of nuclear facilities, and the safe transport of radioactive materials. These are areas where other countries have robust frameworks. The expanded OSSS would implement stringent security protocols, ensure compliance with IAEA security guidelines, and conduct vulnerability assessments to prevent sabotage, theft, or unauthorized access to nuclear materials.

## **4 Conclusion**

Cambodia is committed to improving nuclear safety but faces challenges in establishing a regulatory framework that aligns with international standards. Key areas needing improvement include legislation, enforcement, human resources, and infrastructure. By finalizing its comprehensive nuclear law, Cambodia can build a strong legal foundation for nuclear safety and security. Strengthening enforcement and inspection systems will ensure compliance and reduce risks. Investing in capacity building will help develop the necessary human resources for managing the framework effectively. Addressing infrastructure gaps, such as creating a radioactive waste management facility and improving emergency preparedness, is essential. Regional and international cooperation, especially with the IAEA, will provide technical support to sustain Cambodia's regulatory system.

The proposed measures aim to create a safe environment for nuclear technology, ensuring the country can benefit from peaceful applications while protecting public health, the environment,

and security. By tackling these challenges, Cambodia can enhance its regulatory capacity and become a regional leader in nuclear safety.

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