

ARTICLE

# Review and assessment of national efforts to manage radioactive sources and enhance nuclear security measures in Lebanon

F. Malak<sup>1,2,\*</sup>, R. Baydoun<sup>2</sup>, K. Zahraman<sup>2</sup>, D. Dimitrov<sup>1</sup> and B. Nsouli<sup>2</sup>

<sup>1</sup> Department of National and Regional Security, University of National and World Economy, Sophia, Bulgaria.

<sup>2</sup> Lebanese Atomic Energy Commission- National Council for Scientific Research, Beirut, Lebanon.

Received: 15 July 2020 / Accepted: 23 November 2020

**Abstract** – Radioactive and nuclear materials have been used for a long time in warfare. During the 20th and 21st centuries, a large number of atmospheric and underground nuclear weapons tests were carried out, even after the Non-Proliferation of Nuclear Weapons Treaty (NPT), leading to ecologically and socially destroyed sites. The most recent ones were in North Korea and Russia. With the widespread of peaceful use of radiological and nuclear material, the threats of nuclear terrorism or malicious use of these materials have become major concern across the world. Although the issuing of the Physical Protection of Nuclear Material treaty in 1997 (CPPNM), a considerable number of incidents involving radioactive materials due to unauthorized access or use were reported to the Incident and Trafficking Database (ITDB) system of the International Atomic Energy Agency (IAEA). In Lebanon, radioactive materials are vastly used in medicine, industry, research and agriculture. As a consequence, our country is facing the world common concerns and threats, especially after recent security status and geopolitical situation in the region. This work served to evaluate the current national situation relevant to nuclear security, where strong and weak points, pertinent to legal texts and procedures, were highlighted in order to deduce essential recommendations that could help in strengthening national security regime. The exerted governmental efforts were presented and discussed.

**Keywords:** radioactive materials / nuclear security / disused sources / illicit trafficking / international conventions / risk management / security regime

## 1 Introduction

The radioactive and nuclear materials have been used for a longtime in warfare leading international organizations to exert significant efforts in order to prevent the proliferation of weapons of mass destruction (WMD). The worst nuclear disaster in the world was the Hiroshima bomb in 1945. Later, many nuclear weapons testing were carried out between 1954 and 1963, causing severe damage to the environment (Prävālie, 2014). The most remarkable ones are those conducted, between 1945 and 1992, by the United States and the Union of Soviet Socialist Republics (USSR) to test the first nuclear explosions of hydrogen bomb (An *et al.*, 2015; Division of Nuclear Safety and Security, 2004; International Atomic Energy Agency, 2019a). Between 1966 and 1996, France conducted 210 atmospheric and underground nuclear tests. Seventeen of them were carried out in Algerian Sahara, and 193 in French Polynesia (Cirincione *et al.*, 2005; Peyron, 2009; United Nations, 1970a). International organizations have

exerted efforts to ban these tests (Levin *et al.*, 1994; Mastny, 2008; Rubinson, 2011), and the Non-Proliferation of Nuclear Weapons Treaty (NPT) was issued in 1968 banning nuclear arming and urging states to achieve nuclear disarmament (Sico van der Meer, 2011; United Nations, 1970b). However, few tests are still being conducted, even after the Comprehensive Nuclear-Test-Ban Treaty adopted by the United Nations in 1996 (United Nations, 1994). The most recent ones are those in North Korea carried out in 2013, 2015 and 2016 (Vishwanathan *et al.*, 2016). In August 2019, Russia carried out a nuclear test, however, this is still controversial as some reports mentioned that it was an accident (Gibney, 2019). This large number of nuclear weapons testing was responsible for extensive release of radioactive materials and radioactive wastes, leading to ecologically and socially destroyed sites.

During the last decades, the nuclear terrorism threats and unauthorized access to radioactive materials have become crucial and primary concerns across the world. Historically, recorded attacks on nuclear facilities were carried out by activists or extremists in order to disrupt the function of the facility or to create panic. However, during the last years many terrorists become knowledgeable about radiological and

\*Corresponding author: [fadi-malak-1@hotmail.com](mailto:fadi-malak-1@hotmail.com)

nuclear materials. They exerted efforts to gain nuclear materials, and nuclear facilities became vulnerable target for them. Numerous intentional damage, suspected sabotage and theft of radioactive or nuclear materials were recorded. Hence, national and international efforts were multiplied to face these acts (International Atomic Energy Agency, 2019b, 2014, 2000; United Nations, 2017). In 2005, the International Atomic Energy Agency (IAEA) amended the Convention on the Physical Protection of Nuclear Materials (CPPNM) issued in 1997, to extend the responsibilities of the states to protect radioactive and nuclear materials during use and storage, as well as transport (International Atomic Energy Agency, 2019b). In addition, IAEA established the Incident and Trafficking Database (ITDB) system to register incidents relevant to radioactive and nuclear material that are out of regulatory control. This includes illicit trafficking and malicious use of nuclear and radioactive materials. Till 31st December 2018, the ITDB has contained 3497 incidents reported by Member States (International Atomic Energy Agency, 2019b).

With the widespread of peaceful use of radioactive or nuclear materials, in different applications for civil and military purposes, another form of nuclear terrorism raised is the potential use of these materials in the manufacture of what is known as dirty bomb.

Hence, many countries had exerted efforts to develop powerful security regime to combat and mitigate the increase threats of terrorism. This was recognized in strengthening nuclear security regime and updating legal texts or establishing new ones to achieve this goal.

In Lebanon, radioactive materials of different activity and categories are widely used in various sectors such as medicine, industry, research, and agriculture, giving rise to different practices involving radioactive materials such as import, export, transport, use and disposal (Lebanese Atomic Energy Commission, 2019). However, like other countries, Lebanon is facing terrorism and potential malicious use of radioactive materials, especially after the recent security status and geopolitical situation in the region. As consequence, it was crucial to develop a strong nuclear security regime and adopt adequate physical protection measures.

The main objective of this work is to describe the national status regarding the nuclear security and physical protection measures adopted. As well as, it aims to define weak and strong points relevant to legal texts and procedures followed in order to give recommendations that could improve our security system. In addition, the efforts exerted by the government will be presented and discussed, including the main obstacles faced.

## 2 The peaceful use of radioactive materials in Lebanon

In Lebanon, a large number of radioactive materials has been used since 1960s exclusively in peaceful use of atomic energy. These sources of ionizing radiation are used in various sectors: medicine, industry, agriculture, scientific research in universities and research centers. The largest number is used in the medical field for diagnosis and therapy, especially cancer

### NUMBERS APPLICATIONS FOR IMPORTED RADIOACTIVE MATERIALS

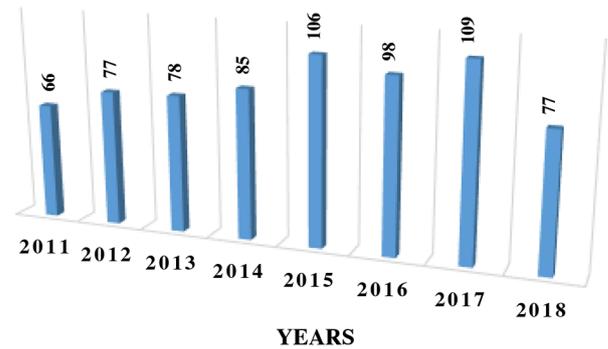


Fig. 1. Number of applications for imported radioactive materials.

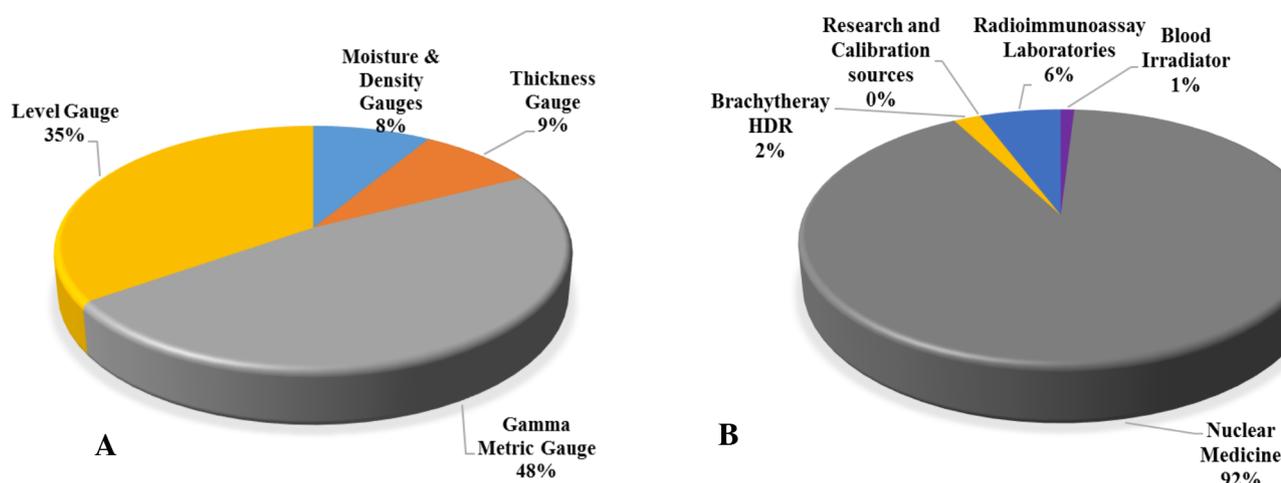
treatment. In industrial field, the radioactive sources are used in measuring the thickness, density, flow rate and packing level in different production plants, as well as in non-destructive industrial imaging specially to test aircraft cracks. The import of radioactive sources has increased during the last decades. About 1055 sources were imported between 2006 and 2019 for different purposes, where 60% were intended for medical uses, 35% scientific and medical researches, and 5% for industrial applications (Lebanese Republic, 2005). The main radioactive sources used in medicine are Tc-99m, I-131, and Ir-192 used in 32 medical facilities. While in industries, the main used ones are Cf-252, Cs-137, Co-60 and Kr-85 distributed in eight institutes. Figure 1 represents the number of applications of imported radioactive materials since 2006 till 2018. Recently, two hospitals has installed two cyclotrons and started to export produced radioactive materials mainly F-18 used in high-resolution imaging of cancer cells using PET or Positron Emission Tomography, to Iraq and Egypt.

## 3 Management of disused sources

After the application Decree 155512/2005 that assigned the radiological and nuclear control to the Lebanese Atomic Energy Commission (LAEC), a national framework to manage the disused sources was developed (International Atomic Energy Agency, 2011). All sources imported after 2005 are returned to the supplier at the end of their life cycle, based on a commitment agreement between user and seller (International Atomic Energy Agency, 2018). This agreement is a crucial requirement for import authorization, otherwise the authorization will not be granted. The main sources exported back to vendor are calibration sources and sources used in industrial applications. Hazardous disused sources of category I and category II used before 2005 were repatriated to countries that are not necessarily the country of origin. Table 1 represents the number of repatriated disused sources, their initial activity and activity at repatriation time and the country. Although this require high cost, the IAEA has provided *via* different donors (EU, Germany, Canada, USA, France) the full support to carry out five recovery missions to export Co-60 disused sources (Fig. 2).

**Table 1.** Repatriated radioactive sources.

Radionuclide	Initial activity	Activity on time	Practice	Date of issuing export license	Exported to country
Co-60	46.3 TBq	0.1231 TBq	Radiotherapy	4/12/2017	Canada
1 source	2/10/1972	26/10/2017			
Co-60	376 TBq	13.55 TBq	Radiotherapy	4/12/2017	Canada
1 source	21/8/1993	24/10/2017			
Co-60	294.9 TBq	29.8 TBq	Radiotherapy	4/12/2017	Canada
1 source	19/5/2000	24/10/2017			
Co-60	294.9 TBq	1.3976 TBq	Radiotherapy	17/8/2016	France
1 source	19/5/2000	12/8/2016			
Co-60	229 TBq	12.497 TBq	Radiotherapy	30/4/2015	France
1 source	19/2/1993	27/3/2015			
Co-60	270.5 TBq	27.7 TBq	Radiotherapy	4/11/2010	Germany
1 source	3/5/1993	19/10/2010			
Co-60	600 TBq	109.15 TBq	Research irradiator	14/5/2009	Russia
36 sources	1995	2009			

**Fig. 2.** Percentages of radioactive materials used in different practices in Lebanon: (A) in industrial field and (B) in medical field.

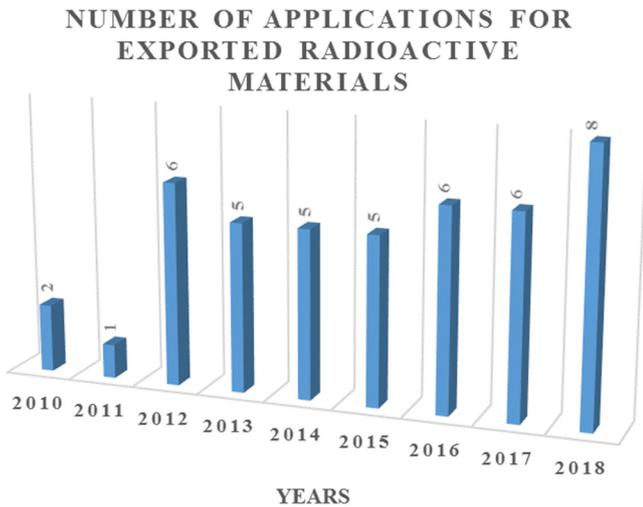
#### 4 Combating illicit trafficking

The Lebanese Customs and the LAEC are the main players in combating illicit trafficking. The Lebanese Customs are in charge of the detection of radioactive or nuclear materials passing illegally across the borders. Their capabilities were strengthened through the installation of 12 Radiation Portal Monitors at sea, land borders and at the airport. The inspectors of LAEC are carrying out systematic monitoring of exported and imported metals and routine inspection at scrap yard. Several orphan sources and contaminated metal alloys had been detected, where more than 150 incidents were reported to ITDB. A national strategy was developed for the recovery of these orphan sources, they are stored safely and securely at the temporary radioactive waste storage at the LAEC, where high levels of security measures are applied. These levels were identified based on threat assessment that was carried out and they aim to prevent unauthorized access to the MORC, sabotage, cyber-attacks and information loss and hacking. A modern surveillance system was established for interior and

exterior area access control, firewalls were constructed. A system of interlocks and restricted access to authorized staff is established.

#### 5 Traceability of radioactive materials

The Applicatory Decree 15512/2005, assigned to LAEC and the Minister of Public Health, the regulatory functions for all practices dealing with ionizing radiation. Hence, the LAEC is issuing mandatory authorization certificates to issue licenses by the MPH, for import, use and export of radioactive materials. LAEC is conducting inspection for all facilities dealing with radioactive materials. LAEC is using IAEA-Regulatory Authority Information System (RAIS) as national register. This enable tracking of radioactive materials from the import stage till the end of its life cycle. It incorporates information about radioactive materials, facilities, radiation protection officer, and workers. Figure 3 represent the life cycle and tracking of radioactive material in Lebanon.



**Fig. 3.** Number of applications for exported radioactive materials from 2010 to 2018.

After Beirut Port explosion, three hospitals in Beirut were destroyed. The national register allowed the Regulatory Body to define those using radioactive sources, there were two Cs-137 sources used in blood irradiators. LAEC had conducted inspection to these facilities in order to check the security measures and to assess any perceived hazard regarding the safety status of these sources. All safety and security measures were still adequate. The tracking procedure using the RAIS had proved that the radioactive sources that were used in well logging, and that they were stored in the vicinity of explosion were exported few weeks before (Fig. 4).

## 6 Legal framework and governmental efforts

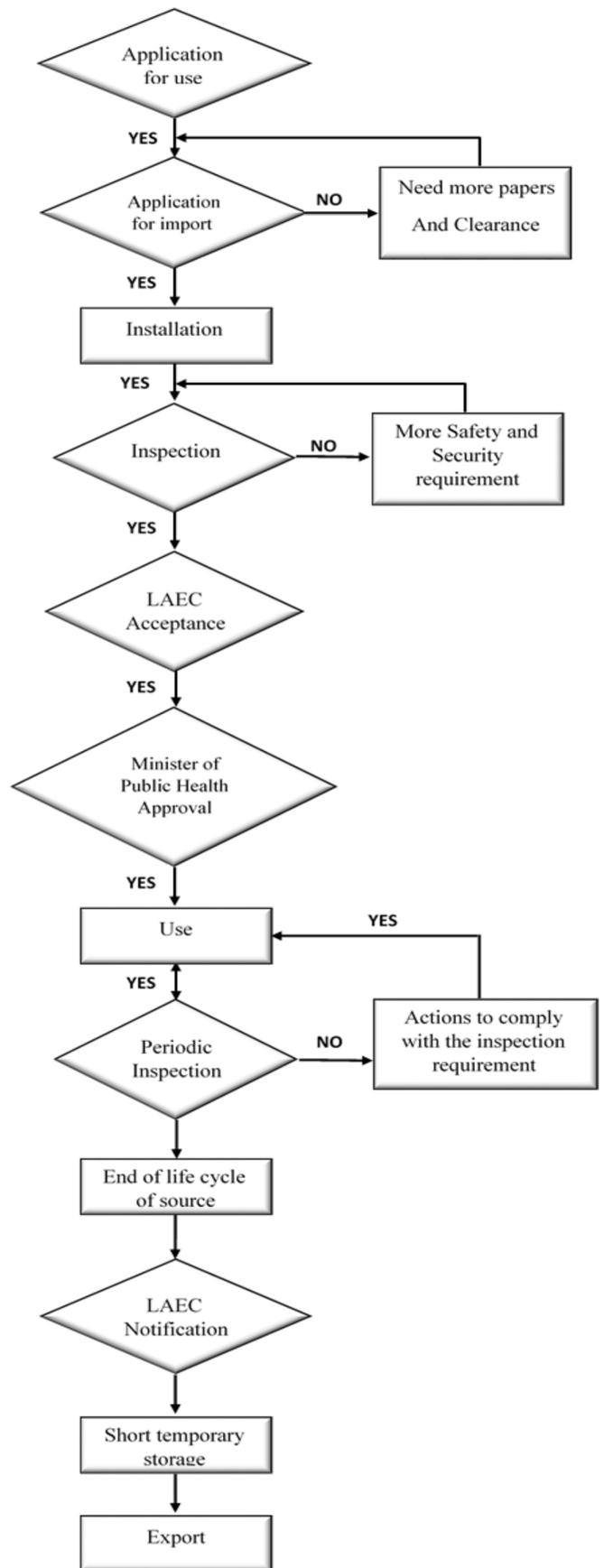
### 6.1 Legal framework

Lebanon joined global efforts to combat the proliferation of weapons of mass destruction (WMD), when he signed the Nuclear Non-Proliferation Treaty (NPT), and later the agreement with IAEA on the application of safeguards in relation to this Treaty in 1973.

In 1983, the first legislative text concerning radioactive and radiation sources, Decree Law 105/83, was issued. This law aims to regulate practices involving ionizing radiation and assigned the issuance of the licensees, as well as the enforcement concerning radiological safety issues to the Minister of Public Health.

In 1996, the Lebanese Atomic Energy Commission was established with the full support and assistance of the IAEA, with the purpose to fulfill the following mandates:

- establish the national infrastructure for radiation protection and prepare the necessary legislations for protecting the public, workers and environment against ionizing radiation (SSS and L via the establishment of a comprehensive regulatory system);
- fulfill the technical requirements related to ratified conventions and treaties in safety, security and safeguards;
- propose and implement plans for the safe, secure and transparent use of radioactive and radiation sources.



**Fig. 4.** Life cycle and tracking of radioactive materials in Lebanon.

**Table 2.** International Conventions and Treaties signed and ratified by Lebanon ([International Atomic Energy Agency, 1961](#)).

Treaty/Convention	Entry into force	Signed by Lebanon	Ratified by Lebanon	Political Commitment
Nuclear Non-Proliferation Treaty (NPT)	05/03/1970	12/06/1968	20/10/1970	
Convention of Physical Protection of Nuclear Material (CPPNM)	15/01/1998	16/12/1997	–	–
Amendment of CPPNM	2005	–	–	In progress
Convention on Early Notification of a Nuclear Accident (ENC)	18/05/1997	26/09/1986	17/04/1997	–
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	18/05/1997	26/09/1986	17/04/1997	–
Agreement between Lebanon and the International Atomic Energy Agency (SQP Agreement) on the application of safeguards in relation to the Non-Proliferation Treaty	05/03/1973	05/03/1973	–	–
Amendment of the SQP	–	2007	2007	–
Vienna Convention on Civil Liability for Nuclear Damage (VC)	17/07/1997	19/9/1995	17/04/1997	–
Code of conduct for the safety and security of radioactive sources	–	–	–	2004
Guidance of Code of conduct for the safety and security of radioactive sources	–	–	–	2007
UN Security Council Resolution 1373	28/9/2001	13/09/2019	–	–
Security Council Resolution 1540	28/5/2004	20/10/2004	–	–

In order to strengthen the radiation safety and legal status regarding the use of ionizing radiations, an Applicatory Regulatory Decree 15512/2005 of the 105/83 Decree Law ([Lebanese Republic, 2005, 1983](#)), was issued by the President of the Republic. In this Decree, the Lebanese Atomic Energy Commission and the Minister of Public Health were assigned officially the functions of Regulatory system. A draft of a comprehensive nuclear law based on the 3S concept (Safety, Security, Safeguard) and liability was prepared in 2015 by the national competent authorities. This draft was reviewed by the office of the legal affairs at the IAEA, and the Lebanese government had carried out the necessary amendment. After getting IAEA approval, the draft nuclear law was endorsed by the Board of Administration of the National Council for scientific Research and submitted by the end of 2018 to the Presidency of the Council of Ministers for promulgation. Safety regulations are in place in line with the latest IAEA safety standards and security guides. LAEC is in charge of issuing endorsement certificates for all practices dealing with ionizing radiation, which is a prerequisite for the Minister of Public Health to issue the licenses. The LAEC is responsible for the inspection and verification scheme that is related, when is relevant, to the issuance of the endorsement certificate. The LAEC established the national register of the radioactive materials and it is tracking their movement in the country till the end of their life cycles. The LAEC organizes regular training for national stakeholders involved in nuclear security regime, implements drills, and proposes scenarios focused on illicit trafficking and recovery of radioactive materials out of regulatory control and provides radiological assistance in case of emergencies

## 6.2 Steps towards powerful nuclear security regime

In 2006, Lebanon started the first step toward the establishment of nuclear security infrastructure, through the

IAEA International Nuclear Security Advisory Service (INSSrev) mission that was carried out upon governmental request. The content of the report and the recommendations therein were the milestones for the establishment and development of sustainable nuclear security regime, in which the relevant national bodies (Army, law enforcement agencies, intelligence, academia, civil defense, LAEC and relevant ministries like foreign affairs, justice, economy and trade and transport) are involved with well-defined roles and responsibilities. In 2008, the Integrated Nuclear Security Support Plan (INSSP) was drafted with the cooperation of IAEA, updated and endorsed in 2010. The last update was carried out in 2019, based on the recommendations and suggestions of the International Physical Protection Advisory Service (IPPAS) mission ([International Atomic Energy Agency, 2019c](#)) that took place in February 2019 upon request from Lebanese government. Under this context, the Lebanese Army Forces, the General Security, the Internal Security Forces had established Units specialized in CBRN materials and weapons of mass destruction.

## 6.3 Joining the global efforts

With the worldwide spread, the use of radioactive and nuclear materials during the last decades, Lebanon joined the global efforts to prevent any threat related to the unlawful use or unauthorized access to these materials and signed with international organization the relevant conventions and treaties. The most relevant ones are listed in [Table 2](#) ([International Atomic Energy Agency, 1961](#)).

## 6.4 Implementation of conventions and treaties

In 2009, a National Committee to Formulate an Emergency Response Plan to Threats from Weapons of Mass Destruction [WMD] and Chemical, Biological, Radiological, or Nuclear [CBRN] Events, was issued by the Prime Minister: Decision

number 96/2009 and Decision number 49/2010. In addition, in 2012 the Prime Minister issued a Decision number 121/2012; establishing the National Commission for the Implementation of Lebanon's Commitment to Treaties in the Development, Production, stockpiling and use of Chemical Weapons for implementation of the CW convention and to play the role of national liaison with Organization for the Prohibition of Chemical Weapons OPCW. Lebanon joined the global effort for mitigation risks and preventing threats related to the use of CBRN materials by joining the EU-CBRN-Center of Excellence initiative in 2013. The Prime Minister appointed a national CBRN focal coordinator and in November 2013 issued a Decision (Decision 179/2013) establishing the CBRN national team composed of relevant security and military directorates and institutions (LAF, GS, SS, ISF, Customs, PCM) in addition to specified ministries such as ministry of industry, financial affair, agriculture, environment, public health and LAEC. The CBRN team, based on different counter terrorism CBRN scenario, established the role and responsibility for CBRN national key players, conducted Gap analysis in 2015 and finalized the five years CBRN national action plan in 2016. In the framework of joint projects of high national impact with the EU, USA, Canada, Italy, France and Germany, the team has organized several trainings, drills in the field of emergency response regarding CBRN incident, as well as in the detection scheme of these materials.

After more than 5 years of works done by the two mentioned committees and in line with the development of the CBRN risk mitigation schemes at the national and international levels including the necessity of a well-coordinated efforts for implementing all ratified conventions and threats related to CBRN and WMD affaires, the President of the Council of Ministers, in 2018, had canceled the two decisions 121/2012 and 179/2013, and had established 'The National Commission for implementing Lebanon's international obligations related to CBRN materials and to WMD'. The main objective of this commission is to guarantee effective communication with the Organization for Prohibition of Chemical Weapons (OPCW), the International Atomic Energy Agency (IAEA) and with the Department Council with the Implementation of the Convention on Prohibition of Chemical Weapons at the United Nations Office in Geneva (UNOG).

The National Commission carried out the following duties (Prime Minister Decision 228/2018):

- defining the roles and authorities of each public administration or competent party in a precise and detailed manner in all the matters concerning mass destruction weapons, CBRN material and dual-use material as well as coordinating with it to ensure the implementation of the following procedures:
  - prohibiting the development, production, acquisition and stockpiling of mass destruction weapons (chemical, biological and nuclear weapons) as well as retaining them, transporting them or using them and applying this prohibition regarding individuals (natural or legal) within the frame of the judicial authority,
  - creating systems that particularly investigate toxic chemical material and their precursors (chemical material listed in tables 1, 2 and 3 in the annex of the Convention on Prohibition of Chemical Weapons) as well as different

types of radiological material (in conformity with the Convention on Prohibition of Nuclear Weapons and the Small Quantities Protocol [SQP]) and biological and bacterial factors (in conformity with the Convention on the Prohibition of Biological Weapons),

- implementing the provisions of the prohibition of the transport of material in tables 1 and 2 (attached to the Convention on Prohibition of Chemical Weapons) to countries that are not part of this Convention and complying with the requirement stipulating that every receiving country should issue an end-user certificate regarding the transport of chemical material listed in table 3 to countries that are not part of the Convention and should review its regulatory lists implemented in the trade of chemical material to ensure its conformity with the subject and purpose of the Convention,
- limiting the import of radiological material to authorized facilities and peaceful use,
- working on creating material protection systems in the facilities using chemical and radiological material of dual use, including their storage locations,
- working on creating effective systems to fight the illegitimate trade of CBRN material of dual use,
- proposing the necessary legal and administrative provisions as well as procedures and steps to implement the conventions regarding mass destruction weapons and CBRN material of dual use and to ensure the security and safety of the use of those material as well as to inform ad hoc international organizations concerned with any new regulation;
  - working on drafting binding reports within the frame of the pertinent conventions and sending them to ad hoc international organizations at the set deadlines;
  - assessing the risks and threats of the use of CBRN material and proposing the necessary plans for the preparedness, protection, detection and response as well as determining the needs and setting priorities;
  - working on enhancing the coordination and complementarity between public administrations and institutions and concerned security agencies in whatever mitigates the risks of unusual terrorism (CBRN);
  - working on enhancing the capacities of each concerned national party based on its role, competence and responsibilities and raising the level of its performance to ensure the efficiency of its duties within the frame of facing and managing the threats of CBRN material;
  - preparing a comprehensive national plan to manage CBRN material and reduce their risks as well as proposing plans to carry out its provisions and submit it to donors, in addition to ensuring necessary and urgent equipment as required;
  - organizing workshops, meetings and training courses for the concerned administrations on whatever enhances their capabilities in facing challenges resulting from the use of CBRN material;
  - coordinating and continuing to implement CBRN risks mitigation programs and projects with competent administrations and donors in order to prevent the duplication of efforts and to benefit as much as possible from those programs and projects.

## 7 Evaluation of the current status

From the above discussion, we realized that the current national status relevant to nuclear security regime encountered several strong points and weak points. The powerful efforts exerted by the Lebanese Government to implement treaties and to enhance nuclear security regime were recognized, especially through the establishment of the CBRN National Commission. The authorization and inspection processes, assigned to the LAEC, for all acts involving radioactive materials such as import, use, decommissioning and export, assure the traceability of movement of radioactive materials. This is supported by the updated national register managed by LAEC. Competent trained staff in radiation safety and nuclear security issues in relevant institutes help in adequate implementation of working protocols. The security institutes and ministries involved in radiological and nuclear materials applications, are working hard to spread the awareness about nuclear security culture and relevant issues. While for the weak points, the absence of a National Nuclear and Radiological Security Law is an essential gap, especially that the draft Safety Regulations doesn't include sections relevant to the security measures for radiological and nuclear materials. Even the Lebanese Government is seeking to implement international treaties, there is absence of written comprehensive physical protection regime including contingency plans in facilities or at national level as stated by CPPNM. The absence of a Design Basis Threats (DBT) could be attributed to the weak coordination between the security systems, regulatory body and operators. Insider threats are not taken in consideration for security measures, in addition to the absence of a competent team taking in charge only the inspection of physical protection measures with a dedicated adequate inspection checklist. The adopted physical protection measures do not follow the principle of graded approach based on source categories. An essential powerless feature is the poor financial resources of the Lebanese government to keep up the steady development of RN applications in Lebanon.

## 8 Enhancing current national nuclear security regime

Upon evaluating the current national security status in Lebanon, passing through the adopted national contexts to manage disused sources and orphan sources, the way to maintain tracking of radioactive materials, the efforts exerted by the Lebanese Government and after highlighting the strong and weak points, some important recommendation could be deduced and could strengthen the prevailing current status once implemented. The concerned ministries and security institutions, members in the CBRN Commission, have to urge and adopt a draft comprehensive nuclear security law and the pertinent legislations for endorsement by the parliament as national legal instruments. The establishment of a strong internal-external communication scheme and exchange of information with key national and regional partners in the field of nuclear security could facilitate cooperation and maintain accuracy of exchangeable data. The awareness about radiological and nuclear threats, especially for potential unauthorized access and insider threats, should be increased

among relevant institutes. For that reason, documented information about current and previous insiders including security and criminal background, affiliations, as well as financial and psychological status should be well maintained. The physical protection measures should be reinforced to reduce as much as possible unauthorized accessibility to radiological and nuclear materials.

## 9 Conclusion

Radioactive materials are widely used in Lebanon in medicine, industry, research and agriculture. In addition, we are facing the global threats regarding the terroristic attacks and potential malicious use. Hence, national contexts to manage disused sources and orphan sources were established based on legal texts. Combating illicit trafficking was enhanced through the installation of radiation portal monitors at borders in cooperation with the Lebanese Customs. An Integrated Nuclear Security Support Plan (INSSP) was drafted with the support of IAEA, and endorsed in 2010. This was lately updated in 2019 upon an IPPAs mission. Lebanon joined global efforts through the signature of relevant binding and non-binding treaties and conventions, and the establishment of a National Commission for implementing Lebanon's international obligations related to CBRN materials and to WMD', as well as to enhance the infrastructure of nuclear security regime and assure comprehensive adequate cooperation and inter-agency coordination between the involved ministries and institutes. The current national security regime was evaluated based on the previous information and recommendations for strengthening are suggested.

## References

- An VA, Ovtchinnikov VM, Kaazik PB, Adushkin VV, Sokolova IN, Aleschenko IB, Mikhailova NN, Kim W-Y, Richards PG, Patton HJ, Phillips W, Scott Randall G, Baker D. 2015. A digital seismogram archive of nuclear explosion signals, recorded at the Borovoye Geophysical Observatory, Kazakhstan, from 1966 to 1996. *Geo. Res. J.* 6: 141–163. <https://doi.org/10.1016/j.grj.2015.02.014>.
- Cirincione J, Wolfsthal J, Rajkumar M. 2005. *Deadly arsenals: nuclear, biological and chemical threats*. 2nd ed. Washington: Carnegie Endowment for International Peace.
- Division of Nuclear Safety and Security. 2004. *Nuclear explosions in the USSR: the north test site reference material*. 4th ed. Vienna, Austria: International Atomic Energy Agency.
- Gibney E. 2019. How nuclear scientists are decoding Russia's mystery explosion. *Nature*. <https://doi.org/10.1038/d41586-019-02574-9>. <https://www.nature.com/articles/d41586-019-02574-9>. ISSN 1476-4687 (online).
- International Atomic Energy Agency. 1961. *Lebanon Page for all treaties with IAEA*. <https://ola.iaea.org/Applications/FactSheets/Country/Detail?code=LB> (WWW document, accessed 7.1.20).
- International Atomic Energy Agency. 2000. *The radiological accident in Istanbul*. Vienna, Austria: IAEA.
- International Atomic Energy Agency. 2011. *National strategy for regaining control over orphan sources and improving control over vulnerable sources: specific safety guide*. Vienna, Austria: International Atomic Energy Agency.
- International Atomic Energy Agency. 2014. *Convention on the physical protection of nuclear material*. <https://www.iaea.org/>

- [publications/documents/conventions/convention-physical-protection-nuclear-material](#) (WWW document, accessed 7.1.20).
- International Atomic Energy Agency. 2018. *Guidance on the management of disused radioactive sources*. Vienna, Austria: International Atomic Energy Agency.
- International Atomic Energy Agency. 2019a. *The United States' Nuclear Testing Programme*. <https://www.ctbto.org/index.php?id=765> (WWW document, accessed 7.1.20).
- International Atomic Energy Agency. 2019b. *Incident and trafficking database (ITDB). Incidents of nuclear and other radioactive material out of regulatory control*. Vienna, Austria: IAEA.
- International Atomic Energy Agency. 2019c. *Nuclear security report 2019. Report by the Acting Director General No. GOV/2019/31/Rev.1-GC(63)/10/Rev.1*. Vienna, Austria: IAEA.
- Lebanese Atomic Energy Commission. 2019. *Radioactive sources in Lebanon (No. 5623)*. Lebanon: Lebanese Atomic Energy Commission–National Council for Scientific Research.
- Lebanese Republic. 1983. *Regulating the use and protection of ionizing radiation (legislative decree No. 105/83)*. Lebanon: Lebanese Republic.
- Lebanese Republic. 2005. *Regulating the use and protection of ionizing rays (applied decree No. 15512)*. Lebanon: Lebanese Republic.
- Levin I, Kromer B, Schoch-Fischer H, Bruns M, Münnich M, Berdau D, Vogel JC, Münnich KO. 1994.  $\delta^{14}\text{CO}_2$  record from Vermunt. In: *Trends: a compendium of data on global change*. Oak Ridge, Tenn., U.S.A: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy.
- Mastny V. 2008. The 1963 Nuclear Test Ban Treaty: a missed opportunity for détente? *J. Cold War Stud.* 10: 3–25. <https://doi.org/10.1162/jcws.2008.10.1.3>.
- Peyron J. 2009. *Four decades of French nuclear testing*. <https://www.france24.com/en/20090324-four-decades-french-nuclear-testing> (WWW document, accessed 7.1.20).
- Práválie R. 2014. Nuclear weapons tests and environmental consequences: a global perspective. *Ambio* 43: 729–744. <https://doi.org/10.1007/s13280-014-0491-1>.
- Rubinson P. 2011. Crucified on a cross of atoms: scientists, politics, and the Test Ban Treaty. *Dipl Hist.* 35: 283–319. <https://doi.org/10.1111/j.1467-7709.2010.00950.x>.
- van der Meer S. 2011. Not that bad: looking back on 65 years of nuclear non-proliferation efforts. *Secur. Hum. Rights* 22: 37–47. <https://doi.org/10.1163/187502311796365862>.
- United Nations. 1970a. *France's Nuclear Testing Programme: CTBTO Preparatory Commission*. <https://www.ctbto.org/nuclear-testing/the-effects-of-nuclear-testing/frances-nuclear-testing-programme/> (WWW document, accessed 7.1.20).
- United Nations. 1970b. *Treaty on the Non-Proliferation of Nuclear Weapons (NPT)*. <https://www.un.org/disarmament/wmd/nuclear/npt/> (accessed 7.1.20).
- United Nations. 1994. *Comprehensive Nuclear-Test-Ban Treaty (CTBT)*. <https://www.un.org/disarmament/wmd/nuclear/ctbt/> (accessed 7.1.20).
- United Nations. 2017. Letter dated 15 August 2017 from the Chair of the Security Council Committee Established pursuant to Resolution 1373 (2001) concerning Counter-Terrorism addressed to the President of the Security Council.
- Vishwanathan A, Chandrashekar S, Krishnan LV, Sundaresan L. 2016. *North Korea's 2016 nuclear test: an analysis – International Strategic and Security Studies Programme | NIAS | India (No. ISSSP-1-2016), International Strategic and Security Studies Programme*. Bangalore: National Institute of Advanced Studies.

**Cite this article as:** Malak F, Baydoun R, Zahraman K, Dimitrov D, Nsouli B. 2021. Review and assessment of national efforts to manage radioactive sources and enhance nuclear security measures in Lebanon. *Radioprotection* 56(2): 161–168