Third National Report of CHILE for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

October 2020

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SECTION A – INTRODUCTION

A.1 Introduction

This national report describes the activities carried out by Chile in relation to the safety of radioactive waste management (RW) and the safety of the spent fuel management (SF).

The report has been prepared prepared in accordance with the guidelines for the structure and form of national reports (INFCIRC/604/Rev.3, from May, 2014). This report, is prepared by the Chilean Nuclear Energy Commission, **CNEC**, in order to comply with the provisions of the Convention.

In Chile, nuclear and radioactive activities began during the 1960s with the creation of the CNEC, a nonprofit public entity with autonomous management and its own assets. It is related to the Government through the Ministry of Energy and is responsible for the development of nuclear science and technology in the country.

CNEC's institutional mission is to carry out research, development, applications of nuclear energy; as well as its regulation, control, supervision and inspection, providing technological services, research and development to external sectors such as Ministries, National Labs, Public and Private companies, Universities and Educational establishments, so as to make an effective contribution to science and technology knowledge, welfare, safety of people and environmental protection.

In 1965, the Chilean Nuclear Energy Commission (CNEC) was officially established by law to study the peaceful uses of nuclear energy in the country.

The main purpose of this Commission was to accelerate the introduction of nuclear techniques in the economic, social, educational and scientific life of the country. The research program would be carried out in coordination with national goals in the areas of industry, power generation, agriculture, education, scientific research, and natural resources.

The existing nuclear facilities administered by CNEC are the following:

- *A nuclear research reactor with a power of 5 MWt* (RECH-1: Chilean Experimental Reactor N° 1).
- *A nuclear research reactor with a power of 2 MWt* (RECH-2: Chilean Experimental Reactor N° 2).
- *Production plant of MTR type fuel element.*
- *Plant of conversion from UF6 to uranium metal.*

In Chile there are no nuclear power plants and it is not planned to have them in the near future.

The location of the research reactor was selected in November 1967. Different sites were considered, analyzing factors such as accessibility, demography, meteorology, wind conditions, geology, soil mechanics, seismology, topography, water and electricity availability, land availability and expansion possibilities.

The RECH-1 nuclear research reactor is located in the La Reina Nuclear Center, 12 km from downtown Santiago, with an area of 29 hectares.

The RECH-1 reactor is a pool-type nuclear research reactor with a thermal power of 5 MW. Light water is used as moderator, coolant and shielding. Beryllium is used as a reflector. The pool has a depth of 11 m and the reactor core is near the bottom of the pool.

The RECH-1 was designed to operate on high-enriched fuel (80% 235U), and operated on this fuel from 1974 to 1989. Between 1989 and 1990 it operated with medium enrichment fuels (45% of 235U). Since 1990 it operated with mixed core HEU-MEU, which was maintained until 1998, when the conversion to medium enrichment fuel was completed. In 1998 the first low-enriched fuels were loaded (19.75% of 235U) and since then it has operated with a mixed MEU-LEU core until full conversion to LEU fuel.

Spent fuel is stored in the reactor decay pool. High enriched spent fuel has been shipped to the United States twice. Spent fuel with 80% enrichment was shipped in 1998, and spent fuel with 45% enrichment was shipped in 2010.

The RECH-2 nuclear research reactor, the fuel element production plant and the Conversion Laboratory are located in the Lo Aguirre Nuclear Studies Center, located at kilometer 20, Route 68, on the way to Valparaíso.

Currently, the RECH-2 is in extended shutdown and has no nuclear fuel inside. In 2010, the 90% enriched RECH-2 reactor fuel was shipped to the United States as part of its HEU recovery program.

In the conversion laboratory, research and development is carried out to produce uranium materials, including obtaining and recovering uranium from by-products or discards of the UF6 to U metal conversion process and in the manufacture of MTR type fuel elements.

The Fuel Elements production plant supplies the RECH-1 nuclear reactor with fuel elements and has facilities and equipment for manufacturing, inspection and quality control of the fuel material and the structural elements that make up the fuel elements.

On the other hand, in the 1990s, and in order to satisfy the national needs, CNEC created the Radioactive Waste Management Unit.

The main radioactive waste generated in Chile comes from applications of nuclear techniques, hospitals, industries and research centers, with sealed sources being the most frequent. In addition, elements contaminated with radioactive material, compactable heterogeneous materials and ion exchange resins are managed.

SECTION B – POLICIES AND PRACTICES

B.1 Spent Fuel Management Policy

Chile does not have an approved SF management policy, but it does have a legislative and regulatory framework that addresses nuclear safety in general terms, not contemplating specific SF management regulations. Our country adopted the policy of reducing the enrichment of uranium in the fuels of its research reactors since 1998 and an agreement was signed with the IAEA in 2006. The implementation of this policy allowed the reduction of highly enriched uranium from the 90%, 45% enrichment and subsequently less than 20% low-enriched uranium.

Chile does not have a final disposal facility. The spent fuels generated from the operation of the research reactor, to which, at present, they are not expected to be used later, have been chosen to have them for the time being in wet storage, however, if the spent fuels are kept in the For decades, one could expect corrosion degradation, while maintaining water quality at the recommended levels.

The Law establishes the following:

- that it will be the responsibility of the operator (Legal Representative) to provide the necessary means for the treatment and definitive storage of radioactive waste and it will not be able to store radioactive waste in national territory, unless it is produced or originated in it.
- CNEC will be responsible for the maintenance and protection of the national infrastructure for the management and permanent storage of long-lived nuclear or radioactive waste.

In our country, the search for a temporary solution for the safe storage of spent fuel elements generated by the operation of the CNEC reactors has a high institutional importance. But the determination has not been made to carry it out.

For the 2005-2006 biennium, an activity was developed within the framework of Project RLA / 3/004 "Spent Fuel Management for Research Reactors", in which a container was designed for the interim dry storage of the spent fuel elements of the CNEC reactors. In order to verify the nuclear and radiological safety conditions, a criticality and shielding analysis has been carried out for this conceptual design.

Dry storage in prolonged and interim conditions is the option that best adapts to the current conditions of the country's nuclear development. This option complies fully with the fundamental criteria of containment, confinement and recoverability.

B.2 Spent Fuel Management Practice

The spent fuel generated in Chile comes from the RECH-1 research reactor located in La Reina, city of Santiago. The total mass of U-235 in the nucleus is of the order of 5 kilograms. The fuel is used until it reaches an average combustion of 40% U-235, and is then stored wet pending intermediate storage.

Since the beginning of the operation of nuclear research reactors, spent fuels have been stored wet in the decay pool of RECH-1.

Chile has preferred to send spent fuels for storage to other countries. In particular, agreements were signed with the government of the United States of America, for the withdrawal of spent fuel.

Currently and in the future, low-enrichment fuel elements will continue to be stored in the decay pool, while the country decides on a solution in this regard, the GC will have enough cooling time, so that the heat dissipates and the fission products decay, and subsequently managed and relocated to a suitable facility for extended interim storage.

B.3 Radioactive Waste Management Policy

Chile does not have an approved radioactive waste management policy, however there is a legislative and regulatory framework that addresses safety and radiological protection aspects applicable to the management of radioactive waste generated in the country.

The Law establishes that it will be the responsibility of the operator (Legal Representative) to provide the necessary means for the treatment and definitive storage of radioactive waste and that it will not be able to store radioactive waste in national territory, unless it is produced or originated in it.

It will be the responsibility of CNEC to maintain and protect the national infrastructure for the management and permanent storage of nuclear or radioactive waste of long-lived.

The management and storage of radioactive waste generated in the country is carried out by the CNEC through **the radioactive waste management section, SEGEDRA**, which is duly authorized by the regulatory authority in compliance with current regulations.

Chile does not have a final disposal facility for radioactive waste and the State has not ruled on the matter, which is why radioactive waste is conditioned and stored in SEGEDRA so that it can comply the acceptance criteria in a future final disposal facility

Only some facilities in Chile, such as the research reactor and facilities in the medical area, have been authorized to discharge or release gaseous and liquid radioactive waste into the environment based on the clearance limits recommended by the IAEA.

On the other hand, the regulatory authority has not implemented the use of the clearance limits in the management of radioactive waste. But if it, have implemented the solid materials clearance in accordance with IAEA recommendations.

B.4 Radioactive Waste Management Practice

Radioactive waste in Chile is defined as any radioactive material obtained during the process of production or use of nuclear fuels, or whose radioactivity has originated from exposure to radiation inherent in said process, and radioisotopes that having reached the final stage of its preparation and being able to be used for scientific, medical, agricultural, commercial or industrial purposes, are discarded.

CNEC is the only authorized entity in the country for the management of radioactive waste, it is therefore that through SEGEDRA, most of the radioactive waste generated in the country is managed, except the waste for the very short half-life, less than 100 days, from medical facilities that manage their own radioactive waste.

SEGEDRA located in the Lo Aguirre nuclear center, has the minimum infrastructure necessary to carry out the work of reception of radioactive waste, treatment, conditioning, storage awaiting treatment and storage of conditioned radioactive waste of medium and low activity, generated in the country.

The methodology to be used for the practice of radioactive waste management is to ensure the following:

- The radioactive waste that is received is handled safely, meeting the objectives of protecting people and the environment, and its record is kept in a computerized system and on paper.
- The processing of radioactive waste and its storage pending treatment, is based on international recommendations and standards and comprises a series of activities that are carried out with documentation and through which the Radioactive Waste Management Section, SEGEDRA, shapes the waste, so that they can be handled, transported, stored and / or disposed of safely for people and the environment.
- From the process, a bulk of conditioned waste is obtained that is transferred to storage in a facility designed for it.
- Products that do not meet the standards required in the radioactive waste conditioning process are registered as non-compliant.
- The effluents generated are managed in safe conditions, in accordance with the principles of radioactive waste management, considering rules of hygiene and industrial safety, and radiological and environmental protection, keeping a record of it.
- Radioactive waste, for which processing has not been defined, are stored awaiting treatment, in safe conditions, in compliance with current regulations and keeping a documented record of it.

Radioactive waste in Chile, from applications in industry, medicine, research and teaching is low and medium activity. These wastes are generated from the following practices:

- Production of Radioisotopes: in the processes of separation and purification in hot cells, small volumes of liquid radioactive waste of intermediate level and higher volumes of solids of low activity as papers and laboratory material are generated. The generated waste is stored in the cell, to be removed, transferred to the radioactive waste management facility and arranged in a place for its natural decay.
- Medical applications: that use nuclear techniques in both diagnosis and treatment of patients, mainly from nuclear medicine using radioisotope I-131 for clinical therapy. In clinical diagnosis and therapy monitoring, the main radioisotopes used areTc-99, P-32, Y-90 and Sm-153. Nuclear medicine facilities manage their own radioactive waste, since the radioactive material used corresponds to radioisotopes with a half-life of less than 100 days. All radioactive material generated as waste is stored in a duly authorized place. Radioactive waste is stored for at least 10 half-lives, and can then be managed as non-radioactive waste if the dose rate is less than 3 times the bottom measurement.
- Another medical application that generates radioactive waste from the practice of radiotherapy is teletherapy, where sealed sources Co-60 are used and in brachytherapy sealed sources Cs-137 and Ir-192 are used; these sources are managed as radioactive waste in SEGEDRA.
- Industrial applications such as nondestructive testing, mainly industrial gammagraphy, using sealed sources of Ir-192, Se-75 and Co-60; nuclear gauges like thickness, level, and humidity gauges and food sterilization. Generally, all these sources are returned to the supplier, otherwise they are managed in SEGEDRA. Most of the industrial sources of category 3, 4 and 5 of IAEA are managed in SEGEDRA.
- There are also research facilities such as metabolic and toxicological studies associated to different compounds such as drugs, pesticides, fertilizers and minerals. They are related to production of new drugs, agricultural research and environmental studies. The generated waste mainly contains C-14 and H-3, because they can easily be incorporated into complex molecules.
- In compounds marking using I-125, I-131, H-3 and C-14, generated waste consist of laboratory materials, paper, personal protective clothing and commonly are of the order of MBq.

- In research, in solid state physics, post-radiation behavior of materials, development of reactor materials and non-destructive testing, H-3 and C-14 are the main radioactive contaminants and the wastes are lab material; heterogeneous solid (ion exchange resin, equipment pieces containing depleted uranium and fission products such as Cs-137 and Sr-90).

The current production capacity of the radioactive waste management facility is 1 to 2m3 of conditioned radioactive waste, and its production capacity can be increased, according to the needs and available resources, considering that the current structure can be expandable, according to needs future.

B.4.1 Criteria used to define and categorize radioactive waste

The classification of radioactive waste in Chile is according to the half-life of radioisotopes, in relation with the internal regulations of the CNEC. corresponding to:

- **Category 1:** Alpha emitting radioisotopes, whatever their activity.
- **Category 2:** Radioisotopes with beta and gamma emitters whose half-life is greater than 100 days.
- **Category 3:** Radioisotopes with beta and gamma emitters whose half-life is less than 100 days.

To facilitate handling and management of the radioactive waste can be classified internally into compactables, heterogeneous, granular, sealed radiation sources and organic or aqueous liquids.

In Chile there is a proposal for a regulation on the management of spent fuel and radioactive waste. Currently is in Ministry of Energy in the process of analysis and approval by the Government, where the classification and dispensing of radioactive waste is considered based on the IAEA recommendations.

SECTION C – APPLICATION SCOPE

In accordance with Article 3(1) of the Joint Convention, Chile does not perform reprocessing as part of spent fuel management.

In accordance with Article 3(2) of the Joint Convention, the present National Report does not consider natural radioactive materials.

In accordance with Article 3(3) of the Joint Convention, Chile has not destined radioactive waste and/or spent fuel in military or defense programs.

SECCION D – INVENTORIES AND LISTS

D.1 Inventory of radioactive waste in Chile, according to processing:

Next, in table N°1, Below is a summary of the SEGEDRA inventory. Every year, SEGEDRA receives approximately 10 to 20 m3 of radioactive waste, which must subsequently be treated and conditioned. Of the total volume received, 40% corresponds to sealed radiation sources in disuse.

In the following table, the current inventory (year 2017) of radioactive waste stored in SEGEDRA facilities is presented

Table N°1. Inventory Summary

Amount	Unit	Type	Description	Location	Category	Percentages
1830	Liters	Liquid radioactive waste	Concentration activity in MBq per gram	Storage ponds within the radioactive waste treatment plant	Category 1	100%
12	Cubic Meters	Ion Exchange resins	Concentration activity in KBq per gram	Storage facilities for the research reactor's ion Exchange resin	Category 2	100%
38	Cubic Meters	Compactable sealed sources heterogeneous and cemented liquids	Distributed in immobilized packages conditioned of 200 liters	Storage facility for radioactive waste	Category 1 Category 2	20% 80%
15	Cubic Meters	Disused sources of teletherapy	activity measured in TBq		Categoría 2	100%
2	Cubic Meters			Container Temporary Storage	Categoría 2	100%
8	Cubic Meters	Short-life radioactive waste	With average activity concentrations of kBq to MBq per gram	Storage facility for radioactive waste / Modular Temporary Storage Facility	Categoría 2 Categoría 3	10% 90%

The radioactive waste that is received at CNEC comes from nuclear applications in Industries, Hospitals, Universities and CNEC itself. Table N ° 1 presents the percentage in volume of the origin of the radioactive waste of the country, which has been managed in CNEC from 2005 to 2016.

Table N°2. Origin of radioactive waste managed in CNEC per year, in percentages

GENERATOR	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Hospitals	11	0	33	16	7	8	10	0	22	27	9	13
Universities	11	13	4	4	10	6	0	2	4	0	2	0
Industries	49	28	59	44	39	18	26	63	26	29	71	63
CNEC	29	59	4	36	44	68	64	35	48	44	18	25
TOTAL, %	100	100	100	100	100	100	100	100	100	100	100	100
TOTAL, m^3	10	3.9	9.5	9.2	7.1	11	10	20	4.5	12.2	10	8

Source: SEGEDRA, Chilean Nuclear Energy Commission

According to the physical-chemical and radiological nature of these wastes, they have been classified into heterogeneous, granular, compactable, sealed radiation sources, organic and inorganic liquids, according to which the treatment and subsequent conditioning that will be given with the object of configuring a package of radioactive waste that can remain in the environment under controlled safety conditions, this is concentrated and confined to a minimum dose at its contact, thus giving security to the most exposed individuals, the public and the environment.

Table N ° 3 presents the percentage of the types of radioactive waste managed in the last 8 years, and the total volume of waste managed per year. The majority of the radioactive waste managed by SEGEDRA corresponds to compactable material and disused sealed radiation sources; the latter, in an average amount of 100 to 150 units per year, mainly from mining and industries.

Table N° 3. Types of radioactive waste generated in Chile, from 2005 to 2013

Type of waste	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Heterogeneous	3%	21%	0.3%	1%	5%	5%	0,2%	0.5%	1%	11%
Granular	0%	0%	0.7%	2%	0%	0%	0%	3.25	0%	0%
Inorganic liquids	0%	7%	1%	0%	0%	0.2%	0%	0%	0%	0%
Organic liquids	0%	0%	1%	3%	1%	1.8%	0%	0%	1%	0%
Sealed radiation sources	76%	53%	57%	33%	33%	64%	2,1%	6.7%	81%	71%
Compactable	21%	19%	40%	61%	61%	29%	2,2%	1.8%	18%	17%
TOTAL VOLUME m^3/year	9,5	9,2	7,1	11	10	20	4,5	12.2	10	8

Source: SEGEDRA, Chilean Nuclear Energy Commission

Currently there is an approximate amount of 84m3 of radioactive waste in CNEC, product of nuclear applications in the country, that come from CNEC and from external radioactive facilities. Of these, a volume of 53m3 is stored in conditioned form. The capacity of the Radioactive Waste Storage Facility, IADRA, located at CEN Lo Aguirre, is 48 m3, a capacity that is currently 100%.

The rest, a volume of 30 m3 is awaiting treatment and a volume of 1.6 m3 is in the processing stage. Table N°4 presents the current inventory of radioactive waste in the radioactive waste management facilities of CNEC.

TABLE N°4. Inventory of Radioactive Waste in CNEC

FACILITY	WASTE AWAITING FOR PROCESSING m^3	WASTE IN PROCESS m^3	CONDITIONED WASTE m^3
RADIOACTIVE WASTE LA REINA	19	0	0
TREATMENT PLANT LO AGUIRRE	5.2	1.6	0
CONDITIONED RADIOACTIVE WASTE LO AGUIRRE	1.5	0	0
OPERATIONAL WAREHOUS	1.5	0	0
RADIOACTIVE WASTE CONDITIONED LO AGUIRRE	2	0	53
TOTAL VOLUME m^3	27	1.6	53

D.2 Inventory of Spent Fuel in Chile:

Next, you can visualize the inventory of spent fuel located in RECH-1's decay pool that would probably not return to the core.

Table N ° 5 shows the identification number of the spent fuel, the total uranium mass and the uranium 235 mass.

Table N°5. INVENTORY OF SPENT FUEL IN CHILE - OCTOBER 2020

Número de Identificación	Uranio Total [g]	Uranio 235 [g]
LR 02 L	989,86	106,55
LR 01 L	991,04	108,21
LR 04 L	993,22	110,12
LR 03 L	993,62	110,61
LR 63	1.018,41	116,18
LR 67	1.019,56	116,26
LR 65	1.022,95	120,85
LR 64	1.023,33	121,18
LR 61	1.025,11	123,80
LR 58	1.025,92	124,48
LR 52	1.027,97	126,71
LR 62	1.028,30	127,22
LR 53	1.029,42	128,40
LR 45	1.013,15	129,09
LR 44	1.013,94	129,93
LR 51	1.031,79	131,03
LR 55	1.032,05	131,37
LR 82	1.024,79	132,26
LR 59	1.033,46	133,08
TOTAL	**19.337,89**	**2.327,33**

The spent fuel from the RECH-1 nuclear research reactor an average burn of 40% of U-235, Approximately 2.5 spent fuel elements are generated in one year, which are stored wet pending interim storage.

SECTION E – LAW AND REGULATION SYSTEM

E.1 Regulatory framework description

The Law of Nuclear Safety (Law No. 18.302) on its article No. 2, establishes that regulation, supervision, control and inspection of the activities related to the pacific use of nuclear energy, facilities and materials correspond to the CNEC and the Ministry of Energy.

Article No. 4 of the same Law states that for the location, construction, commissioning, operation, closing and decommissioning of facilities, plants, laboratories, centers, and nuclear equipment needs authorization of CNEC.

On the other hand, nuclear power plants, enrichment plants, reprocessing plants and permanent storage deposits of radioactive waste, shall require to be approved by Supreme Decree issued through the Ministry of Energy.

The CNEC has the function to regulate, monitoring, controlling and supervising all the activities related to the pacific use of nuclear energy along with the facilities and nuclear substances used in them, in order to contribute to health protection, security, people safety, goods and the environment.

Chilean regulations do not establish a clear and specific procedure to grant licenses for nuclear facilities, however the Nuclear Safety Law, (Law No. 18,302), indicates that nuclear facilities require an authorization for siting, construction, and commissioning. , operation, closure and decommissioning. For the granting of said authorizations, the conditions that allow the preservation of a pollution-free environment must be considered. In addition, there must be a number of people with special authorization to work for them as determined by the commission, considering the physical, psychological and professional conditions that concur in the interested party.

Supreme Decree 133/84 is the regulation used to grant licenses to radioactive facilities. In the event that there is no specific guidance on technical issues that are not regulated in national standards, including the case of nuclear facilities, the adoption of IAEA recommendations.

The Government of Chile has jurisdiction over the CNEC, an autonomous administration body of the state that is governed by the provisions of the law, its regulations and internal regulations issued by the Board of Directors. The CNEC is related to the supreme government through the Ministry of Energy and is directed and administered by a Board of Directors and an Executive Director. The councilors are appointed by the President of the Republic, for a period of three years, unless they no longer have their trust, and in this case they may be re-appointed.

Some of CNEC's objectives in the nuclear safety regulatory field are to promote a safety culture that encompasses both the individual component (managers and workers) and the collective component (organization) in their relationship with safety; strengthen the competencies of the officials that make up the regulatory body; systematize communication to the various interest groups, improving their knowledge of the regulatory function and incorporating them into the regulatory process; and permanently update the regulations, so that they adapt to national needs and in accordance with good international practices.

E.2 Legislative and regulatory framework

The hierarchy of the regulatory framework is based on:

1° National Constitution.
2° Constitutional Organic Law
3° Law and Law Decree
4º Supreme Decree
5º Rules.

The legislative and regulatory framework applicable to nuclear and radioactive facilities in Chile, is defined by the following laws and regulations:

a) Law Nº 18.302: 1984's NUCLEAR SAFETY LAW. This law has six titles: OF REGULATORY AUTHORITY, defines the different regulation bodies and their respective application scopes, NUCLEAR SAFETY DEFINITIONS, establishes the general criteria related to nuclear safety, including authorizations and requirements to operate a nuclear facility, the obligation to inform and the inspections, VIOLATION OF LEGAL RULES ON SAFETY AND NUCLEAR PROTECTION, establishes the penalties that can be applied in case of non-compliance, CIVIL LIABILITY FOR NUCLEAR DAMAGE, sets the amount and types of insurance that cover nuclear damage, OF RADIOACTIVE FACILITIES, sets the competent authority for the control of radioactive facilities, the responsibility of the elaboration of rules applicable to those facilities and competence to propose new regulations on radiation protection and nuclear security lies in the CNEC. The regulations related to radiation protection and authorization as a supreme decree shall be proposed by the Ministry of Health and the Ministry of Energy.

b) LAW N° 19.300: LAW OF GENERAL RULES OF THE ENVIRONMENT, from April, 1994. This law has six titles: GENERAL ASPECTS, ENVIRONMENTAL MANAGEMENT TOOLS, Sets projects requiring environmental assessment. Projects requiring environmental assessment include nuclear power stations, nuclear facilities and related, and production, storage, transportation, disposal or reuse of radioactive material, LIABILITY FOR ENVIRONMENTAL DAMAGE, INSPECTION, ENVIRONMENTAL PROTECTION FUND, NATIONAL COMMISSION OF THE ENVIRONMENT.

c) Supreme Decree Nº 115/76: APPROVES BASIC RADIATION PROTECTION STANDARDS, from April, 1976.

d) Supreme Decree Nº 87/84: REGULATION ON PHYSICAL PROTECTION OF NUCLEAR MATERIAL AND NUCLEAR FACILITIES, from 1984.

e) Supreme Decree No. 82/20: APPROVES THE REGULATION OF PHYSICAL PROTECTION OF RADIOACTIVE MATERIALS IN FIRST CATEGORY RADIOACTIVE FACILITIES, of July 2020, establishes the provisions for the physical protection of radioactive materials that are produced, treated, handled, stored or used in radioactive facilities of the first category.

f) Supreme Decree Nº 133/84: REGULATION OF AUTHORIZATION OF RADIOACTIVE FACILITIES OR EQUIPMENT THAT GENERAL IONIZING RADIATION, PERSONNEL WORKING IN THEM, OR OPERATE SUCH EQUIPMENT AND OTHER RELATED ACTIVITIES, from August, 1984. This decree classifies the different radioactive facilities, according to the risk of the practice, required authorizations and associated requirements for facilities and workers, including import, export and radioactive material transportation and how to apply sanctions.

g) Supreme Decree Nº 3/85: REGULATION ON RADIATION PROTECTION OF RADIOACTIVE FACILITIES, from January, 1985. Establishes the acceptable dose limits

(based on No. ICRP 26) and the requirements for personal dosimetry services provided in the country.

h) Supreme Decree Nº 12/85: REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIAL, from June, 1985. This is a transcript of the 1985 version of the Safety Guide No. 6 from the IAEA "Regulations for the Safe Transport of Radioactive Material".

i) Supreme Decree N° 40/2013: REGULATION ON THE ASSESSMENT SYSTEM OF ENVIRONMENTAL IMPACT. Published in the Official Gazette on August 12, 2013. Establishes a categorization of projects according to the potential environmental damage and the procedure for carrying out the environmental assessment of each category.

Chilean Law does not establish a licensing process for nuclear facilities, except for the mention in the Nuclear Safety Law, which indicates that nuclear facilities require authorization for siting, construction, operation and decommissioning. The decree used to issue authorizations for radioactive facilities is the Supreme Decree 133/84. For technical issues that are not regulated in national standards, including the case of nuclear facilities is the adoption of the IAEA recommendations or the supplier country regulations, when there are no specific guidance documents from the IAEA.

j) Supreme Decree No. 323/74: LICENSING REGULATION OF THE CHILEAN NUCLEAR ENERGY COMMISSION REGARDING THE INDICATED ACTIVITIES. Published in the Official Journal of July 18, 1974. establishes the conditions and procedures that will govern the granting of licenses to civil entities to carry out activities related to fertile, fissional and radioactive materials and sources of ionizing radiation.

k) Internal Safety regulation of CNEC: NCS-DR-01 "Radioactive Waste Management". It establishes the activities and technical and administrative procedures to authorize, carry out, control and record the management of radioactive waste.

In addition, figure 1, shows other regulatory documents from Chile.

CONCEPTUAL MAP OF THE LEGISLATION IN CHILE

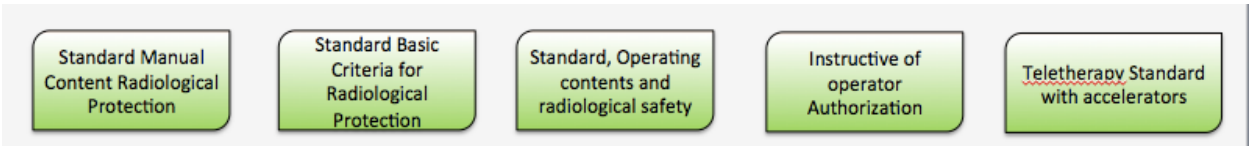

Figure 1: CURRENT REGULATIONS OF CHILE

E.3 Regulatory Body

The country has two regulatory authorities to control and oversee nuclear and radioactive facilities:

- **CNEC Regulatory Authority:** in charge of **first category** radioactive facilities (associated with the regulation of radionuclides with higher activity and higher radiotoxicity). CNEC also controls and oversees nuclear facilities.

- **SEREMI Regulatory Authority:** (Regional Ministerial Health Undersecretaries of Health): in charge of **second and third category** radioactive facilities (associated with the regulation of radionuclides that have low activity.

The Chilean government has jurisdiction over the CNEC and SEREMI through the Ministry of Energy and the Ministry of Health.

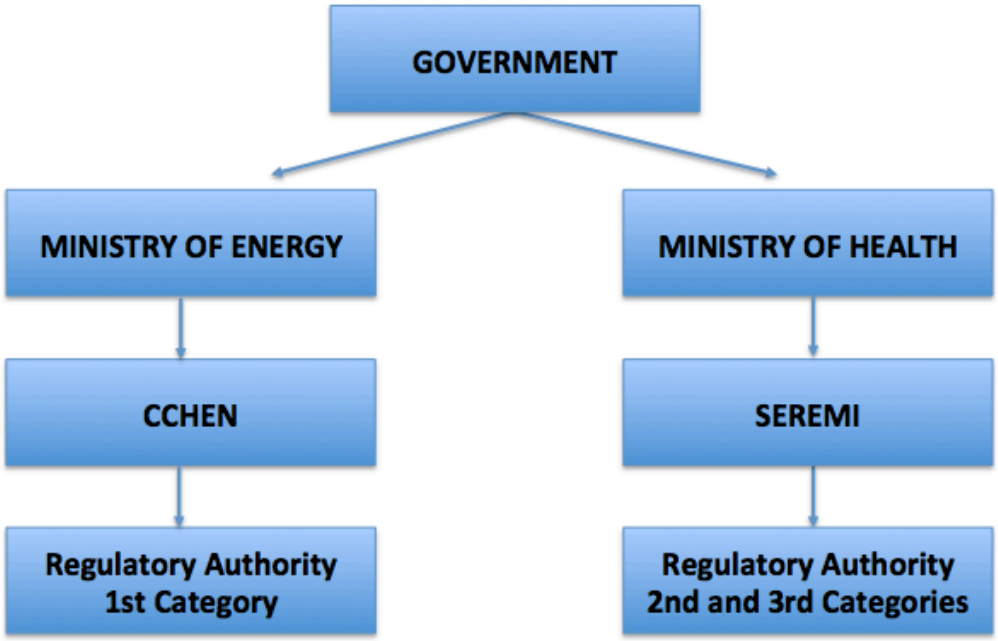

Figure 2: REGULATORY BODY IN CHILE

According to Supreme Decree No. 133/84. Radioactive facilities are classified into the following categories:

1st Category (CNEC):

- Particle accelerators
- Irradiation plants
- High radiotoxicity laboratories
- Radiotherapy and deep Roentgentherapy,
- scintigraphy
- industrial radiography (X-rays)

2nd and 3rd Categories (SEREMI):

- Low radiotoxicity laboratories
- Dental X-rays for medical or dental diagnosis
- Superficial radiotherapy
- Industrial gauges
- standard sources

figure 3 shown below, where a diagram of the government's jurisdiction over the CNEC is displayed, which fulfills a double function, as a Regulatory Authority and Operator (operator) of Nuclear and Radioactive Facilities.

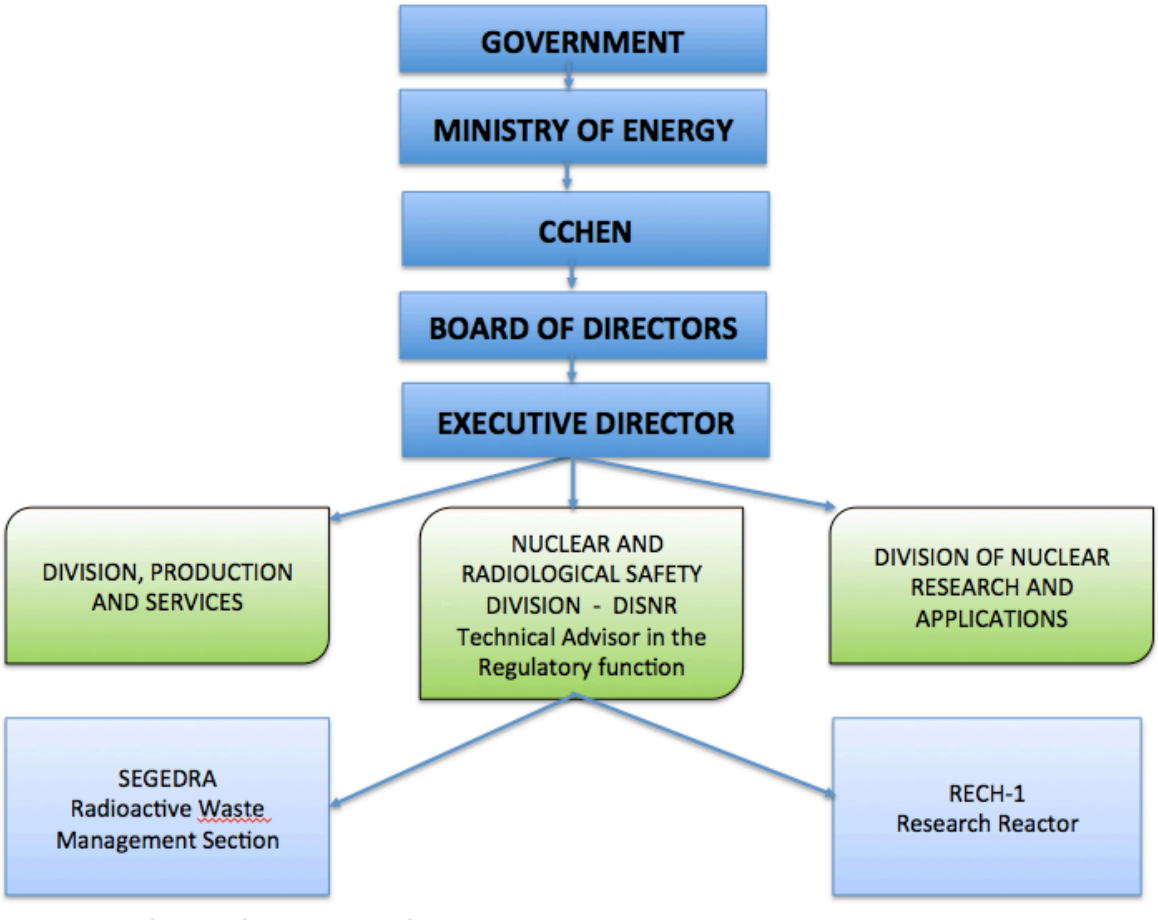

Figure 3: INSTITUTIONAL FRAMEWORK OF CHILE

SECTION F – OTHER GENERAL DISPOSITIONS RELATED TO SECURITY

F.1 Responsibility of the licensee

The main responsibilities of the licensee (operator) are as follows:

a) The Legal Representative of the Institution (hereinafter the Operator); is responsible for the operation of the installation and that the personnel operating it comply with the legal provisions and the limits and conditions established in the license (hereinafter authorization), and will be responsible as long as the installation is not transferred to another duly authorized Operator Comply with the limits and conditions established in the authorization.

b) The Operator must obtain all other permits and authorizations established in current legislation.

c) The Operator must operate the Facility under the operating and safety procedures established in the regulatory documentation. In particular, the legal representative and the operators must comply with the provisions indicated in the Radiological Protection Manual.

d) Radioactive facility of the first category must always be under some type of authorization granted by the Commission, be it Operation Authorization, Temporary Closure or Definitive Closure.

e) The Operator must have a specific authorization before using the Facility in an activity not contemplated in the licensing documentation. The lease, sale, transfer to any title, disablement, dismantling or any other destination of the facility is considered to be included.

f) The operator must comply, permanently and within the established deadlines, with the requirements derived from the inspection actions.

g) The Operator will always be responsible for the security of its location, commissioning, operation and temporary or permanent closure.

h) Take responsibility for nuclear or radioactive damages that could occur in the facilities under its control.

i) Comply with the requirements of the competent authority regarding the number of people authorized to work in each facility, plant, center or laboratory.

j) Meet the requirements of the competent authority on the amount of authorized people to work in each facility, plant, center or laboratory.

k) Provide the necessary means for the treatment and definite storage of radioactive waste. It is forbidden to authorize nuclear or radioactive waste in the country, unless they are originated in it.

l) Develop and maintain emergency plans reviewed and approved by the regulatory body for radioactive or nuclear accidents that may occur in their facilities.

m) Prevent damages arising from theft or loss of nuclear substances and radioactive material.

n) Provide, to the requirements of the regulatory body, enough guarantee for decommission and comply with any requirement established in the regulation, when giving up a license or authorization.

The way to verify that the operator has assumed its primary responsibility for the safety of the radioactive or nuclear facility is through inspection, where the inspectors verify compliance with the conditions and requirements of authorization and compliance with current legislation.

F.2 Human and financial resources

The legislation provides operator with the obligation to have an amount of qualified people determined by the Competent Authority. These people with special authorization to work in radioactive facilities will receive adequate training on the risks it involves and the security measures that will have to comply.

Financial resources for the maintenance and protection of permanent storage deposits for long-lived radionuclides and nuclear waste is a responsibility given to CNEC by Nuclear Security Law No. 18.392

Regarding to radioactive waste that are not "long-lived", the national legislation demands to the operators of radioactive facilities the safe management of radioactive waste generated in them, thus operators must consider the financial costs.

CNEC's nuclear and radioactive facilities are state-owned; the State covers the financial costs for installation and operation of radioactive waste and spent fuel.

National legislation does not consider in advance the financial resources that radioactive and nuclear facilities should have for the program for the decommissioning and dismantling of radioactive waste and spent fuel, however, as they are state-owned facilities, the state must cover with financial resources. for these purposes.

F.3 Quality assurance

CNEC has established and implemented a quality management system based on the ISO 9001 standard; Based on this, it has defined its policy, has a quality manual and the operational and support processes are established in procedures and documented. There is currently a project that seeks to establish a comprehensive management system, based on the IAEA GRS part 2 guide, that integrates all systems in order to establish and maintain leadership and management for safety.

All CNEC facilities, including radioactive and spent fuel management, are under a quality management program being audited periodically. This quality program is based on the system norm of quality management of ISO 9001:2008 requirements and each facility has its own quality plan.

Regarding quality assurance, SEGEDRA has a quality management system based on ISO 9001: 2015, a system that allows traceability to each of the stages of the radioactive waste management process from reception to storage prior to final disposal. .

The quality assurance of the fuel elements is obtained through a quality control system for each of the stages of the manufacture of the fuel elements. In addition, control is implemented and recorded for tracking the fuel elements from their entry into the core to storage in the decay pool. This quality control is through measurements and tests of the different parameters related to the FS.

F.4 Operational radiation protection

The norm that refers to the legal requirements on radiation is the Supreme Decree No. 3 from 1985, based on ICRP 26, which defines the dose limits, and establishes general conditions of radiation protection, as well as the requirements for personal dosimetry services.

Establishes personal radiation protection measures and radioactive dose limits that people that are occupationally exposed may receive, in order to prevent and avoid overexposure to ionizing radiation and its effects on health.

For the operation of the existing radioactive waste and spent fuel management facilities in the country, the CNEC has established radiological protection programs such as the "**Operational Radiological Protection Manual**", that establishes specific aspects of the facility, such as radiological characterization, operating procedures, safety procedures, radiological surveillance, detection instruments, personnel training, records. It also establishes the dose limits lower than those established in Supreme Decree No. 3 and ensures good procedures in the operation, protection of workers and the public from unnecessary exposure to ionizing radiation.

Annual limits for individuals from the public will be equal to 1/10 of the corresponding maximum permissible doses indicated according to the Supreme Decree No. 115/76. The dose limits for workers exposed to ionizing radiation, according to Supreme Decree No. 3, they are the following:

Exposed organ	*Dose limits*
Whole body, gonads, bone marrow	5 rem/year
Eye's lens	30 rem/year
Any other body organ individually	50 rem/year

According to the safety standard NS-02.0 of the year 2018, on Basic Criteria for Radiological Protection, it establishes the primary limits and reference levels in relation to nuclear facilities and radioactive facilities of the CNEC, which are shown below:

The limits for occupational exposure of exposed workers are as follows:

a) Effective dose: 20 mSv per year averaged over 5 consecutive years (100 mSv in 5 years) and 50 mSv in any one year.
b) Equivalent dose in the eyes lens: 20 mSv per year averaged over 5 consecutive years (100 mSv in 5 years) and 50 mSv in any one year.
c) Equivalent dose to extremities or skin: 500 mSv in one year.

The limits for an individual in the public representative of the critical group of the population are the following:

a) Effective dose: 1 mSv in one year
b) Equivalent dose in the eyes lens: 15 mSv in one year.
c) Equivalent dose in the skin: 50 mSv in one year.

In the case of higher education students and personnel in training whose role involves radiation exposure, the following limits shall apply.

a) Effective dose: 6 mSv in one year
b) Equivalent dose in the eyes lens: 20 mSv in one year.
c) Equivalent dose in the skin: 150 mSv in one year.

The reference levels must meet the following conditions:

a) Registration Level: It should not exceed 10% of the authorized limit.
b) Level of investigation: It should not exceed the average, of the level of intervention and the normal level of operation.
c) Level of intervention: It should not exceed 100% of the authorization limit.

Radiation protection must be obtained as a priority based on the application of safety in the design of the facilities, considering the use of physical control elements such as distance, shielding, confinement or ventilation, as appropriate.

Security by operation considers the application of administrative control measures, such as access control, mandatory use of personal protection elements or control of exposure times. It shall establish programs for operational radiological surveillance, medical surveillance and dosimetric control, as appropriate, in order to guarantee radiological safety.

Operational limits may be set at the facilities, such as the dose rate and concentration of radionuclides in the air, provided they do not exceed the authorized limits. These operational limits must be specified in the conditions and requirements of the authorizations or in the Radiological Protection Manual of the facility.

Likewise, the concentration of radionuclides in air should not exceed 1/10 of the DAC in the discharge of gases, unless there is a background that justifies it, periodic monitoring programs should be established to record such parameters.

There is a program of radiological surveillance of CNEC facilities that includes measurements of dose rates, surface contamination and air pollution, in addition, environmental radioactivity monitoring is carried out in different areas of CNEC to guarantee the protection of workers and the public from unnecessary exposure to ionizing radiation.

There is also a 24/7 monitoring system for environmental radiological surveillance throughout the country, which allows online viewing of radiation doses that may be present in the environment due to natural causes (eg: cosmic radiation that comes from space or the one emitted by certain radioactive elements on Earth). The objective is to control that the levels of background radiation are within normal parameters and, in the long term, to have a baseline such as the average dose of ionizing radiation that a person receives in Chile. This, because today there is only the international reference.

Additionally, the data collected by these systems will also feed into an international network called the International Radiation Monitoring Information System, a system run by the International Atomic Energy Agency (IAEA), which allows the exchange of radiation monitoring data, and puts them available to participating countries, to notify early any nuclear accident or radiological emergency at the hemisphere level

F.5 Emergency preparedness

The facilities of radioactive waste and spent fuel management have a Radiological Protection Operational Manual approved by the Regulatory Authority, which includes a chapter on emergency situations of each facility.

The Nuclear Safety Law requires that each facility must have an emergency plan that covers the whole spectrum of possible events in a particular facility.

In this regard, CNEC has prepared emergency plans for its two nuclear centers; La Reina and Lo Aguirre, considering emergency situations that also involve areas outside the site.

The CNEC, in collaboration with the National Emergency Office under the Ministry of Interior, is developing the "National Radiological Emergency Plan". This plan, proposes to carry out emergency drills establishing the response actions developed by the national level in the different operational phases, in the face of emergency situations, disasters and / or catastrophe due to incidents involving dangerous substances or materials, through the coordination of technical agencies and exercises with other agencies involved in emergency management, to provide protection to people, their property and the environment.

F.6 Closing

There are no facilities of spent fuel or radioactive waste in closing process, however, when it is required, shall comply with regulatory safety aspects required through closure authorization, which will be requested by the operator and issued by the Regulatory Authority.

There are two types of Closing Authorization:

- **Temporary:** this authorization will have a maximum validity of two (2) years.
- **Final:** this authorization will validate the closure plan of the facility previously presented by the operator, which, once carried out in a timely manner, must be certified by the Commission through an inspection.

SECTION G – SAFETY ON SPENT FUEL MANAGEMENT

G.1 General Safety requirements

CNEC must ensure the safety of individuals, society and the environment, and adequately protect them in all stages of radioactive waste and spent fuel. This is achieved through the Chilean regulatory regime. When there is no legislation, rule or regulation to a safety issue, Chile adopts recommendations, guidelines and safety practices from IAEA.

In addition, provisions are established for the physical protection of radioactive materials and radioactive waste from first-category radioactive facilities, in order to prevent and detect their misappropriation, and other illegal or unauthorized uses and acts in the aforementioned facilities, and regulate the response in the event of the occurrence of such events, in order to provide security and protection of people, property and the environment.

G.2 Existing Facilities

In Chile there is a 5 MWt research reactor in operation located at the facilities of the Chilean Nuclear Energy Commission La Reina is located in the main building, which constitutes the last containment barrier against the escape of any type of radiation that could be released from the reactor core in a possible nuclear or radiological accident, ensuring through the ventilation system that losses or leaks occur only from the outside to the inside of the reactor building.

The containment building measures 33 m long by 21 m wide and 22 m high, it is built of high-density reinforced concrete.

The main function of the reactor pools is to house the reactor core and to allow burnt fuel elements to be stored, handled and served as a transfer station for irradiated material. The pools are part of the primary cooling circuit and their volume is approximately 250 m3.

The main pool, houses the reactor core at its bottom and consists of 32 fuel elements and the secondary pool, has the diffuser in the center of its base where the water from the primary circuit returns after passing through the heat exchanger. This pool is also used to store burned fuel elements, to let irradiated material decay, and to load capsules into the transfer container to the Radioisotope Production Laboratory. The Sipping test system is installed in this pool, used to detect leakage of fission products from fuel elements. On the north side of this pool is the system to measure the burning of U-235 of the fuel elements with a short decay time (approx. One week). Other uses are also carried out in this pool, such as the loading and unloading of the container used to transport a burned fuel element.

The burned fuel elements are stored in the decay table, a structure designed to temporarily store the burned fuel elements that come out of the reactor core. These elements can be fuel elements that have reached their maximum burnout or elements that leave the core during reordering operations or to configure subcritical cores during maintenance of the control board system and that are subsequently returned to the core.

The decay table is made of aluminum and made up of two horizontal plates joined to two other vertical aluminum plates. The table top and bottom plates each have 30 holes and are aligned with the square holes on the top plate.

G.3 Location of proposed facilities

Currently there is no proposed facilities location for spent fuel. The country has not made a decision on disposal for storing spent fuel.

G.4 Design and Construction of facilities

There is no current construction of facilities for spent fuel. The country has not made a decision on disposal for storing spent fuel.

G.5 Safety evaluation of facilities

There have been no changes to the established requirements for accomplishing the safety evaluation of the spent fuel facilities.

G.6 Operation of facilities

In Chile, spent fuel is stored in a decay pool located on the side of the reactor pool. Spent fuel is not managed as waste, it is only stored in wet for several years and in that time spent fuel will not be manipulated while maintaining stored.

There have been no changes to the established requirements to accomplish the operation of spent fuel facility.

G.7 Disposal of spent fuel

Chile has not made a decision on spent fuel disposal.

SECTION H – SAFETY IN RADIOACTIVE WASTE MANAGEMENT

H.1 General Safety requirements

Chile must ensure the safety of people, society and the environment and adequately protect them in all stages of radioactive waste management. This is achieved through the national regulatory regime, exercised in this case by the CNEC. When there is no legislation, regulation or norm for a nuclear safety issue, Chile adopts the recommendations, guides and safety practices of the IAEA.

In addition, provisions are established for the physical protection of radioactive materials and radioactive waste from first-clategory radioactive facilities, in order to prevent and detect their misappropriation, and other illegal or unauthorized uses and acts in the aforementioned facilities, and regulate the response in the event of the occurrence of such events, in order to provide security and protection of people, property and the environment.

H.2 Existing facilities and past practices

In Chile there is a set of facilities within the Radioactive Waste Management Section, SEGEDRA, located in the CNEC headquarters, Lo Aguirre and La Reina, and it has three facilities:

1) **Installation of Radioactive Waste - La Reina:** destined for those wastes of very short half-life, generated in decay, in majority, in the CEN La Reina, and that after a predetermined period (due to its radiological characteristics) and then of a monitoring can be delivered as common trash, if its level of radioactivity has fallen to the natural range and does not have in its composition dangerous chemical elements. This installation considers, has the following work areas.

    a) **Laboratory of segregation:** where the tasks of processing, characterization and segregation of decaying radioactive waste are performed.

    b) **Well of Ion Exchange Resins:** Installation designed for decay of ion exchange resins.

    c) **Modular Temporary Storage Facility:** a facility designed and built to temporarily store the radioactive waste generated from the dismantling of the Radioisotope Production Laboratory at CEN La Reina, waste is stored for a very short half-life, but with high radiation doses.

2) **Radioactive Waste Treatment Plant:** It has an area for the treatment of liquid and solid waste. The treatment consists of reducing the volume of the radioactive material in order to confine a smaller volume than the original one, in benefit of the economy in the management of radioactive waste. After treatment, the waste is conditioned in cementitious matrices, giving a solid form

for storage prior to disposal. This form of storage is recommended by the International Atomic Energy Agency.

a) **Laboratory of Experimentation and Instrumentation:** Where research is developed to process, characterize and define lines of treatment of radioactive waste.
b) **Liquid Radioactive Waste Storage Area:** where radioactive waste, whether organic or aqueous, is stored awaiting treatment
c) **Operational Warehouse:** area where sealed radiation sources are stored awaiting treatment or those whose treatment has not been defined.
d) **Liquid Treatment Plant:** Area destined to the treatment of liquid radioactive waste contaminated with uranyl nitrate.
e) **Container Temporary Storage:** Area that allows the temporary storage of conditioned radioactive waste, pending the construction of the new storage facility.

3) **Storage of Radioactive Waste Storage:** Specially designed to keep in a controlled manner and under conditions of radiological safety, such as physical, radioactive waste that has been conditioned to remain in the environment without the risks associated with its danger.

H.3 Location of the proposed facilities

Chile has a new centralized storage facility for conditioned radioactive waste, which is in the final phase of construction where pre-operational tests and equipment acceptance are being carried out. This facility is specifically located in the western sector, within the exclusion area of the Lo Aguirre nuclear studies center, located on Route 68 km 20, on the way to Valparaíso, Pudahuel, Metropolitan Region.

The facility is located in an area defined in the Santiago Metropolitan Regulatory Plan (PRMS), as "Risk Area for Dangerous Activity" and "Protection of Nuclear Centers". This protection area is limited by a circumference of 3,800 [m] radius, centered on the reactor chimney, encompassing territories in both the Pudahuel and Curacaví communes. Within this area an exclusion zone is distinguished, which is defined as the area limited by a circumference of 600 [m] radius, centered on the chimney of the CEN Lo Aguirre reactor, where only facilities considered as "Own of the Study Center"; in addition to a low density zone, which is defined as a perimeter and concentric strip with the exclusion zone of a width of 3,200 [m].

H.4 Design and Construction of facilities

Chile has a new centralized storage facility for conditioned radioactive waste, which is in the final phase of construction where pre-operational and equipment acceptance tests are being carried out.

H.5 Safety Evaluation of the facility

The safety evaluation of radioactive waste facilities established in the Law No. 18.302 of Nuclear Safety is associated with a number of limits and safety conditions required by the Competent Authority. Inspectors verify that the license conditions, radiological safety,

physical security and operation procedures are accomplished and thus is guaranteed that there are no risks to health, safety or the environment.

Security by operation considers the application of administrative control measures, such as access control, mandatory use of personal protection elements or control of exposure times. It shall establish programs for operational radiological surveillance, medical surveillance and dosimetric control, as appropriate, in order to guarantee radiological safety.

Operational limits may be set at the facilities, such as the dose rate and concentration of radionuclides in the air and on the surface, provided they do not exceed the authorized limits. These operational limits must be specified in the conditions and requirements of the authorizations or in the Radiological Protection Manual of the facility.

H.6 Operation of facilities

One of the facilities of SEGEDRA, is the Radioactive Waste Treatment Plant (PTDR), described below is the operation of the facility:

a) Operation requirements:

- The facility possess its current operating license
- The staff possess their valid operator authorization
- Operating and safety systems are suitable
- The radiological monitoring is operational
- The ventilation system is operational
- Operating staff use personal protection assigned
- A responsible facility professional.
- The entry and exit of the staff take place through the changing clothes room, with radiological checks at the exit.
- Clear and clean working and access areas.

b) Operational Processes:

- Reception, admission and registration of radioactive waste
- Radioactive waste processing
- Non-conforming product control
- Management of liquid effluents generated in treatment plant of radioactive waste
- Solid radioactive waste compaction
- Conditioning of sealed radiation sources in disuse and heterogeneous waste
- Preparation of containers for solid radioactive waste conditioning
- Entry of radioactive waste to SEGEDRA facilities
- Preparation and quality control of mortar
- Segregation and sampling of granular waste from drums
- Effluents shipment from the treatment plant of radioactive waste to the Liquid Control System Storage Tanks.
- Decontamination of surfaces and equipment
- Sampling of stored effluents
- Emptying

The person in charge of the facility is responsible for maintaining the safe operating conditions of the facility at all times, keeping track of all waste that enters it, as well as its

trajectory until it is destined for another facility. To do this, the operating personnel must comply with and enforce the operating authorization conditions of the facility, coordinating with the headquarters the operations that must be carried out according to the annual planning.

Te person in charge of the installation is responsible for complying with the operating authorization conditions during the development of operations; know the process that has been assigned, develop, together with the operator, the operations of the process, record the data obtained, keep the person in charge of the installation of the operation under development informed and report to the headquarters when appropriate.

H.7 Institutional measures after closure

Institutional measures have not been implemented as to date the closure of radioactive waste management facilities has not been carried out, however, the closure of the conditioned radioactive waste storage facility, Lo Aguirre headquarters, is planned in the near future.

SECTION I – CROSS-BORDER MOVEMENTS

In Chile, cross-border movements are carried out such as entry and exit of radioactive material to the country, the return of decayed sealed sources (disuse) to the country of origin and sometimes to remove the spent fuels generated by the reactor from the country.

The Regulatory Authority grants an import and export authorization in accordance with Decree Law No. 133, on authorizations for the import, export, sale, distribution and storage of radioactive substances, which may not be brought into the national territory or sent out of it, without the corresponding authorization. Likewise, the transfer and storage of radioactive material between two facilities must have the corresponding authorization granted by the Regulatory Authority.

According to regulation 12 "Safe Transport of Radioactive Materials", it is established that all transport of radioactive material will require authorization from the Regulatory Authority. The modes of transport are by land, water or air, which must comply with the provisions of the regulations.

SECTION J – SEALED SOURCES IN DISUSE

In Chile, the Regulatory Authority establishes requirements in order to provide for health protection, safety and people protection, goods and the environment.

Disused sealed sources in Chile must be returned to its supplier or be managed as radioactive waste.

In Chile, there is no fabrication of sealed sources, which is why sources are imported. One of the practices that have a major demand of sealed sources is industrial gammagraphy that generally use Ir-192 and Se-75 sources with an approximately maximum activity of 3.7 TBq. Most sealed sources are small and their radioactivity can range from dozens to gigas of becquerels (Bq).

The Regulatory Authority is responsible for controlling the export and import of sealed sources in the country, provided that the applicant complies with all the documents and requested information.

When a sealed source is no longer necessary or its activity has decayed beyond its useful life, it can be treated as radioactive waste, to do that, the installation of the decayed radioactive source or in disuse shall transfer the source to the CNEC, specifically to Radioactive Waste Management Facility, or be returned to the origin or factory owner. To do that is necessary an export and transfer permit.

SECTION K – PLANNED ACTIVITIES TO IMPROVE SECURITY

Chile has had several initiatives in order to improve the management of radioactive waste and spent fuel, to guarantee the safety of human beings, society and the environment. Some of these activities reviewed in previous meetings have made positive progress, as indicated below.

1) Improve the storing capacity of radioactive waste:

The construction of the new centralized Storage Facility for Conditioned Radioactive Waste is in the final phase of construction where pre-operational tests and equipment acceptance are being carried out, to later continue with the operation authorization process of the installation, scheduled for 2021.

The installation is planned for 20 years of operation with a capacity of 138m3, distributed in 583 containers of 200L, and 45m3, for radiation sources sealed in containers of different configuration.

2) Develop long-term of dry management option on spent fuel:

Since 2007 to date, the development of this project has not continued.

In 2007, Chile participated in a project RLA / 3/004 on Spent Fuel Management for Research Reactors. The advances that Chile achieved were the following:
Design basis, technical specifications, criticality and shielding calculations, Thermal calculations at the project level, Structural calculations done by hand and using Solidworks 2006 and COSMOSWorks and drawings at the basic engineering level.

3) Improve and implement new processes for radioactive waste management:

SEGEDRA built an armored workbench, which will allow the recovery of sealed radiation sources to be carried out, a process that will allow the optimization of conditioning volumes. It remains to continue with the authorization process of operation of this facility.

4) Participate in security projects on radioactive waste:

SEGEDRA has participated in security projects in the operation to immobilize sealed sources in the regional project of technical cooperation for the development and improvement of the management of sealed sources in Latin America.

Chile has made no progress regarding the challenges proposed in previous review meetings, regarding the development of a long-term waste management program and finding a final solution for the management of spent fuel from research reactors, due to that efforts and resources have been directed to the construction of the new radioactive waste storage facility.