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VLLW DISPOSAL EXPERIENCE: PERSPECTIVES FOR RUSSIA

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The paper overviews the practice of very low- level radioactive waste disposal in several countries. It presents specific aspects of national VLLW classification systems and studies the benefits from introducing this waste category. The paper also examines the differences between very low-level waste disposal facilities and other facilities in terms of their regulation.

Key words: *radioactive waste disposal, very low-level radioactive waste, radioactive waste management.*

Prior to introducing the very low-level radioactive waste (VLLW)[1] category into relevant provisions of the Federal law on RW Management, a comprehensive study of international RW disposal practices and the state of affairs in nuclear industry had been undertaken by Russian experts. The law development was supported by the detailed examination of new RW classification system with VLLW class which was presented in IAEA Safety Guide № GSG-1 [1] published in 2009. Practical experience was also substantively studied with primary focus placed on the operation of VLLW disposal facilities in Sweden and France. This and broader topics were covered in surveys on international RW disposal practices [2] and engineering and financial benefits resulting from the introduction of VLLW category [3] prepared by Swedish consultancy SKB International AB, in other publications [4, 5], as well as during workshops and discussions arranged by Nuclear Safety Institute in 2009—2011. In October 2010, a workshop dedicated specifically to VLLW issues was hosted by the Swedish regulator SSM in Stockholm.

Considering that international experience in arranging RW management systems has been extensively studied for more than a decade, its practical implementation is viewed as the present-day priority. This task is being set. Investigated are relevant solutions including the development of regulatory approaches relevant for VLLW [6] and accounting for RW generation factor in the selection of decontamination and dismantling options under particular decommissioning projects [7]. We believe that efforts should be focused in this area ensuring most prompt start of VLLW disposal operations with the necessary prerequisites already in place. VLLW class is regarded as the easiest to manage as demonstrated by extensive international experience. It

[1] Abbreviation ONAO used in Russian regulations refers to industrial waste containing technogenic radionuclides (Sanitary Rules SP 2.6.6.2572-2010). According to Russian classification system this waste is not considered as radioactive waste. In a number of countries (for example, France) such waste class, namely industrial waste with increased radioactivity, is not provided for. As it comes to very low-level RW (referring to the terminology used in the Federal law on Radioactive Waste Management) experts are using the abbreviation "ONRAO". Whereas, in literature sources, also referred to in this article [2, 3, 5, 13] ONAO abbreviation also appears. To ensure uniform terminology, abbreviation ONAO was used in this article referring to the category of very low-level radioactive waste as indicated in IAEA waste classification system for disposal, as well as similar analogues of such waste from national classification systems including the Russian one. Specific aspects of national classification systems have been indicated in the paper.

seems feasible to start mastering waste disposal practice from this simplest, evident and massive segment. In terms of higher efficiency and lower RW management costs, routine VLLW disposal in Russia may happen quite fast and at a low price and thus enable the operating organizations to avoid equipping necessary onsite storages which could be difficult to place due to lack of space at many sites.

This article primary focuses on the VLLW management experience gained in different countries denoting particular aspects associated with national regulatory systems and relevant trends that have emerged over the past decade. Particular attention will be paid to the issues previously not being reflected in literature or those, that in our opinion, haven't been sufficiently amplified.

VLLW as an RW class

In keeping with IAEA General Safety Guide № GSG-1 provisions, VLLW is waste that does not necessarily meet the criteria of exempt waste, but that does not need a high level of containment and isolation and, therefore, is suitable for disposal in near surface landfill type facilities (tranches with soil backfill) with limited regulatory control. The Guide also indicates that in order to determine whether a particular type of waste can be considered to fall into the class of VLLW, acceptance criteria for engineered surface landfill type facilities have to be derived [1]. Experience of countries that have been for a long time engaged in such activities clearly demonstrates the relationship between waste classification and disposal conditions. Waste acceptance criteria serve a basis for RW classification in Sweden, France, Spain — countries for decades having been engaged in waste disposal operations. In the above-mentioned countries, as well as in Lithuania and Japan, a specific waste class is used for VLLW (table 1). Specific activity values given in IAEA Safety Guide № RS-G-1.7 "Application of the Concepts of Exclusion, Exemption and Clearance" can be used to specify the lower limit for waste falling into this class (United Kingdom, Sweden, Japan). Whereas special criteria established for such waste by particular waste disposal facilities can be considered as the upper limit. It should be noted that though Table 1 taken from relevant NEA OECD publication [8] indicates activity concentration as VLLW criterion, for France it rather reflects the practice than the classification system itself. French National Report stresses out that "Numerous criteria are therefore required to determine the acceptability of a given waste in a given route. The licensees of disposal facilities determine acceptance specifications to define the acceptable waste packages. It is the conformity with these specifications which in the end defines the category of a given waste" [9].

In other countries, VLLW are not specified as an individual RW class but can be indicated separately under LLW class. For example, in UK VLLW is LLW sub-category divided into two components: low-volume VLLW and high-volume VLLW. The former one includes radioactive waste which can be safely disposed of to an unspecified destination with municipal, commercial or industrial waste ("dustbin" disposal), each 0.1m^3 of waste containing less than 400 kBq of total activity or single items containing less than 40 kBq of total activity. For waste containing Carbon-14 or Hydrogen-3 (tritium): (i) in each 0.1m^3, the activity limit is

Table 1. VLLW characteristics considered in some countries [8]

Country	VLLW lower limit	VLLW upper limit	VLLW criteria
Australia	GSG-1	GSG-1	GSG-1
Czech Republic	Considered as LLW sub-class	Considered as LLW sub-class	Iincluding NORM
Finland	Considered as LLW/ILW sub-class	Considered as LLW/ILW sub-class	May be released or recycled
France	*	< 100 Bq/g	Activity concentration
Germany	Considered as a sub-class of no heat generating waste	Considered as a sub-class of no heat generating waste	*
Japan	RS-G-1.7	Special criteria	Disposal route
Slovenia	Considered as LLV/ILW sub-class	Considered as LLV/ILW sub-class	*
Spain	*	Special criteria	Disposal route
Sweden	RS-G-1.7	Special criteria	Waste origin + Disposal route
Switzerland	*	*	*
UK	RS-G-1.7	Special criteria	Complex criteria
USA	*	*	*

*Not used in national inventories and lists

4,000 kBq for Carbon-14 and Hydrogen-3 (tritium) taken together (ii) for any single item, the activity limit is 400 kBq for Carbon-14 and Hydrogen-3 (tritium) taken together. Controls on disposal of this material, after removal from the premises where the wastes arose, are not necessary. High-volume VLLW is "radioactive waste with maximum concentrations of 4 megabecquerels per tonne (MBq/te) of total activity which can be disposed of to specified landfill sites". For waste containing Hydrogen-3 (tritium), the concentration limit for tritium is 40 MBq/te. Controls on disposal of this material will be necessary in a manner specified by the environmental regulators. The latter case suggests controls on the total volume of VLLW disposed of at one landfill which is considered as a fundamental difference between the above VLLW sub-categories [10].

In Russia, waste is considered as radioactive waste if specific activities of man-made radionuclides are higher then the levels set up in relevant provisions of the Government Decree № 169 of October 19, 2012. According to Russian classification system, VLLW is waste of Class 4. This class involves solid RW containing radionuclides with a specific activity of up to 10^7 Bq/g for tritium containing radioactive waste, up to 10^3 Bq/g for those containing beta-emitting radionuclides (except for tritium), up to 10^2 Bq/g — for radioactive waste containing alpha-emitting radionuclides (except for transuranic radionuclides), up to 10 Bq/g — for radioactive waste containing transuranic radionuclides, and subject to disposal in near-surface repositories located at the ground surface level [11].

VLLW storage and disposal volumes

Depending on RW classification system adopted, some countries indicate either VLLW or LLW as a lower limit denoting which waste should be considered as radioactive[2]. It somewhat complicates such cross-country comparisons in terms of VLLW and LLW storage and disposal volumes. This aspect has been recently pointed out by IAEA in its publication [10] indicating relevant data on particular countries with the estimates based on GSG-1 classification. Table 2 presents global estimates of storage and disposal volumes for different RW classes accounting for RW package volume.

[2] It should be noted that in France no lower limit indicating that waste should be considered as radioactive exists: all waste from a specific waste generation source (according to waste disposal planning provisions, these are primary basic nuclear facilities) should be considered as radioactive requiring storage in specialized facilities. At present time, opportunities for waste clearance are being discussed.

Table 2. Volume of stored and disposed RW of different classes around the world, m^3 [10]

RW class	Solid RW		Liquid RW	
	storage	disposal	storage	disposal
VLLW	2,356,000	7,906,000	No data available	No data available
LLW	3,479,000	20,451,000	53,332,000	39,584,000
ILW	460,000	107,000	6,253,000	8,628,000
HLW	22,000	0	2,786,000	68,000

To date, a total of 77 % of solid VLLW and 85 % of solid LLW have been disposed of worldwide which demonstrates that this practice is widely used and considered as a routine. In fact, if LLW is disposed of in a country, VLLW is disposed of as well. The question is whether different disposal facilities are used for these purposes. As compared to other RW classes, VLLW and LLW account for over 95 % of global RW volume referring respectively to 0.5 % and 1.5 % of accumulated activity (figure 1).

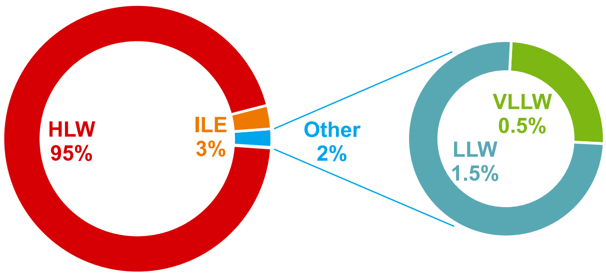

Figure 1. Breakdown of activity for the global RW inventory (by volume) for different RW classes, % [10]

Provided below is a brief overview on VLLW disposal in a number of countries. In Sweden, VLLW repositories are available at all NPP sites, except for Barsebak NPP, as well as at the site of the Nuclear Research Center in Studsvik. Relevant inventories are presented in Table 3. Barsebak NPP is the only exception as its site is being considered not suitable for repository construction. At Barsebak NPP, VLLW class is not applied for disposal purposes. Combustible LLW (including VLLW) are incinerated, resulting ash is disposed of in SFR — short-lived LLW and ILW disposal facility in Forsmark [3]. In Sweden, VLLW have been disposed of for over 30 years.

In France, all VLLW are disposed of in a centralized disposal facility CIRES having a design capacity of some 650,000 m^3 of waste. Morviller is another name given to this site according to its location and is commonly used in literature [13, 14]. CIRES has been operated since 2003. By the end of 2016, a total of 360,000 m^3 of VLLW has been disposed of in this repository. At the same time, by the end of 2015, 154,000 m^3 of VLLW remained stored at this site awaiting final disposal [9].

Table 3. Inventory of VLLW disposed of in Sweden [12]

Site	License conditions			Waste disposed as of December 31, 2016		
	Licensed until	Capacity, m³	Max activity/max. alpha-activity (TBq)	Weight (t)	Volume, m³	Activity, GBq
Forsmark	2070	17,000	200/0.2	4,395	6,572	34.3
Oskarshamn	2075	10,000	200/0.2	5,415	10,949	37
Ringhals	2060	10,000	1,100/0.1	5,360	9,180	265
Studsvik (Svafo)*	2040	1,540	100/0.1	1,151	1,140	28

*Facilities are closed

In Spain, VLLW are disposed of in a centralized facility El Cabril that has been operated since 1992. However, a specially designated area for VLLW disposal was opened only in 2008. It consists of four sections with a total design capacity of 130,000 m³. It's assumed that this capacity is enough to dispose all the waste resulting from nuclear decommissioning. Disposal section consists of a shallow earthen trench fitted with several layers of drainage and waterproof materials (figure 2). After waste emplacement is finished, the trench is backfilled with protective layers, also including gravel, clay, soil and vegetation layer. The first section with a design capacity of 30,000 m³ has been already filled with waste. Second section with a design capacity of 39,000 m³ of VLLW has been operated since 2016 (it consists of 2 sections one overlying the other). New sections are planned for construction in the future. Most part of VLLW are supposed to be generated from nuclear decommissioning (it should be noted that the operator of the centralized disposal facility (ENRESA) is also responsible for nuclear decommissioning projects in Spain). By the end of 2016, a total of 32,198 m³ of VLLW were disposed of in El Cabril with additional 3,912 m³ being stored at its site. Some VLLW (totally over 7,000 m³) are also stored at the sites of their generation [15].

VLLW management policy does not necessarily stipulate their disposal as RW. For example, in Austria and China decay storage with subsequent clearance is provided for waste categorized as VLLW in keeping with provisions of GSG-1. In Netherlands, national operator COVRA is responsible for waste storage. Following such storage, waste is cleared from regulatory control. In Finland and Spain, such waste can be either cleared, recycled or disposed of at industrial waste landfills. In UK, VLLW is also disposed of at conventional landfills [10].

Figure 2. General view of VLLW trench at El Cabril disposal facility [15]

Specific aspects of VLLW repository operation

Technical aspects of VLLW disposal have been quite thoroughly discussed in a number of publications [4, 11], whereas national RW classification systems, including VLLW disposal in Spain, have been presented in the overview of international disposal practices [14]. To avoid repetitions, only particular aspects of waste disposal practice in Sweden and France are briefly overviewed below enabling to compare some characteristics of the operating repositories.

Differences in VLLW repository regulation as compared to other facilities

French centralized disposal facility for VLLW CIRES is not considered as a basic nuclear facility. Thus, its operation is regulated by relevant regulatory provisions applicable to facilities designed for environmental protection purposes [9].

Operator

In Sweden, operator of an NPP is also responsible for the operation of a VLLW disposal facility on its site. National operator SKB is responsible for other disposal facilities, both operated and planned for construction. In France, all such facilities, including CIRES, are operated by the National Operator ANDRA.

Repository types

Shallow land disposal facilities (at NPP sites in Sweden). Trench repositories (Studsvik in Sweden and CIRES in France).

Waste origin

CIRES accepts waste from different waste generators, including institutional ones. Swedish repositories accept waste generated onsite.

Waste composition

Studsvik facility accepts waste from decommissioning of legacy facilities, as well as operational waste generated in-situ. In Sweden, repositories located at NPP sites accept operational waste, involving plastics, rags, paper, metal scrap, isolation materials, wood and rubber. The same composition is common for solid operational VLLW in France. Moreover, TENORM waste (Technologically Enhanced Naturally Occurring Radioactive Materials) not allowed for disposal at industrial landfills are also accepted by CIRES [9].

Compaction

At NPPs in Sweden, paper, plastics, rags and other waste are being compacted into briquets. 30 % of waste delivered to CIRES site are handed over directly to compaction and solidification facilities. Waste not suitable for compaction (for example, stone and metal scrap) is disposed of after storage without preliminary treatment [14].

Packages

Different waste package types are used for different waste (containers, drums), including most simple packaging — plastic bags. In CIRES bulky VLLW can be disposed of without packaging.

Bulky waste

Since 2013, bulky waste has been accepted for disposal in CIRES. Four steam generators from Chooz NPP were disposed of without preliminary cutting and packaging following extensive deactivation enabling to lower the waste class, namely from short-lived LLW/ILW to VLLW. Although this approach is not going to be necessarily applied with respect to currently operated NPPs, construction of a new trench for this type of waste was started in 2016 [9].

Frequency of waste disposal

In Sweden, due to a small amount of VLLW generation its disposal is performed at specific sites with a frequency of some 3–5 years. Each disposal campaign requires particular permit from responsible authorities. CIRES accepts the waste continuously.

Plans on increasing disposal capacities

These opportunities are being investigated both in Sweden and in France. In Sweden, RW resulting from decommissioning of reactor units at Oskarshamn and Ringhals NPPs has to be stored for some time at the sites pending either expansion of SFR repository or construction of SFL repository. For this reason, NPP operators are investigating the opportunities for near-surface disposal of decommissioning VLLW at their sites [12].

In France, notwithstanding the large storage capacity of CIRES its potential shortage has been recognized. As due to current and future decommissioning activities large waste amounts are to be generated, ways enabling more efficient VLLW management including both storage capacity extension and decrease in waste volume due to its treatment and recycling are being evaluated. The following potential solutions are being currently investigated: opportunities enabling to increase CIRES storage capacity without site expansion; construction of a new VLLW disposal facility; feasibility of constructing repositories at waste generator sites; consolidation of estimates on the volume of VLLW generation by waste generators; decrease in waste volume and studying the opportunities for recycling some types of materials; comparation of environmental impacts associated with direct disposal and operation of industrial facilities for combustible VLLW incineration; studying the opportunities for VLLW use as a buffer material to backfill the voids in CIRES and etc. [9].

Benefits of applying VLLW category

The key benefits from VLLW category introduction are associated with ensuring easy and cost-effective management of waste. VLLW repository siting requirements can be followed quite easily and in most cases such facilities can be constructed at operating nuclear sites. Disposal cost per 1 m^3 of VLLW is somewhat between one-tenth and one-fifth of the disposal cost specified per 1 m^3 of LLW. The estimated total disposal cost per 1 m^3 of VLLW (investment and operational costs) accounts for 350 and 370 euros for Oskarshamn and Ringhals NPPs respectively. As for Forsmark NPP, it amounted to 200 euros for the first repository and 540 euros for the second one (the second repository involved more complex designs with 20 % of the cost being accounted for expert review and regulatory approval). For reference: average disposal cost for SFR accounts for 4,500 euro per m^3. However, the disposal cost appears to be lower in SFR sections with a lower number of engineered barriers [3].

In the early years of CIRES operation, the cost of VLLW emplacement accounted for some 200 euros per 1 m^3 of waste (estimates for over 90,000 m^3 of disposed waste). For reference: 1 m^3 of short-lived LLW/ILW was disposed of at cost of some 2,700 euros in the nearby Centre de l'Aube [3].

As mentioned above, not all countries distinguish VLLW class. Moreover, disposal experience largely reflects relevant business approaches adopted in the countries. For example, whether the operator is a state or a private company. In this regard, a brief overview of US disposal practice being quite different from the European ones seems worth presenting.

Two RW classification systems based on waste origin — commercial and defense waste are being applied in the US. Classification of commercial RW is based on LLW acceptability for disposal and involves four classes: A, B, C and Greater-Than Class-C. These classes depending on short- and long-lived radionuclide contents are characterized by gradual increase in the strictness of relevant disposal requirements [8]. Class A, B and C waste may be disposed of in near-surface repositories, whereas Greater-Than Class-C waste requires geological disposal. Class A may be conditionally considered as VLLW analogue as their disposal provides for less strict requirements.

Currently four LLW disposal facilities are being operated in the US: Andrews Count (Texas), Barnwell (South Carolina), Clive (Utah) и Richland (Washington). Clive accepts only Class A and mixed waste (mixed waste contains not only radionuclides, but also other chemically hazardous substances). Other sites accept classes A, B, C. Licenses for the above-mentioned disposal facilities are granted by relevant states and not by the Nuclear Regulatory Commission (NRC) which can be viewed as a specific aspect of their regulation. This can be done by means of delegating such powers by NRC on condition that the regulatory framework of the state is considered to be consistent with federal regulatory requirements. NRC may license these facilities on its own, however, to date all operated sites have been granted with relevant licenses at the state level. The origin of waste is viewed as another specific regulatory aspect. Clive can accept waste from generators all across the US (acceptance of waste from a number of regions may require relevant approval of the Utah State). Other sites can accept waste generated only in a group of states that had previously signed contracts on waste disposal in a particular repository. For example, Andrews Count can accept waste from Texas and Vermont States. In some cases, RW can be shipped from other regions but this would require relevant consent of the hosting State. Legislative consolidation of such a regulatory system enables to increase the public acceptance of disposal (particular State can only accept the waste produced within its territory and in the neighboring States, or, in the case of Clive repository, only Class A waste), thus, ensuring availability of appropriate capacities for waste disposal.

Table 4 presents NRC data [16] on LLW disposal at the above-mentioned sites for 2014—2017. Waste volumes and activities vary significantly by year due to types and amounts of radioactive waste accepted for disposal. At the same time, most part of waste by volume — up to 99% in particular years — accounts for the Clive repository, i.e. class A (or roughly VLLW) is considered as the primary waste stream.

Clive site is located in the desert of the Utah State, some 120 km away from Salt-Lake-City and is operated by EnergySolutions. The following waste classes are accepted for disposal in Clive: contaminated soils resulting from remediation activities; RW generated by NPPs, as well as dismantled equipment; radioactive material from remediated sites run by the Department of Energy (DOE); medical waste contaminated with radionuclides. Disposal cost in Clive accounts for some 2,600 euro per m^3 of waste. For reference: disposal cost for Class B and C waste at Andrews Count site accounts for 133,000 euro/m^3 if the waste is shipped from a State not being a party to the agreement. In some cases, waste can be disposed of at conventional landfills having appropriate licenses. For example, landfill operated by US Ecology in Idaho can accept hazardous waste, as well as waste with gamma-activity of up to 0.6 Bq/g. Relevant disposal cost is usually less than 550 euro/m^3 [17]. It should be noted that in practice operators can provide big discounts if the contract suggests that a big amount of waste is to be disposed of.

Table 4. LLW disposal in the US: volumes (m^3) and activity (Ci)

Disposal facility	2014		2015		2016		2017	
	m^3	Ci	m^3	Ci	m^3	Ci	m^3	Ci
Andrews Count	1,135	52,361	693	43,199	361	116,214	327	34,111
Barnwell	289	4,977	280	9,618	200	737	383	1,256
Clive	30,119	6,787	34,922	13,300	45,589	11,633	142,007	11,987
Richland	580	6,594	776	739	601	75,743	394	9,826
Total*	32,122	70,719	36,672	66,857	45,751	204,326	143,110	57,179

*Total value in cubic meters may be inconsistent due to rounding

Figure 3. Waste loading during decommissioning of Maine Yankee NPP [17]

Figure 4. Disposal of large-size waste at Clive site (Utah, USA) [19]

Decommissioning is considered as the main source of Class A waste. For example, a total of 107,000 m^3 of RW was generated from the decommissioning of Main Yankee NPP with a PWR unit (860 MW). 91,000 m^3 of this waste accounted for Class A [17]. Figure 3 demonstrates shipping of RW from Main Yankee site, figure 4 — disposal of large-size waste at Clive site. It should be noted that according to the US legislation, large-size waste can be shipped and disposed of as a single component with no preliminary cutting. Thus, Main Yankee reactor pressure vessel was shipped by a barge to Barnwell disposal site. Moreover, regulations allow for "concentration averaging" during the identification of waste class, i. e. balancing the specific activity per weight or volume enabling to categorize part of the equipment as Class A waste. In addition to calculated averaging, physical mixing of certain waste, termed "blending", is allowed: waste of classes B and C can be mixed with class A waste to produce a waste mixture complying with acceptance criteria set for a commercial repository that accepts class A waste for disposal [18].

Generally, in the US, RW disposal is not the only business activity of the operating company. Thus, Andrews Court site was initially involved in the disposal of hazardous chemical waste and it was only in 2012 that it started to accept RW for disposal. Energy Solutions operating Clive and Barnwell sites provides services on waste transportation, treatment and packaging, development of engineering solutions for RW management at operating facilities. This company is also an active player at the decommissioning market, offering a full range of services. For example, in May 2019 EnergySolutions plans to finalize the decommissioning of SEFOR research reactor (Arkansas) started in 2009 with a "greenfield" specified as its end state [20].

Thus, experience of the United States shows that considering high disposal cost and large RW amounts resulting from large-scale decommissioning and remediation, introduction of VLLW waste class offers considerable benefits both in terms of cost reduction and opportunities for RW management (disposal of large-size RW without preliminary cutting and packaging, combining waste to meet relevant waste acceptance criteria, etc.). Availability of waste disposal capacities and RW management services is viewed as an important factor enabling the operator to withdraw its facility from regulatory control and to terminate its financial obligations.

Conclusions

For decades, VLLW has been disposed of in many countries. According to global estimates, almost 80 % of such waste is currently sent for disposal. VLLW management challenges appear to be most pressing when it comes to decommissioning with large waste amounts generated. Global trends suggest that specific aspects associated with such waste should be accounted for, including:

- Acceptance of large-size VLLW by operating repositories, including unpackaged waste;
- Development of RW management plans at the decommissioning stage;
- Development of waste management technologies to reduce waste volume;
- Evaluating the opportunities for repository construction at waste generator sites.

Development of VLLW disposal facilities is believed to be a cost-effective solution, since relevant costs are 5—10 times lower than those associated with LLW near-surface repositories. Some cases suggest higher economic benefits, others — lower. However, cost efficiency is quite evident and is achieved wherever this practice is applied.

VLLW management approaches are shaped in line with relevant efforts on the development of national RW management systems, also by combining certain approaches to achieve increased efficiency of this activity in general. Thus, VLLW management should be considered as an integral part of the overall system addressing specific tasks. Relevant possibilities include both the use of waste clearance option suggesting its co-disposal with LLW and construction of either centralized or at-site disposal facilities, including the option of constructing VLLW repository and disposal facilities for other waste types at a single site. Much attention is paid to the development of plans regarding waste generation activities (decommissioning, remediation), since the large waste volumes require appropriate storage capacities and shipment arrangements within the site, planning off-site transportation, etc.

In general, international experience demonstrates certain flexibility in disposal system development, potential for adaptation to changing conditions and tasks, the use of fine-tuning mechanisms. It also reveals the commitment to discovering more technically and financially effective approaches. We believe that the main conclusion that can be drawn by Russia is that development of a disposal system should be started from its foundation, i. e. from facilities being considered the simplest from engineering perspective and most demanded in terms of future RW streams.

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