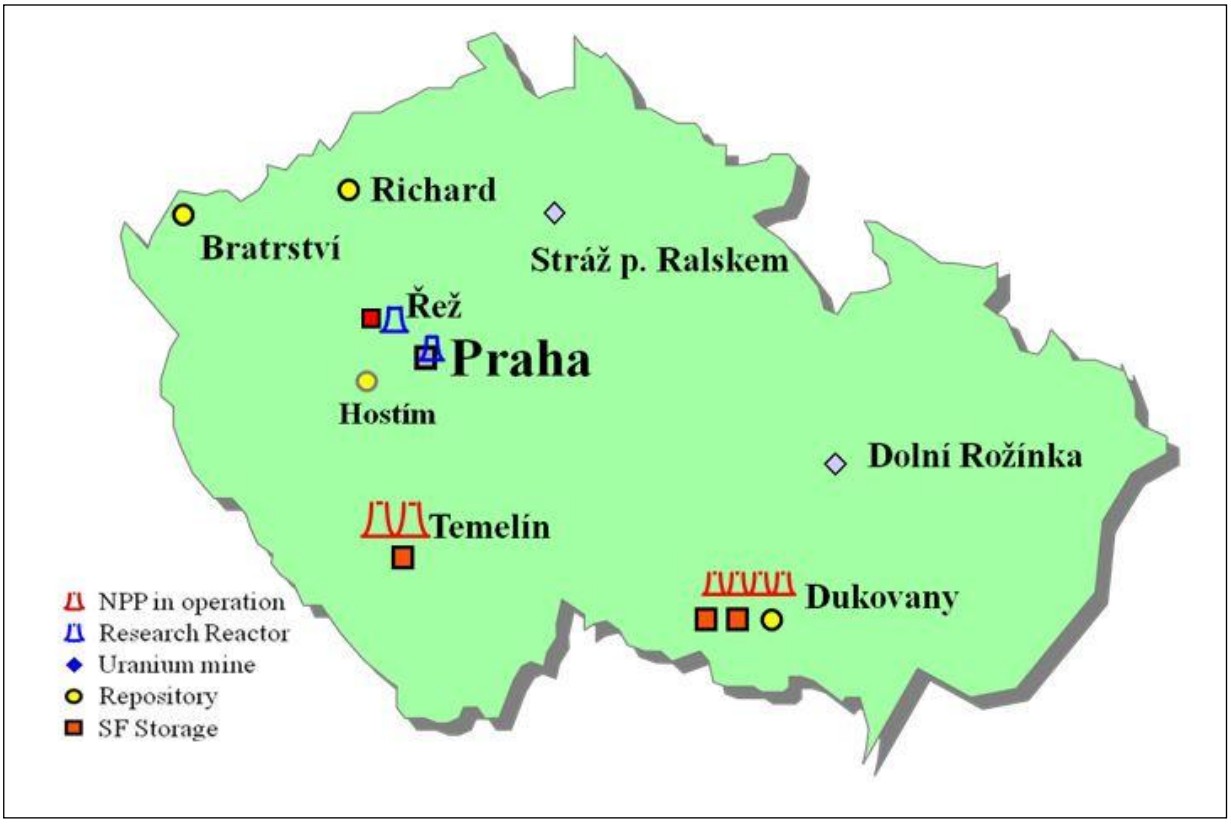
**RADIOACTIVE WASTE MANAGEMENT PROGRAMMES IN OECD/NEA MEMBER COUNTRIES**

**CZECH REPUBLIC**
**[2013]**

## NATIONAL NUCLEAR ENERGY CONTEXT

Utilization of nuclear energy in the Czech Republic started by establishing the Nuclear Research Institute (NRI) in Řež, in the 1955. Commercial utilization of nuclear power at the territory of the Czech Republic started in 1985 by start up of the first nuclear reactor unit at the NPP Dukovany. As of the end of the year 2012 there are 6 nuclear reactor units connected to the electricity grid. Those are the 4 VVER 440/213 type reactor units at the NPP Dukovany and 2 VVER 1000/320 reactor units at the NPP Temelín. Production of electricity from the NPP's is in average approx.33% of the total electricity generated in the Czech Republic.

Besides above mentioned nuclear power reactors there are in operation also other nuclear facilities, including the radioactive waste repositories. Their location is shown at the figure below:



At the NPP Dukovany site, besides the VVER 440/213 units there are installed also following nuclear facilities:

MSVP Dukovany – intermediate spent fuel (SF) storage facility; in operation since 1997,

SVP Dukovany – SF storage facility; in operation since April 2008 and

ÚRAO Dukovany – repository for short live, low and intermediate level waste (LILW-SL); in operation since 1995, owned by state since 2000.

In addition to the mentioned standalone nuclear installations, the NPP Dukovany units also include SF pools and storage tanks for liquid operational waste.

At the NPP Temelín site, besides two reactor units VVER 1000/320 (including SF pools and storage tanks for liquid operational waste), a dry SF storage facility is in operation since September 2010.

SF and RW generated during operation of the research reactor LVR–15 at the NRI Řež site may be stored in the high level waste (HLW) storage and LILW storage facilities at the site.

The other research reactors one in NRI Řež site (LR–0) and second at the Faculty of Nuclear Engineering Praha (VR–1) do not produce any SF, due to their small thermal output and limited time of operation

The LILW - SL repository Dukovany is designed for disposal of RW prevailingly from the NPPs operation. For disposal of the institutional waste from research, industry and/or medicine there are other following disposal facilities:

LILW-SL repository Hostim near Beroun (operated within 1959-1964; sealed in 1997),

LILW-SL repository Richard Litoměřice (in operation since 1964),

LILW-LL repository Bratrství Jáchymov (waste containing only natural radionuclides; in operation since 1974).

The legal framework for the nuclear energy utilization is given mainly by the act No. 18/1997 Coll. "On Peaceful Utilization of Nuclear Energy and Ionizing Radiation (the Atomic Act), as amended and by its implementing regulations. Disposal of RW in underground formations is also subject of the Mining regulations.

## SOURCES, TYPES AND QUANTITIES OF WASTE

### General classification of radioactive waste:

According to the Atomic Act, radioactive waste is defined as „substances, objects or equipment containing or contaminated by radionuclides for which no further use is foreseen".

In the Decree No. 307/2002 Coll., "on radiation protection", RW is divided into three physical categories as gaseous, liquid and solid waste. Solid RW are further divided into three basic classes:

transient, low- and intermediate- and high-level radioactive waste:

- transient RW is waste, which radioactivity after short-term storage (up to 5 years) does not exceed the clearance levels,
- High-level radioactive waste (HLW) is waste for which heat generation from decay of contained radionuclides must be taken into account during its storage and disposal.
- Low-level and intermediate-level waste (LILW) is divided into two sub-categories. The first sub-category is short-lived waste (LILW-SL) in which the half-life of radionuclides contained is shorter than 30 years (including Cs-137) with a limited mass activity of long-lived alpha emitters (in individual packages a maximum of 4000 kBq/kg, and a mean value of 400 kBq/kg in the total volume of waste produced in a calendar year). The other subcategory is long-lived waste, that is waste not ranking in the short-lived radioactive waste subcategory

Very low-level waste (VLLW) and waste contaminated with naturally occurring radioactive material (NORM) form a specific sub-categories of the LLW. Both types contain an amount of radionuclides below or near the limit permitting their release into the environment. The collection, sorting and processing of NORM is currently carried out on an ad-hoc basis, a system for its collection and assessment has been partially implemented. A legal framework for the management of such materials has not yet been established.

According to the Atomic Act, SF shall not be considered as radioactive waste unless it has been declared as radioactive waste by its owner or by the State Office for Nuclear Safety. SF storage shall be subject to the requirements equal to RW before its disposal and SF shall be stored in that manner, so that its further treatment is not disrupted.

Natural radioactive materials produced in the course of mining and processing of uranium ore are also subject to the Act No. 44/1988 Coll., "on protection and use of mineral resources" (the Mining Act). Their deposits containing solely natural radionuclides are not considered as nuclear installations under the Atomic Act.

In practice we divide radioactive waste into two general categories – that one, which meets the acceptance criteria for existing LILW repositories and which will be disposed of there; and the other which does not meet the criteria and which will be disposed of in the planned deep geological repository..

**Low and intermediate level waste – short-lived (LILW-SL)**

LILW-SL represents the highest volume of radioactive waste generated. It arises in liquid or solid form during the operation and decommissioning of nuclear reactors, and during the use of radioactive sources in health-care, research and industrial applications.

The quantities of LILW-SL in the Czech Republic are summarized in the table below. This shows the quantities of operational and decommissioning waste arising from the Dukovany and Temelin nuclear power plants (NPP) over indicated time periods, together with average annual waste production rates. It also shows the quantities of waste arising from the activities of institutions outside the nuclear industry over indicated periods, also with average annual production rates.

| Expected production of conditioned LILW-SL [$m^3$] | | | |
|---|---|---|---|
| **Installation** | **Operation** | **Decommissioning** | **Average production/year** |
| NPP Dukovany (1985-2025) | 10250 | | 256 |
| NPP Dukovany (2025-2035) | | 3640 | 364 |
| NPP Dukovany (2085-2094) | | 2389 | 239 |
| NPP Temelín (2000-2042) | 12000 | | 285 |
| NPP Temelín (2040-2047) | | 620 | 78 |
| NPP Temelín (2090-2095) | | 4012 | 669 |
| **Total NPPs** | **32907** | | **1891** |
| Institutions (1958-2000) | 2800 | | 67 |
| Institutions (2000-20950) | 5700 | | 60 |
| **Total institutions** | **8500** | | **127** |

**Low and intermediate level waste – long-lived (LILW-LL)**

LILW-LL appears to a lesser extent and a great majority of such waste cannot be accepted by currently operated near-surface repositories. Requirements for the method and quality of processing for storage and subsequent disposal in a DGR will be stipulated for this waste at a later date. The method of processing and treatment of such radioactive waste is well-known and used commercially; hence the issue of implementation is more a time and financial rather than a technical issue. For the time being, waste of this kind is mainly stored unprocessed at the generators, and small amount is being stored by RAWRA.

**Spent nuclear fuel (SF) and high-level waste (HLW)**

According to the Atomic Act, spent nuclear fuel is not considered to be waste until it is declared as such by its owner or by the State Office for Nuclear Safety. The company that operates the nuclear power plants in the Czech Republic is CEZ, which has adopted the open nuclear fuel cycle concept. Under this concept, SF is not reprocessed for recovery of reusable material, but is stored at the premises of the NPPs. For this reason, the management of HLW from SF reprocessing is not currently an issue of direct concern.

HLW contains substantial amounts of radionuclides with short and medium half-lives, together with longer-lived radionuclides. It would arise mainly from the reprocessing of spent nuclear fuel, but only if the Czech SF policy is changed.

The quantities of LILW-LL and SF in the Czech Republic are summarized in the table below. This shows the quantities of operational and decommissioning waste and spent nuclear fuel arising from the Dukovany and Temelin nuclear power plants over indicated time periods, together with analogous figures for the waste and spent fuel arising from the activities of institutions outside the nuclear industry. The table does not include information about waste and/or SF that may arise from any new nuclear facilities, as well as information on any potential HLW that would be generated if a decision were made to reprocess SF.

| Expected production of conditioned LILW-LL and SF | | | |
|---|---|---|---|
| **Installation** | **Operation [$m^3$]** | **Decommissioning [$m^3$]** | **Spent Fuel [t of HM]** |
| NPP Dukovany (1985-2025) | 50 | | 1937 |
| NPP Dukovany (2085-2094) | | 2000 | |
| NPP Temelín (2000-2042) | 50 | | 1787 |
| NPP Temelín (2090-2095) | | 624 | |
| **Total NPPs** | **2724** | | **3724** |
| Institutions (1958-2000) | 80 | 5 | 0.2 |
| Institutions (2000-20950) | 150 | 20 | 0.3 |
| **Total institutions** | **285** | | **0.5** |

## RADIOACTIVE WASTE MANAGEMENT POLICIES AND PROGRAMMES

### Waste management policy

The Radioactive Waste Management Policy adopted by the Czech Government on May 15, 2002 (the Government Resolution No. 487/2002) is a fundamental document which defines the RW management policy and strategy of the Czech Republic approximately by 2025, with an outlook to the end of the 21st century.

The main principles of the Policy are:

- The State guarantees safety of RW disposal. RW repositories are in the state ownership,
- for disposal of the RW is responsible the state organization Radioactive Waste Repository Authority (RAWRA) which operates the existing LILW repositories and is also responsible for development of the deep geological repository (DGR) for disposal of HLW and/or SF,
- the short-term LILW in the Czech Republic are being disposed of in the existing near-surface RW repositories whose safety case is periodically evaluated and optimized,
- the main management option for the long-term LILW and HLW (including SF if decided) is its disposal in the DGR; before its conditioning, these materials are stored at their generators or in facilities of RAWRA; simultaneously, possibilities of SF reprocessing and utilization of new advanced technologies leading to HLW volume and toxicity reduction are being monitored and evaluated,
- costs of activities associated with the DGR development and its future construction and operation, including its closure are paid from the so called Nuclear Account, funded by RW and SF generators in compliance with the Atomic Act and the Government Order. The Nuclear Account is a part of the governmental assets and liabilities and it is managed by the Ministry of Finance. This ensures that disposal costs for waste currently generated will not be transferred to future generations,
- the general public is kept informed about the Policy and its fulfillment

In 2011begun preparation of a new State Energy Policy and its approval is expected in 2013. The new energy policy will include besides the other also enlargement of the nuclear energy sector, i.e. construction of new nuclear reactor units, so RAWRA is obliged to prepare review and update of the recent RWM Policy. The RWM policy review will include:

- evaluation of accomplishment of the short and long-term objectives of the recent RWM Policy by the individual RW classes and RWM areas and specification of new objectives,
- evaluation of the technical level of RW and SF management from the viewpoint of its long-term sustainability and definition of research and development needs and
- review of the economical aspects of RW and SF management, particularly concerning the assurance of a long-term equilibrium between resources and costs.

An overview of main radioactive waste categories and a summary of RW and SF management option in the Czech Republic are in the following table below.

| Waste category | Long - term option | Current practices/facilities | Planned facilities |
|---|---|---|---|
| **Spent fuel** | Considered alternative – direct disposal in the planned DGR, but other alternatives are not excluded (reprocessing, regional repository) | Long term storage / the storage facilities at Dukovany, Temelín (SF from NPP) Reprocessing in Russia and storage / the storage facility at NRI (research) | DGR |
| **Waste from NPPs operation** | Disposal in the operating repositories and in the planned DGR | Disposal in the operating repository (Dukovany) and storage in RWM facilities at NPPs | DGR |
| **Institutional waste** | Disposal in the operating repositories and in the planned DGR | Storage and disposal in operating repositories (Richard, Bratrství, Dukovany), and in storage facilities at the NRI Řež site | DGR |
| **Decommissioning waste** | LILW will be disposed in the Dukovany repository and/or DGR | Update of decommissioning plans; at present, all nuclear facilities are operated (NPP, nuclear reactors, storage facilities, repositories) | DGR |
| **Disused sealed sources** | Disposal in the operating repositories and in the planned DGR; return to the country of origin | Storage and disposal in operated repositories (Richard, Bratrství, Dukovany) | DGR |
| **Uranium mining and milling waste** | Remediation of U mining and milling tailings ponds | Remediation of the U mining site Stráž pod Ralskem and operation of tailings ponds at the Rožná site (Dolní Rožínka) | None |

## Programs and projects

### LILW management

The main management option for LILW is its disposal in the existing LILW repositories if it meets the acceptance criteria, otherwise must be stored until the DGR will begin operation. Techniques for the processing and conditioning of such radioactive waste, before its disposal, are well-developed and implemented. Responsibility for RW pre treatment, treatment and conditioning are responsible waste generators. As the main disposal units are used the 200 l galvanized steel drums. Liquid waste concentrates from the NPPs operation are bituminized, while liquid waste from institutions and research is cemented. The disused ion-exchange resins from NPPs operation are fixed in the alumino-silicate matrix. The solid waste are compacted or disposed of without conditioning.

The quantities of LILW-LL are relatively small, but majority of it is not suitable for disposal in the existing near-surface repositories, except limited amount of LILW-LL which contains naturally occurring radionuclides only, that may be disposed of at the repository Bratrství. The LILW-LL that is not acceptable at the repository Bratrství is stored at the premises of its generators and will continue until the DGR starts its operation. A limited amount of LIL-LL is accepted for storage by RAWRA at the repository Richard.

The transient waste is processed, treated and stored in the same way as other LILW, but at the time when its activity decreases below the release limits, the waste is released for recycling or for disposal of at a controlled non-radioactive waste dump.

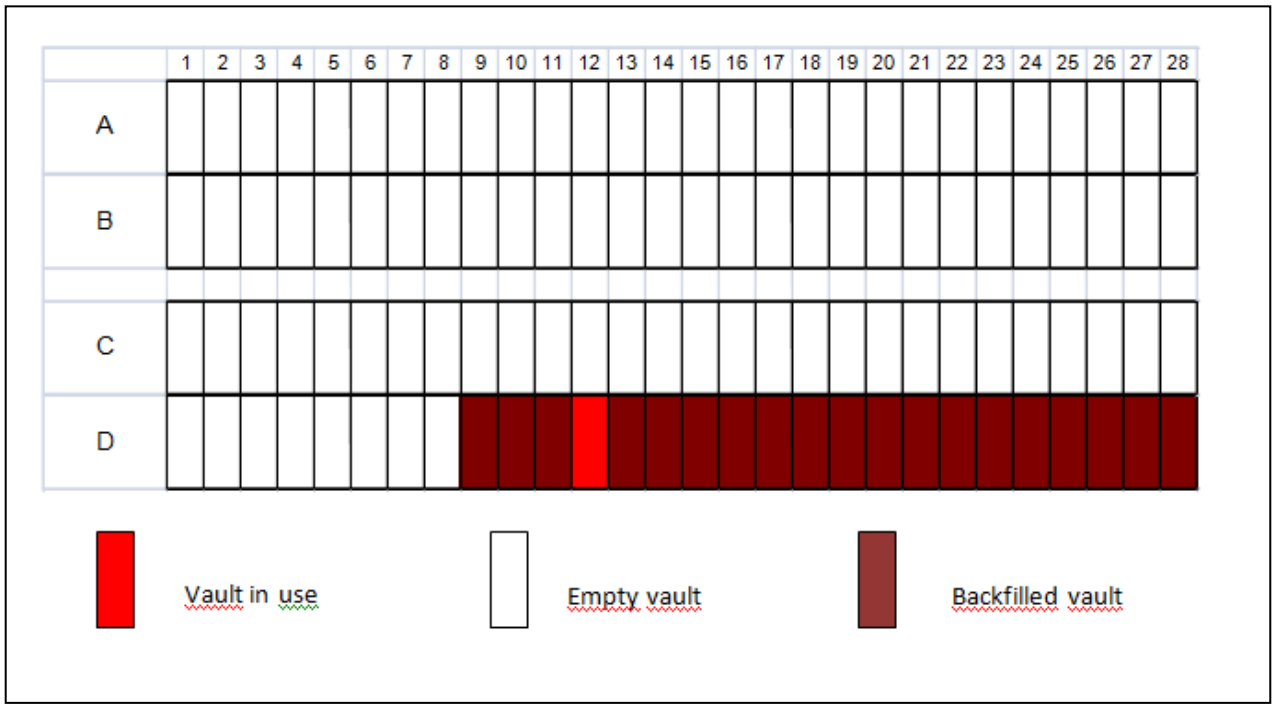
The VLLW production was up to now very low, but with ongoing partial dismantling and remediation activities at the NRI site, it is being in discussion nowadays. Within the update of the RWM policy, RAWRA will prepare a program for the VLLW management and disposal optimal solution.

**The LILW-SL repository Dukovany** is located on the site of the NPP Dukovany. It is primarily designed for disposal of waste generated by both NPPs during their operation and future decommissioning; however institutional waste, meeting the acceptance criteria, is also disposed of there. Its disposal capacity of 55 000 $m^3$ is large enough for both Dukovany and Temelín NPPs, including LILW-SL waste from their decommissioning.

The Dukovany repository inventory and its vaults scheme, as of 31.12.2012, are in the following table and figures.

| Radionuclide | Total activity [Bq] | Radionuclide | Total activity [Bq] |
|---|---|---|---|
| $^{14}C$ | 1,81E+11 | $^{99}Tc$ | 1,39E+09 |
| $^{41}Ca$ | 3,15E+08 | $^{129}I$ | 5,52E+08 |
| $^{59}Ni$ | 5,33E+09 | $^{137}Cs$ | 8,7E+12 |
| $^{63}Ni$ | 6,66E+11 | $^{239}Pu$ | 1,26E+08 |
| $^{90}Sr$ | 8,93E+10 | $^{241}Am$ | 5,68E+08 |
| $^{94}Nb$ | 1,24E+09 | All nuclides | 9,65E+12 |

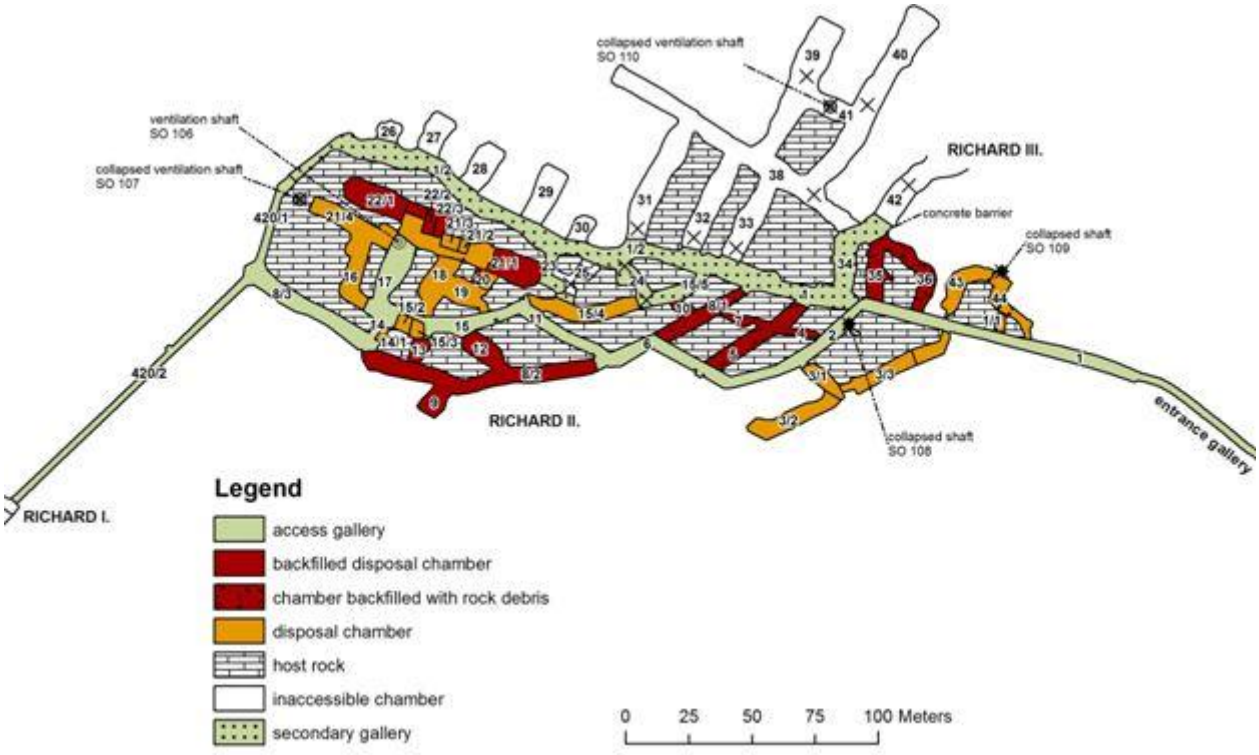
The activity of radionuclides is not corrected by their half-life during the repository operation since 1997.




**The repository Richard**, is located near the town of Litoměřice and is constructed on the premises of a former limestone mine. It is designated for disposal of institutional LILW-SL. Part of its capacity is used for storage of limited amount of LILW-LL and for the nuclear material. This waste will be before the repository closure removed and it is expected, that will be disposed of in the DGR. Its total excavated volume is approx. 18 900 $m^3$ from which the disposal capacity is approx. 10 250 $m^3$, which should be sufficient for disposal of the institutional LILW-SL, expected to be generated up to 2070.

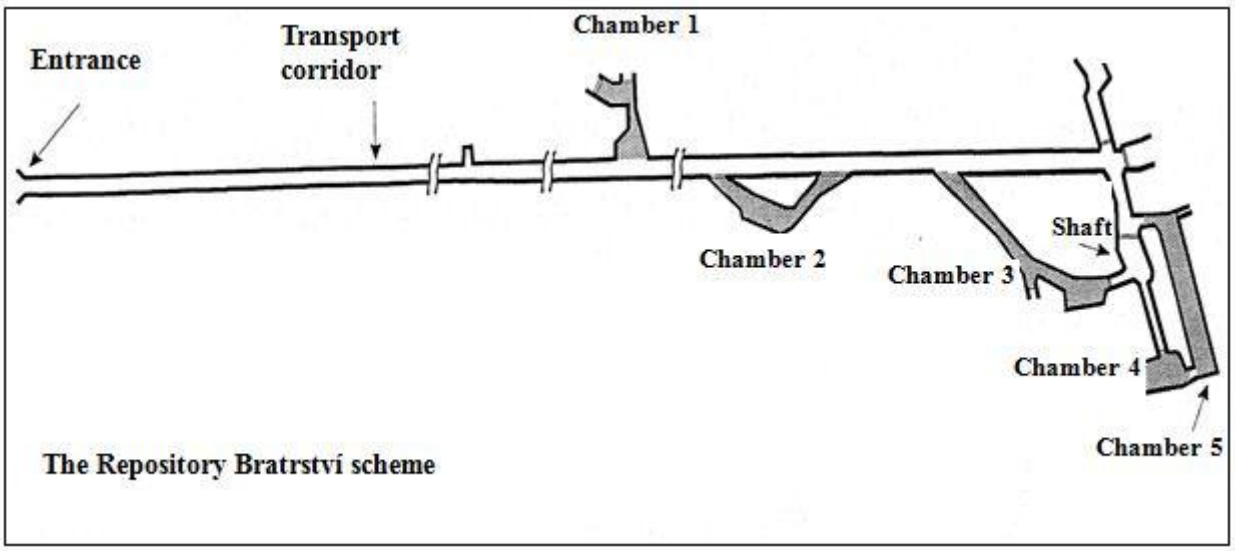
The repository Richard inventory and its scheme as of 31.12.2012 are seen in following table and figure.

| Radionuclide | Total Disposed Activity [Bq] | Activity limit [Bq] | Exploitation of the activity limit [%] |
|---|---|---|---|
| **H-3** | 3,50E+13 | 1,00E+15 | 3,5 |
| **C-14** | 8,20E+12 | 1,00E+14 | 8,2 |
| **Cl-36** | 9,04E+09 | 1,00E+12 | 0,9 |
| **Sr-90** | 2,41E+13 | 1,00E+14 | 24,1 |
| **Tc-99** | 9,79E+07 | 1,00E+11 | 0,1 |
| **I-129** | 2,14E+07 | 2,00E+08 | 10,7 |
| **Cs-137** | 4,97E+14 | 1,00E+15 | 49,7 |
| **total activity of long lived α nuclides** | 8,86E+12 | 2,00E+13 | 44,3 |




**The repository Bratrství** is located in a former uranium mine near the town of Jáchymov and is designed for disposal of waste containing naturally occurring long-lived nuclides only, such as $^{226}$Ra and uranium. Its disposal capacity is approx.1 200 m$^3$, from which is free approx. 340 m$^3$. In 2012 the chamber 2 was sealed with special concrete backfill. Sealing of the remaining chambers will follow.

Repository Bratrství scheme and its inventory as of 31.12.2012 are seen in following figure and table.



| Radionuclide | Total disposed activity [Bq] | Activity limit [Bq] | Exploitation of the activity limit [%] |
|---|---|---|---|
| $^{226}$Ra | 1,35+E12 | 5+E12 | 27,0 |
| U | 4,95+E11 | 2+E12 | 24,75 |
| $^{232}$Th | 1,37+E08 | 3+E12 | 0,004 |
| Alpha | 1,88+E12 | 1+E13 | 18,8 |

**HLW and SF management**

Due to the adopted RW and SF management policy, the HLW will come into account only if decision on reprocessing of the SF will be taken. The main final HLW and SF management option is its disposal into a DGR built in the Czech Republic, but the option of its disposal in an international regional repository is not excluded.

Currently, SF from the Dukovany and Temelín NPPs is stored in SF storage facilities on the premises of the plants. CEZ has adopted a concept of dry storage in dual-purpose, transport/storage containers. Spent fuel from research reactors is stored at the Nuclear Research Institute site at Rez. It is expected that storage of the SF at its generators sites will be until the DGR strts its operation, which is expected around the year 2065.

The overview of spent fuel management capacities:

| Locality | Facility name | Storage capacity [pieces FA] | Storage capacity [tons of HM] |
|---|---|---|---|
| **Dukovany** | SF pool reactor unit 1 | 699 | 83 |
| | SF pool reactor unit 2 | 699 | 83 |
| | SF pool reactor unit 3 | 699 | 83 |
| | SF pool reactor unit 4 | 699 | 83 |
| | Interim Spent Fuel Storage Facility | 5040 | 600 |
| | Spent Fuel Storage Facility | 11172 | 1340 |
| **Temelín** | SF pool reactor unit 1 | 703 | 396 |
| | SF pool reactor unit 2 | 703 | 396 |
| | Spent Fuel Storage Facility | 2888 | 1370 |
| **NRI Řež** | Annex to HLW Storage Facility (ÚJV) | 360 | |
| | SF pool in HLW Storage Facility (ÚJV) | 465 | |
| | Wet tank (CV Řež) | 60 | |
| | RAW Storage Facility (CV Řež) | 80 | |

## RESEARCH AND DEVELOPMENT

### Geological repository development

The DGR dvelopment program is in the first phase of its siting process. The main problem delying its development is rejection of a detailed geological survey by the municipalities at the preliminafy selected sites. In 2012 its generic, conceptual design has been updated, taking into account development in regulations, technology and economy within the period from its first issue in 1999. Within the DGR program RAWRA coordinates supporting R&D pojects connected with site characterization, sealing materials development, disposal casks development, etc.

RAWRA also participates on several international R&D projects organized by IAEA, EU and or OECD.

### Waste management and SF reprocessing

What concerns the LILW management there are not running any R&D projects. Recently RAWRA supports several projects coordinated by the NRI Řež in the field of SF reprocessing.

## DECOMMISSIONING AND DISMANTLING POLICIES AND PROJECTS

### Concept for decommissioning of Dukovany NPP and Temelin NPP

A nuclear facility decommissioning plan must be developed by any operator of the nuclear facility and it is a precondition for receiving the construction license. The plan must be updated also prior the operation license application and after that must be updated every fifth year. The plan update concerns namely the estimated decommissioning costs, from the point of view of a decommissioning reserve fund creation.

The option adopted for decommissioning of the Dukovany and Temelin NPPs, operated by CEZ, may be described as gradual decommissioning with deferred site clearance. In this option, all spent nuclear fuel will be removed from the reactors soon after final shutdown. After removal of peripheral equipment, the reactor structures will then be left in place under protective closure for a period of about 50 years. After this delay, it will begin decontamination and dismantling of remaining equipment and structures and the site clearance.

## TRANSPORT

The Czech Republic has implemented all the international treaties and conventions on transport of hazardous goods by road, rail and air, by which it is bound. It has also transposed into its legal instruments all EC regulations concerning transportation of radioactive material and/or waste.

## COMPETENT AUTHORITIES

**The Czech Government and State Authorities in general** are responsible for development and implementation of the legislative framework and the state policy in the field of radioactive waste management which should be in compliance with the international commitments.

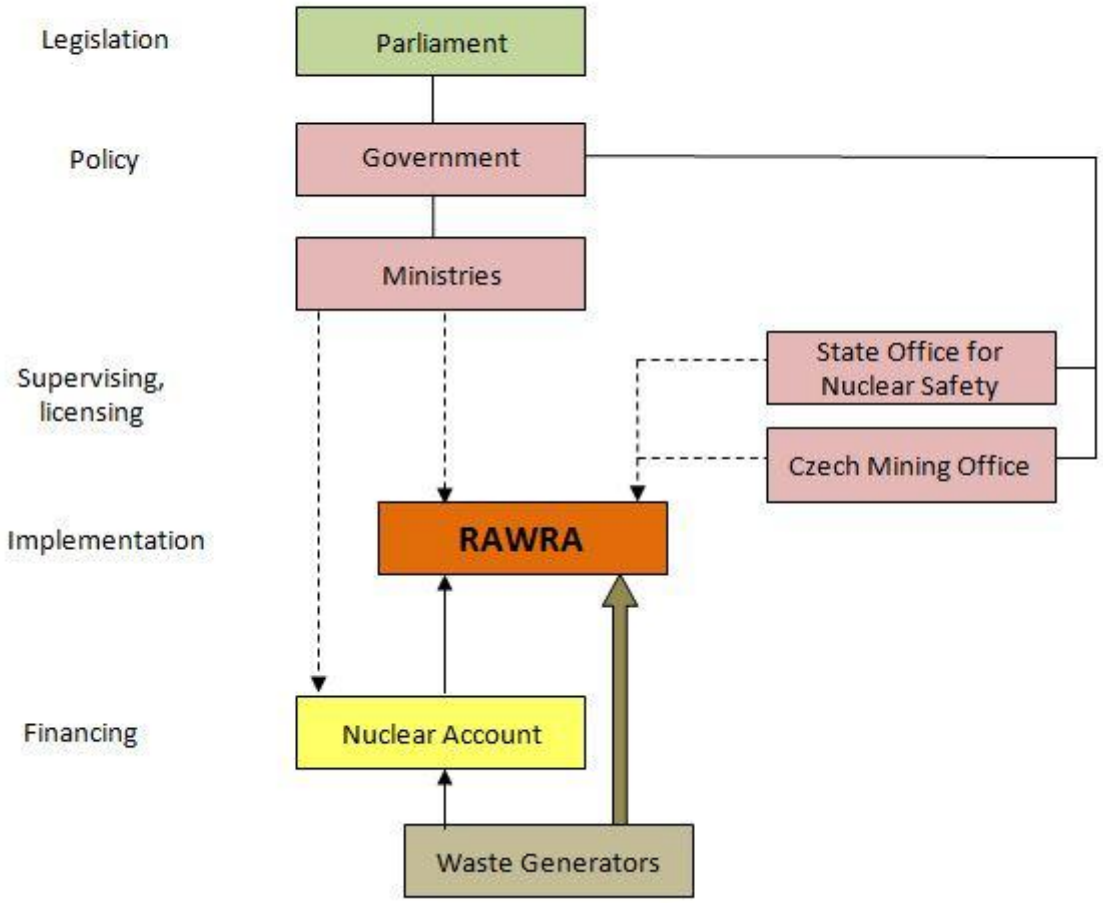
**The State Office for Nuclear Safety** is responsible for nuclear safety and radiation protection supervision and for development of legal regulations in the field of nuclear energy use and radioactive waste management. Gives permits for siting, construction, operation and closure of the repositories as well as for RW management in general.

**The Czech Mining Office** gives a final approval for construction and operation of repositories in the underground formations and is supervising activities connected with radioactive waste mangement in these repositories, from the point of view of the miming regulations.

**The Radioactive Waste Repository Authority (RAWRA)** is the state organization which is responsible for disposal of radioactive waste and for preparation, construction, commissioning, operation and closure of radioactive waste repositories and monitoring of their impact on the environment. Besides these main responsibilities RAWRA is also responsible for providing other activities connected with RWM including coordination of research and development in the field. Activities of RAWRA are financed from Nuclear Account (fund which is created from levies of waste generators for the waste disposal) and partially from the State budget.

**Generators of Radioactive Waste and Spent Nuclear Fuel** are responsible for RWM at their premises and for its conditioning prior its disposal. They shall allocate to their own debit financial provisions to the Nuclear Account to cover expenses for disposal of radioactive waste which have been arising or will arise and for associated activities of RAWRA.

**Main authorities and bodies involved in radioactive waste management in the Czech Republic**




## FINANCING

In compliance with internationally acknowledged principles, the Atomic Act requires that the radioactive waste generator bear all the costs of radioactive waste management from production to disposal of such waste, including the cost of monitoring repositories after their closure and the cost of the associated research and development. The processing of radioactive waste for disposal is paid for by the generator in the form of direct payments to specialist organizations that carry out such activities on the generator's behalf. Radioactive waste disposal and spent nuclear fuel encapsulation and disposal are the responsibility of RAWRA. The generator pays for these services in the form of payments to a nuclear account.

**Nuclear account**

The nuclear account is controlled by the government and nuclear account funds may only be used through RAWRA for tasks specified in the Atomic Act. The distribution of nuclear account funds and amounts and methods of waste generators payments are stipulated by certain government decrees. RAWRA administers payments to the nuclear account and prepares documentation on the level of payments.

**Cost of waste disposal in near-surface repositories**

The costs of operation and closure of existing repositories are covered by nuclear account resources. Individual RW generators contribute into the nuclear account depending on the character and amount of waste being disposed. The level of payments required to cover these costs are determined according to relevant methodology in compliance with current government decree, either in the form of one-off payments or regular installments.

**Cost of HLW and SF disposal**

The costs of design, construction, operation and closure of a deep geological repository as well as the cost of spent nuclear fuel conditioning into a form suitable for disposal, and that of high-level waste or spent nuclear fuel disposal itself, are settled by regular installments from SF generators.

**Provisions for decommissioning**

Under the provisions of the Atomic Act, licensees are obliged to make financial provision for decommissioning nuclear facilities or workplaces with significant or very significant sources of ionizing radiation. Funds should be available for both the preparation for decommissioning and decommissioning itself at the required time, and in an amount commensurate with the proposed method of decommissioning as approved by the State Office for Nuclear Safety. Such financial provisions are tax-deductible and are maintained by respective licensees. The estimated cost of decommissioning is verified by RAWRA and licensees are obliged to update their estimates every five years.

## PUBLIC INFORMATION

For more information, the websites of relevant organizations are listed below:

| | |
|---|---|
| Government | State Office for nuclear Safety – SUJB, Praha, http://www.sujb.cz |
| | Radioactive Waste Repository Authority – RAWRA, Praha, http://www.surao.cz |
| Industry | CEZ (NPPs operator), http://www.cez.cz |
| Research | Nuclear Research Institute – NRI, Řež, http://www.ujv.cz/ |