# Inventory of radioactive wastes and management of RAW at the Armenian ANPP

*Armenian Nuclear Power Plant*

Konstantin Pyuskyulyan pyuskyulyan@bk.ru Karine Ghazaryan ghazaryuan.karine@gmail.com

ISOE symposium Beijing, China October 22 - 24, 2019

# GENERAL

Operation and decommissioning of the nuclear power plant results in generation of the large amount of waste. And appropriate radioactive waste (RAW) management is important in terms of safety, RAW impact on the environment, impacts on personnel working directly in the NPP premises, impact on inhabitants living in immediate vicinity and in the surroundings of a NPP, as well as in terms of RAW long-term storage or disposal. The most critical group among all generated waste is a group of RAW.

Radioactive waste can be divided according to its origin and way of its generation. It can be classified into the following main groups:

- Historical waste
- Operational waste
- Waste from decommissioning

# RAW MANAGEMENT AT THE ANPP

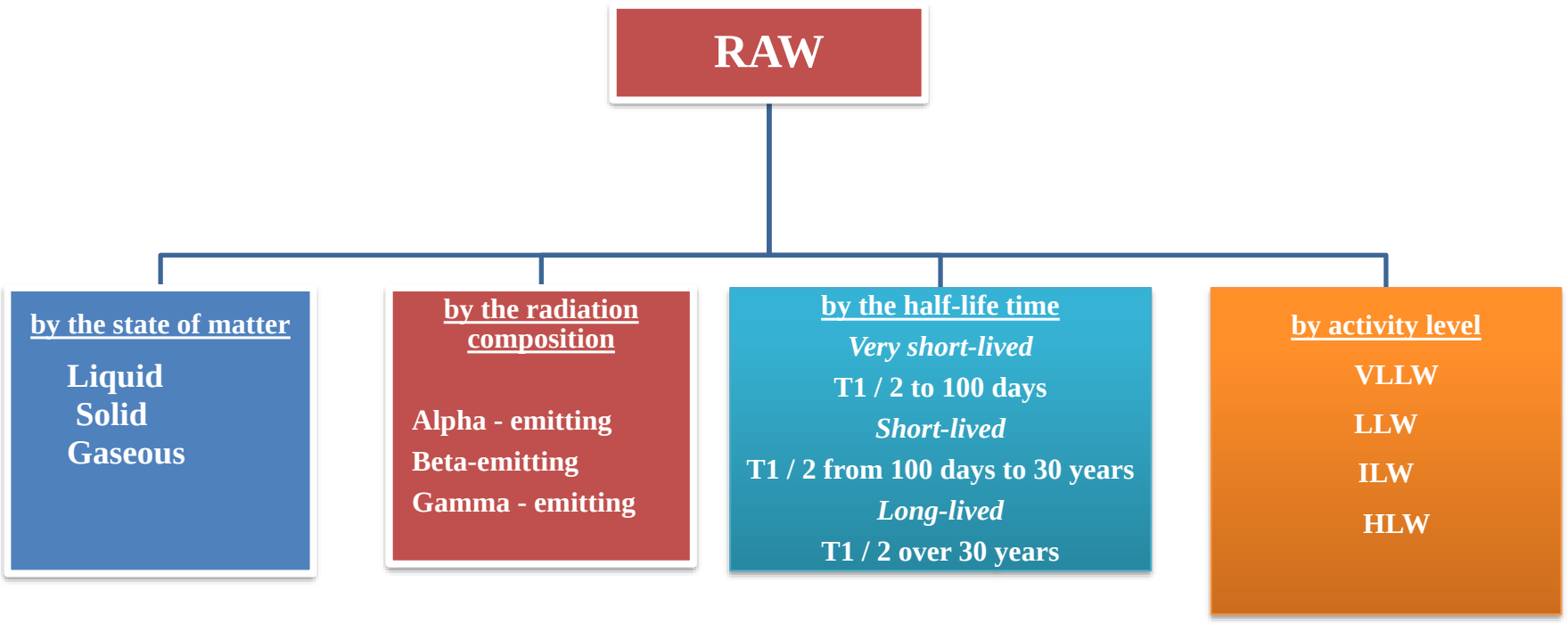
RAW management is a long time issue that cannot be solved without defined concept or pre-planned steps. Each type of RAW requires a specific way of processing to transform it into safe form in which it can be temporarily stored and subsequently treated for its final disposal in the repository.

Radioactive waste management at ANPP is regulated by the following:

- Appropriate Laws of Republic of Armenia;
- Legal standards, decisions of the RA government;
- National standards and rules;
- Guides, instructions and programs for RAW management at the ANPP;
- Quality Assurance Programs and Administrative Management Programs for RAW Management at ANPP;

These documents define the procedures for radioactive waste management, responsible persons, RAW transportation routes, their accounting, methods for monitoring waste management and the state of storage facilities.

# RADIOACTIVE WASTE CLASSIFICATION



# RAW classification by activity level

| Waste category | Specific activity, kBq/kg | | |
|---|---|---|---|
| | Beta-emitting nuclides | Alpha-emitting Nuclides (except of transuranium) | Transuranium nuclides |
| Very low-level | less than $10^2$ | less than $10^1$ | less than 1 |
| Low- level | from $10^2$ to $10^3$ | from $10^1$ to $10^2$ | from 1 to$10^1$ |
| Intermediate level | from $10^3$ to $10^7$ | from $10^2$ to $10^6$ | from $10^1$ to $10^5$ |
| High level | more than $10^7$ | more than $10^6$ | more than $10^5$ |

# RAW GENERATION AT THE ANPP (1)

Radioactive waste at the Armenian NPP is generated during the daily cleaning and decontamination of the premises of the controlled area (KA), during the decontamination and repair of equipment, during maintenance activities in the KA, etc.

RAW also includes parts of technological equipment that are not subject to decontamination or irradiated in the reactor, instrumentation, piping or protection fittings, overalls and personal protective equipment contaminated above acceptable levels, ventilation systems filters, spent sources of ionizing radiation, appliances, special laundry, sanitary locks water, etc.

Radioactive waste generated at the ANPP can be divided according to its origin and way of its generation. It can be classified into the following main groups:

- ***Historical waste -*** the RAW which has been generated during the operation of NPP since its commissioning. In case of ANPP this type of RAW has not been treated or conditioned (**only part of liquid RAW has been processed at deep evaporation facility**). The RAW are stored within the premises of ANPP waiting for further processing and final disposal.
- ***Operational waste -*** the RAW that generated during NPP operation. These include RAW typically generated at NPP which are not currently processed (only part of liquid RAW has been processed at deep evaporation facility), but only collected and stored waiting for further treatment. According to planned duration of NPP operation and based on the assessment of historical RAW stored at the plant, it is possible to estimate further amount of such waste that will be generated till planned plant shutdown.

# RAW GENERATION AT THE ANPP (2)

- ***RAW generation from decommissioning***

✓***Primary RAW from decommissioning*** – RAW that will be generated during NPP decommissioning after plant shutdown. Primary RAW are generated during dismantling and demolition of the decommissioned nuclear power plant structures. A standard status of NPP before starting its decommissioning is the status, when all systems are drained. And fuel is not stored in the Spend Nuclear Fuel pools any more. This means that most of the primary radioactive waste from decommissioning **will be of solid, not liquid nature**.

✓***Secondary RAW from decommissioning*** – the RAW that will be generated during decommissioning of NPP as a consequence of primary RAW removal. NPP decommissioning should to take into consideration a significant amount of secondary RAW, such as contaminated water, used cleaning and decontamination agents, used tools and equipment, demolition waste (dust, sawdust, etc.), used clothes and personal protective means, etc.

# RAW STORAGE FACILITIES AT THE ANPP (1)

**Solid radioactive waste stored at ANPP in:**

- Solid low-level waste storage facility
- Solid intermediate-level storage facility
- Solid high -level storage facility

**Liquid radioactive waste storage system.**

Liquid radioactive waste are temporary stored at the ANPP in:

- Six tanks for evaporator condensate storage (ECT 1-6) total volume - 3720 $m^3$
- Two tanks for high level sorbents storage - total volume 430 $m^3$

**Currently liquid RAW storage system is filled to 65% of its volume**

# RAW STORAGE FACILITIES AT THE ANPP (2)

Filling of RAW storage facilities at ANPP

- ***Low-level solid RAW storage facility***


**Composition of solid LL RAW**:
- Combustible (paper, plastic, wood, textile, etc) – 75%
- Non- combustible – (metal, thermal insulation, construction waste) -25%.

**Storage facility is filled to 39% of volume**

- ***Intermediate- level solid RAW storage facility***

Composition of solid IL RAW:
- Combustible - (paper, plastic, wood, textile, etc) – 20%
- Non- combustible – (metal, thermal insulation, construction waste, slit, activated spent ion-exchange resins, salt cake drums) -75%. **Filling degree – 46, 5%**
- In 1996 on the roof of the special building a special storage area was organized for storage of DEF (salt cake) drums.

# RAW STORAGE FACILITIES AT THE ANPP (3)

***High- level solid RAW storage facility***

**Composition of solid HL RAW:**

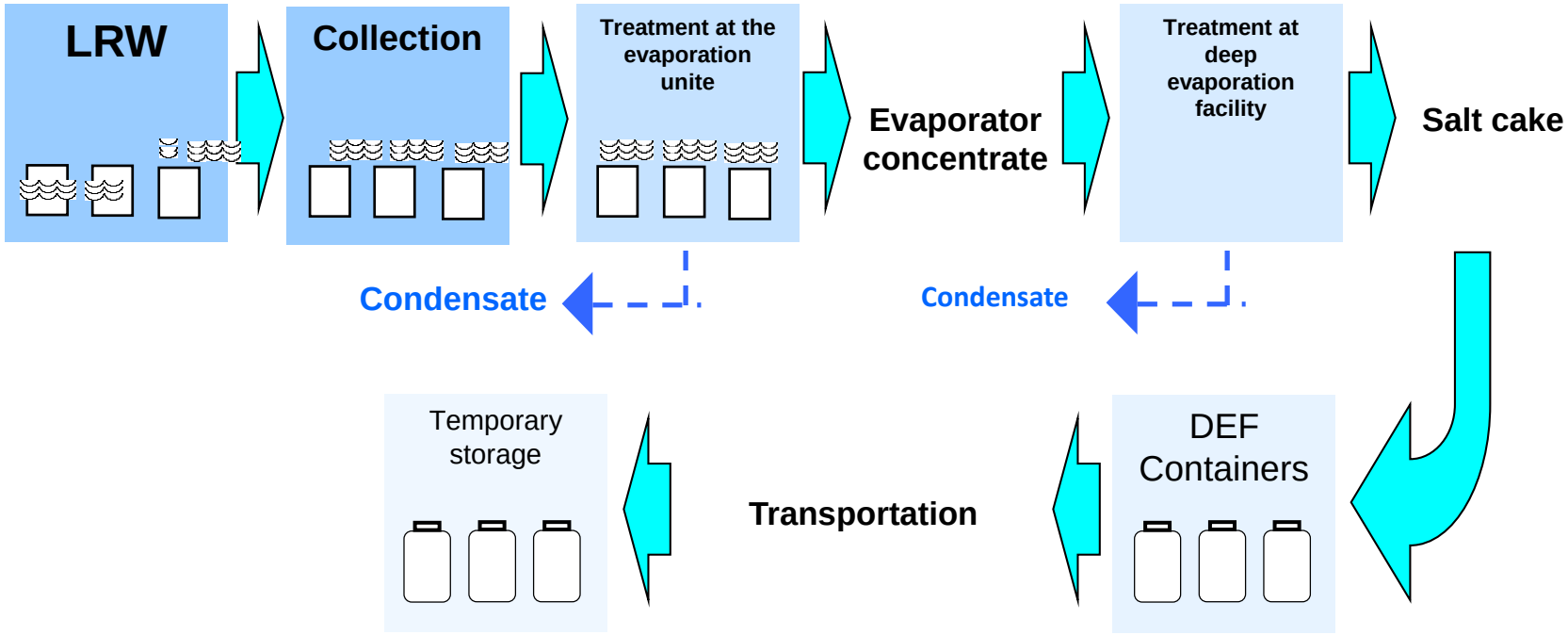
- Combustible (paper, plastic, wood, textile, etc) –5%
- Non- combustible – (metal, disused sources, I&C, parts of technological equipment) - 95%.

**Storage facility is filled to 48% of volume**

***Very low- level solid RAW storage facility***

***There is no VLL solid RAW facility at the ANPP***

# Management of liquid radioactive waste (LRW) (1)



# Management of liquid radioactive waste (LRW) (2)

The system of collection and processing of liquid radioactive wastes, as to the original design, includes:

- System of waste water collection and processing, which includes:
  - 2 tanks of low level sorbents
  - 3 tanks of waste water
  - 2 evaporator units
  - 2 lines of special water purification

- Liquid radioactive waste storage system, which includes:
  - 2 tanks of high level sorbents
  - 6 tanks of evaporator concentrate

# Management of liquid radioactive waste (LRW) (3)

**Radioactive waste water**:

- annual generation – 8 000-13 000 $m^3$/y;
- *sedimentation* in a tank (LLS);
- mechanical filtration;
- evaporation – 2 evaporator output 6 $m^3$/h each;
- ion exchange filtration;
- evaporator concentrate stored in tanks;
- evaporator distillate – released into the environment after radiation control.

**Evaporator Concentrate (EC):**

- Annual generation – 30-60 $m^3$;
- Between 50 – 70 $m^3$ annually are transferred to the DEF for processing.

**Evaporator Concentrate parameters**

- total salt content – 170 g/L;
- boric acid content – 57 g/L;
- Co-60 – $1.2 \times 10^5$ Bq/L
- Cs-137 – $1.3 \times 10^6$ Bq/L

# Management of liquid radioactive waste (LRW) (4)

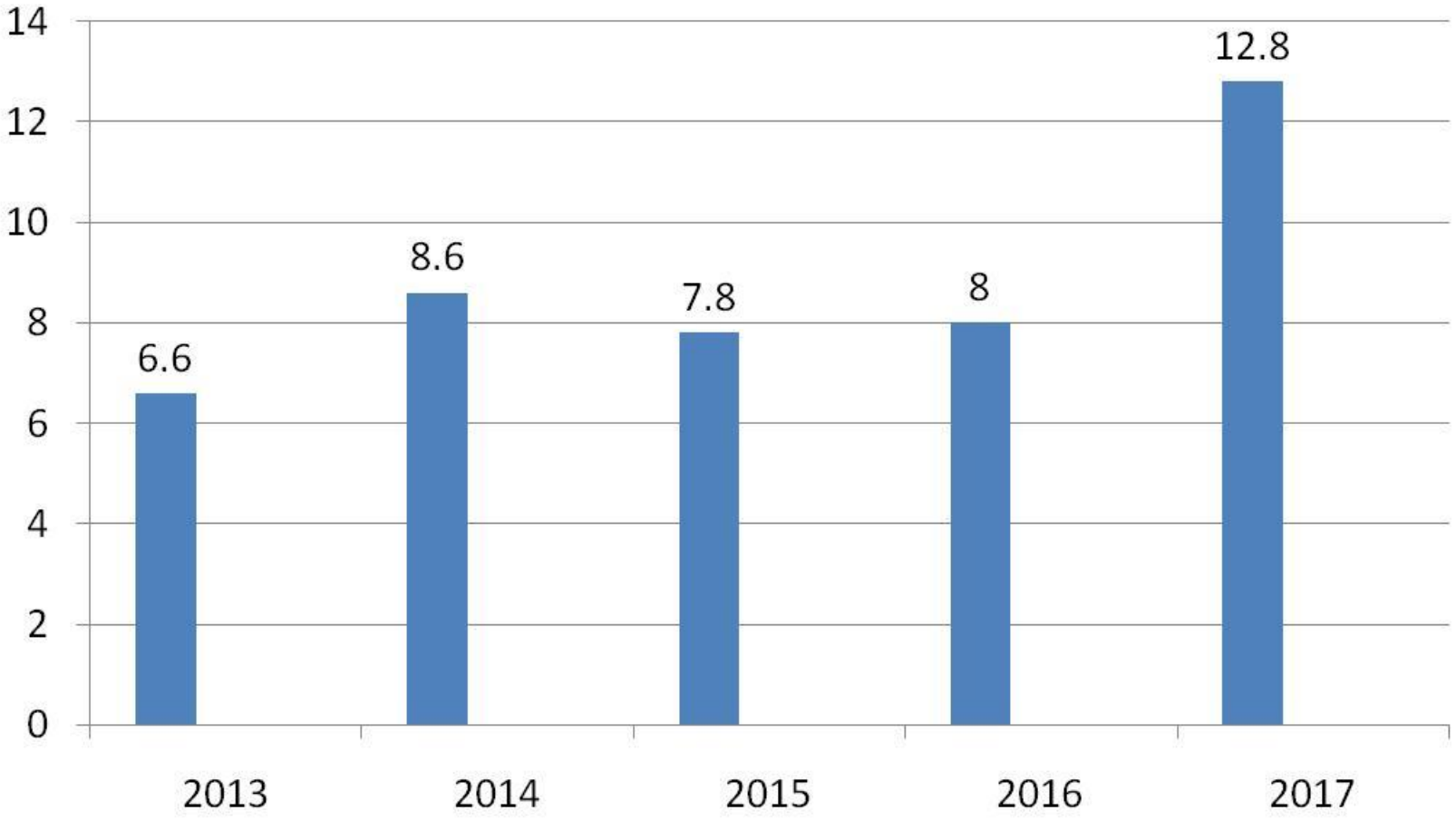

- The ANPP is processing liquid radioactive waste by means of deep evaporation.
- Solidified liquid radioactive waste is filled into carbon steel (type 3 steel) drums of 150-250 L volume.
- These drums are then stored in the Intermediate Level Solid Waste Storage in the auxiliary building and on the roof of the Special Building.

# Isotope and chemical composition of ILW-containers with salt melt, formed after processing of liquid radioactive wastes:

| Isotope composition | Average Specific activity, Bq/kg |
|---|---|
| Cs-134 | Cs-134 – $5,3x10^6$ |
| Cs-137 | Cs-137 – $2,2x10^6$ |
| Co-60 | Co-60 – $4,2x10^5$ |

| Chemical composition of contents of DEF containers | | |
|---|---|---|
| Composition | Unit | Quantity |
| pH | | 8-12 |
| $BO_3$ | g/kg | 5-120 |
| $NH_4$ | mg/kg | 20-250 |
| CL_ | g/kg | 0,04-4,0 |
| Salt content | g/kg | 0,5-480 |
| $Na_+$ | g/kg | 2-100 |
| $K_+$ | g/kg | 1-30 |
| $Fe_-$ | mg/kg | 18-120 |
| $No_3$ | mg/kg | 5-20 |

# Salt Cake Generation, $m^3$

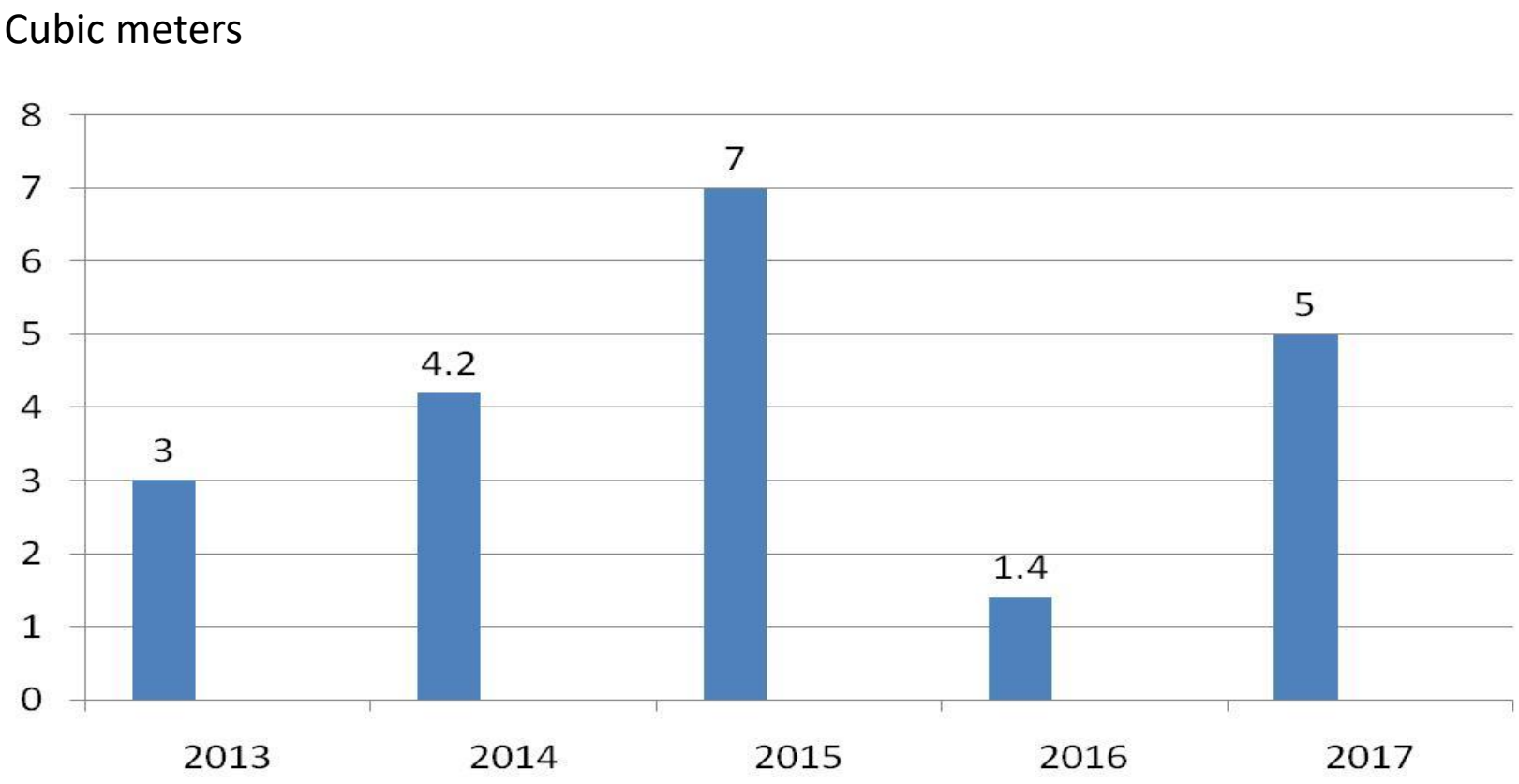


# Spent Ion Exchange Resins

Annual generation in the last years - about 4 $m^3$/y ;

Stored quantity – 172 $m^3$. Spent ion exchange resins are stored at ANPP in the auxiliary building in a stainless tank.

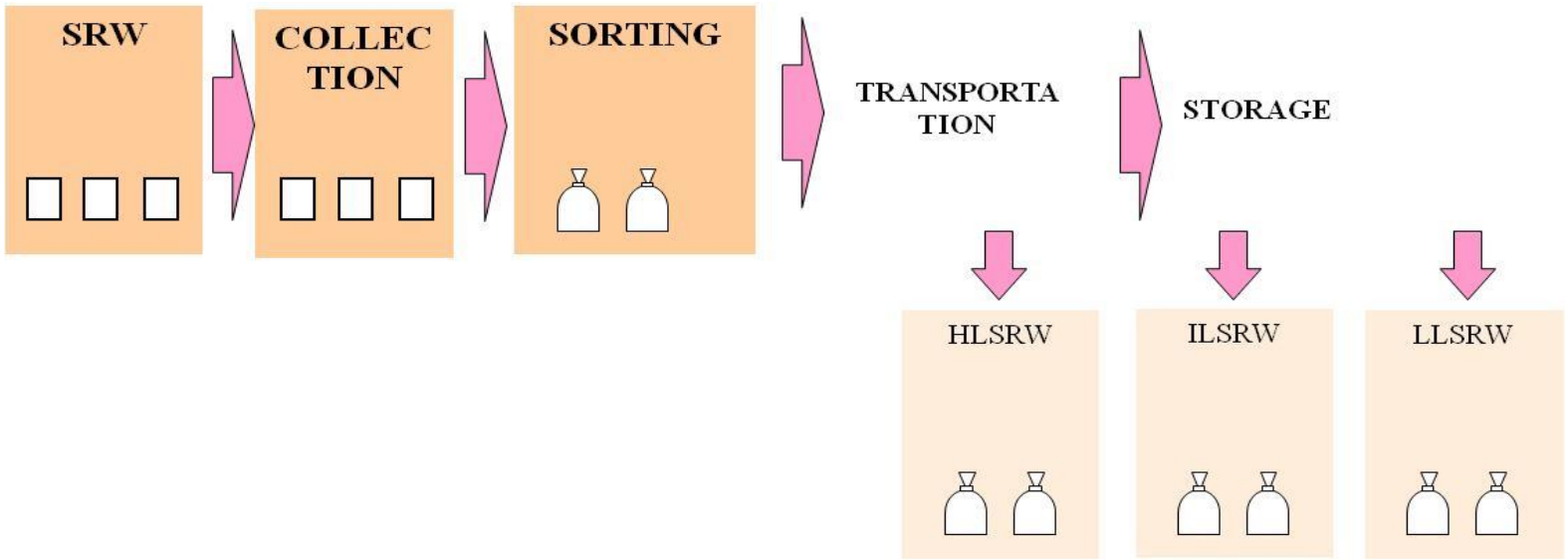
Currently no treatment of spent ion exchange resins is undertaken



# Management of solid radioactive waste (SRW) (1)

**All waste generated in the controlled area is considered as radioactive waste.**

The ANPP operates a technological scheme for handling SRW, which provides for their collection, sorting, transportation and safe storage.




**SRW are not treated yet at the ANPP**

# Management of solid radioactive waste (SRW) (2)

- Storage of solid low-level radioactive wastes. Total storage volume is 17051$m^3$.
- Storage of solid intermediate-level radioactive waste. Total storage volume is 1001.2 $m^3$
- Temporary storage for the drums with salt cake. Area - 655 $m^2$.
- Storage of solid high-level radioactive waste. Total storage volume of is 78.3$m^3$

**Inventory of Solid Waste as of 01 January 2019**

| It. No. | Storage facility name | Storage capacity, m3 | RW quantity in the facility | |
|---|---|---|---|---|
| | | | m3 | % of filling |
| 1 | Low level SRW storage facility at ANPP | 17051 | 6626 | 39 |
| 2 | Intermediate level SRW storage facility at ANPP (various IL SRW, including salt cake drums- 1850 drums) | 1001.3 | 464.5 | 46.4 |
| 3 | Temporary storage of the drums with solidified waste (3000 drums). | Area 655 $m^2$ | 435 | 100 |
| 3 | High level SRW storage facility at ANPP | 78,34 | 37.5 | 47.9 |

# Low level solid waste activity

| Component | Specific activity, Bq/kg |
|---|---|
| Metal | $^{134}$Cs -4400; $^{137}$Cs -9000; $^{60}$Co -5500; $^{110m}$Ag -800 ; $^{54}$Mn -890; $^{58}$Co -400; $^{90}$ Sr/$^{90}$Y -150; $^{59}$Fe -560; $^{95}$Nb -650; $^{141}$Ce -650; Alpha active - absent |
| Metallic facing | $^{134}$Cs -4400; $^{137}$Cs -9000; $^{60}$Co -5500; $^{110m}$Ag -95; $^{54}$Mn -890; $^{58}$Co -400; $^{90}$Sr/$^{90}$Y -150; $^{59}$Fe -560; $^{95}$Nb - 650; $^{141}$Ce -150; Alpha active - absent |
| Plastic | $^{134}$Cs -2000; $^{137}$Cs -2000; $^{60}$Co -3000; $^{58}$Co -1200; $^{90}$Sr/$^{90}$Y -150; Alpha active - absent |
| Polyvinyl film | $^{134}$Cs -3000; $^{137}$Cs -1200; $^{60}$Co -400; $^{58}$Co -380; $^{90}$Sr/$^{90}$Y - 50; Alpha active - absent |
| Rubber | $^{134}$Cs -1000; $^{137}$Cs - 1000; $^{60}$Co - 800; $^{58}$Co - 300; Alpha active - absent |
| Wood | $^{134}$Cs - 1000; $^{137}$Cs - 500; $^{60}$Co - 800; Alpha active - absent |
| Paper, textile | $^{134}$Cs - 3500; $^{137}$Cs - 10000; $^{60}$Co - 6000; $^{110m}$Àg - 350; $^{54}$Mn - 600; $^{58}$Co - 250; $^{90}$Sr/$^{90}$Y – 200; Alpha active - absent |
| Concrete | $^{134}$Cs - 800; $^{137}$Cs - 4000; $^{60}$Co - 3500; Alpha active - absent |
| Glass, ceramics | $^{134}$Cs -600; $^{137}$Cs - 1000; $^{60}$Co - 500; Alpha active - absent |
| Heat insulation | $^{134}$Cs - 500; $^{137}$Cs - 2000; $^{60}$Co – 400; Alpha active - absent. |

# INTERMEDIATE LEVEL SOLID WASTE ACTIVITY

| ILW | Location | Volume $m^3$ | Isotope content | Average specific activity | Packaging type | % |
|---|---|---|---|---|---|---|
| ILW | Special building | 99,1 | Cs-134<br>Cs-137<br>Co-60 | $2,4x10^6$ Bq/kg<br>$6x10^7$ Bq/kg<br>$2,8x10^6$ Bq/kg | Metal containers of different size | 9,9 of storage capacity |
| **Composition of ILW** | | | | | | |
| ILW | Metals | 2,97 | No data | | Without packaging | 3,0 of ILW volume |
| ILW | Paper, textiles | 24,78 | Cs-134<br>Cs-137<br>Co-60 | $5,5x10^6$ Bq/kg<br>$8,5x10^7$ Bq/kg<br>$6,8x10^6$ Bq/kg | Metal containers of different size | 25,0 of ILW volume |
| ILW | Mixed | 71,35 | No data | | Metal containers of different size | 72 of ILW volume |

# Questions?