Improvement of Radwaste Management System at Bilibinskaya NPP in the Far North Conditions – 13456

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ABSTRACT

Since 2009 Bilibinskay NPP is getting started to prepare to the decommissioning in the Far North conditions. Bilibinskaya NPP is located in the Far North of Russian Federation in Chukotka region. Since 1974 it operates 4 units EGP-6 with the capacity of 48 MW each.

According to the contract, SIA Radon has performed the following works:

- LLRW disposal safety analysis,
- The technology of spent ion-exchanger and salt residue solidification is proposed,
- Expected radwaste (till 2027) management economical analysis
- Technical proposals for LLRW and IRW management.

INTRODUCTION

At present time radioactive waste management at Bilibinskaya NPP comes only to their on site storage. There are no plants for waste treatment and conditioning (solidification, pressing, incineration and so on) at the NPP. RW does not taken out from the territory of Bilibinskaya NPP. Storage of liquid and solid radioactive waste is organized at special storages: SRW - storage for liquid radioactive waste, SRW - storage for intermediate- and high-level solid radioactive waste and SRW - storages (trenches) #1 and #2 for LRW.

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DESCRIPTION

For storage of low-level solid RW at Bilibinskaya NPP concrete sunken storage with a volume of 2150 m^3 is used (SSRW #1). Storage for SRW is a concrete trench with dimensions – 15x40 m. Concrete constructions have damp course. Walls, floor and ceiling of the trench are reveted with stainless steel with thickness of 4 mm. The storage was commissioned in 1991. Before 1991 low level RW were kept storage at earthen trenches and their contents were after overloaded into SSRW #1.

At present time SSRW #1 is filled completely. Ramming by heavy bulldozer has been used several times in order to receive extra volume for further storage. Overall weight of waste at SSRW #1 is 1487,4 ton. Waste is placed in a bulk way.

In 1998 the second concrete sunken storage for SRW was built at Bilibinskaya NNP which has a volume of 3180 m^3 (SSRW#2). It had not been filling till 2003.

At the SSRW #2 also combustible waste are kept storage together with incombustible waste. According to the Rules for Radiation Safety at NPP -99 combustible waste ought to be incinerated at special plants or being kept at separate modules at storages equipped with systems of fire alarm and remote fire suppression.

Data about annual receipt of SRW is presented in table (Table 1). Data about SRW accumulation at storages at Bilibinskaya NPP is presented in table (Table 2).

At SRW storages intermediate level and high level waste is being keep (an amount of high-level waste does not exceed 0,5 % from an overall waste weight). Only low level waste is being keep at SSRW #1 and #2. Annual receipt of low level SRW was 106, 92 m^3 to the trenches since 1998 till 2010 and for the last 5 years was 93 m^3.

Taking into account averaged morphological composition of low level SRW it is possible to estimate volumes of waste of different types storing at SSRW #1 and #2 (trench).

Approximately an amount of low level solid radioactive waste can be estimated (according to averaged annual accumulation) which will have been produced till the end of exploitation of Bilibinskaya NPP's units (for nearest ten years) – about 1070 m^3, and till that time there will be 1532, 8 m^3 at the trench #2.

Total activity of solid LLRW accumulated till 2011 at Bilibinskaya NPP is $0{,}37 \cdot 10^{12}$ Bq at SSRW #1 and $6{,}46 \cdot 10^{10}$ Bq at SSRW#2. Averaged volume activity is 230 kilo Bq per kilo.

According to this level of volume activity a great part of the waste at SSRW should have turned into non radioactive category due to the decay for 20-25 years.

Radioactivity of low level solid radioactive waste is determined by presence of activated corrosion products: ^{60}Co, ^{54}Mn, ^{51}Cr. The main part of activity (about 80%) is caused by ^{60}Co radionuclide which also among the abovementioned radionuclides has the longest half life. Taking this fact into account its share into the total activity will increase in future.

Radioactive fission products among low level solid radioactive waste are almost lacking what is caused by construction of reactor's fuel assemblies practically expelling release of fission products from fuel assemblies into heat-transfer material and accordingly further contamination of the equipment.

DISCUSSIONS

According to the ways of power-generating unit EGP-6 decommissioning at Bilibinskaya NPP ("Elimination" of units or "disposal on site") the amount of RW producing during works implementation can be different.

According to technical and economical calculation carried out by different organisations the optimal way of units decommissioning is disposal on site. At the same time planned period of decommissioning works implementation according to the requirements of normative documentation will depend on planned terms of spent fuel management works termination. These conditions can ultimately determine selection of the following way such as "Immediate decommissioning" or "Deferred decommissioning".

Nevertheless non depending on the way of decommissioning of power-generating units of Bilibinskaya NPP can be marked out a group of radioactive waste which will be common for both ways of decommissioning. (Waste placed at RW storages (Storage for SRW #1 and Storage #2) can be conditionally refer to operating waste).

To this group of low level SRW can be referred equipment subjected to dismantling on the stage of Bilibinskaya NPP's units disposal and including significant amount of articles made of carbon steel and stainless steel (fittings, piping, pumps, tanks, driving gears and so on).

Estimation of radwaste amount is carried out taking into consideration the following assumptions:

1. Dismantling equipment and constructions with a dose rate of 20-30 micro Sv per hour at the time of final reactor stop will transfer into non radioactive category due to the natural decay during long-time period on the stage of units disposal;
2. A part of dismantling equipment (with a dose rate of 20-300 micro Sv per hour at the time of the final reactor stop) is decontaminated with the purpose of its transferring to non radioactive category;
3. To radioactive waste category is considered dismantled equipment during the stage of units disposal which decontamination is inexpedient and dose rate is more than 200 micro Sv per hour at the time of final reactor stop.

Taking abovementioned into consideration the total weight of low level solid radioactive waste during decommissioning of 1-4 units of Bilibinskaya NPP will be 1954,837 ton this weight with reserve henceforth is referred to low level waste during determination of the complex productivity. With an averaged package density of metal solid radioactive waste into containers (about 2 ton per m^3) the waste volume will be 977,4 m^3.

These methods are directed to waste isolation and they prevent radionuclide migration to the adjusted soil and subsoil water. They are used when waste should be disposal at the present place or temporary localized. In general technologies of waste isolation are applicable for all types and forms of waste. Typical means realized according to these technologies are – preservation coverings, water tight shields (screens) "wall in soil" and ground barriers.

Preservation coverings:

Clay coverings – is quite an effective and cheap way of different surfaces decontamination. Temporary coverings as a layer of material based on clay, cledgy minerals and clinoptilolite. Arrangement of such a covering does not claim complicated equipment and lot of labor contribution.

Asphalt and concrete coverings, synthetical membranes (geomembranes) and geo-textile are widely used in a world practice.

Shields "wall in soil". Chopping off vertical shields are constructed with the purpose of averting of lateral flows of subsoil water from contaminated areas thereby reducing migration of radionuclides. Effectiveness of such shields significantly depends on physical characteristics of the object: uniformity, penetration, porosity of soil, depth of deposition of natural waterproof layer, volume of waste or contaminated soil. Some varieties of the shields "wall in soil" are widely used in standard industrial practice.

Liquid bentonite mixtures. Most often soil-bentonite and cement-bentonite mixtures are used for creation of vertical shields. The shield is formed by construction of a trench with liquid building mixture as a bore hole fluid. At the same time bentonite mixture, filling the trench, prevent caving-in from walls of a trench. The stuff of such mixture reduces losses of liquid into soil since forming of a filter-cake. Soil-bentonite mixtures have a wider range of chemical compatibility with other materials and lower penetration than cement-bentonite mixtures, but the last are more durable and less elastic.

Cement screens are formed by cement grout injection into soil through pipes or screw arrangements in piped body. Pipes and screw arrangements are brought in soil by crane with vibro-hammer or by drilling machine. The screens of this type are not so effective as abovementioned bentonite shields. During cement grout setting shrinkage takes place and because of that pores form in a screen. Furthermore this technology is of little use if there is a significant content of organic substances in soil (for example if soil is contaminated with mineral oils) since organic substances prevent setting.

Cement grout injection. Two ways of cement grout supply into near-bottom spaces of contaminated objects are considered:

- Supply of cement grout under small pressure into soil with high natural porosity;
- Pumping of the grout with the help of a jet-mixer and screw drilling machine (a machine used for holes plug-backing).

When the second method is used soil is destroyed advisedly and mixed with cement grout. The both methods need preliminary holes drilling in a definite depth lower contaminated area. .Special equipment is used for horizontal holes drilling. Holes are drilled parallel through same intervals.

CONCLUSIONS

1. Carried out substantiation of safe isolation of low level waste from SSRW (trench #2) at Bilibinskaya NPP.
2. Suggested and tested on mimics a technology of evaporate concentrate and ion-exchange resins solidification on site.
3. Carried out economic assessment of two ways of RW management for the waste which will have been accumulated up to 2027. The first one is RW disposal on site and the second is retrieval, conditioning and disposal of waste at a regional center. The assessment has showed advisability of RW disposal on site.
4. Developed technical proposals of accumulated and producing during decommissioning RW disposal.

REFERENCES

No References available.

ACKNOWLEDGEMENTS

Carried out assessment calculations have shown undeniable economic efficiency of RW disposal at Bilibinskaya NPP on site.

Taking into consideration the abovementioned conception of power-generating units disposal on site as well as the composition of RW from Bilibinskaya NPPC (main radionuclide is ^{60}Co) and experience of 37 years of RW storage on the territory of the NNP, which shows almost lack of radionuclides revealed to the environment, it is suggested to accept the conception of accumulated waste and waste from decommissioning on site disposal.