Minimization of Radwaste Production in NPP Dukovany

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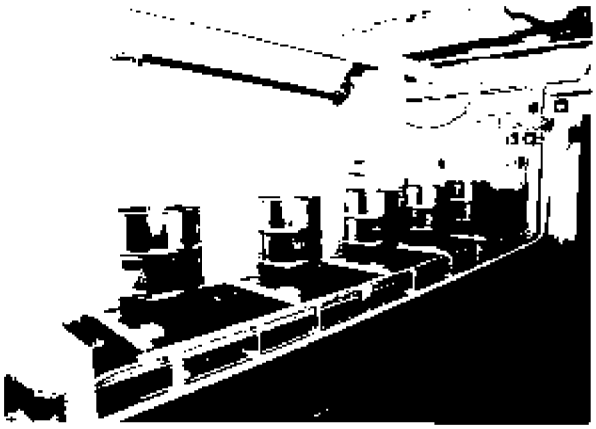

1. Introduction

The Dukovany Nuclear Power Plant is the first Czech nuclear power plant. After 16 years of operation it is reaching excellent results in many respects. To maintain long-term acceptability and competitiveness, the power plant management has adopted the Harmonization Programme, which plans further significant improvement of the power plant in seven main areas. The minimization of production of radwaste production is necessary because of introducing EMS (Environmental Management System) according to ISO 14 001 Standard.

2. Production of RW

Before the year 2000 the production of radwaste in NPP Dukovany (with 4 Units, each of 440 MWe) was following:

Wastes	Quantity	Note
Solid low-level waste of all sorts (combustible, compressible, metal, …)	**60 t/y**	In addition, also much solid cold waste is produced in the restricted area
Liquid concentrates	**350 cu. m/y**	Content of salts ca 150 g/l and pH up to 11.5
Ion exchangers	**25 cu. m/y**	Sharp decrease to 6 cu. m/y in 2000
Sludge	**5 t/y**	Estimate related to 20 per cent of dry matter
Oils	**1 t/y**	

Solid RW have been processed in campaigns (high-pressure compacting), liquid RW continually (by bituminization). Other RW have only been collected and stored.

3. Minimization Principles

Rules that regulate the minimization have been adopted. The procedures which eliminate the approaching endangering of the power plant are being introduced as the first ones. This relates especially to radioactive ion exchangers and sludge, whose stored quantity is limited by SONS and for which we have no technology of treatment. Further the measures which prevent production of RW with relatively low cost are being implemented. When deciding on the economic effectiveness of cost of the planned measures, the price of RW storage is taken into consideration. Roughly we can say that

the cost of the disposal of one drum containing 200 l makes about 16 thousand Czech Crowns. Further cost of waste treatment into a form acceptable for disposal is approximately the same. These basic economic data have their meaning also when evaluating so called **substitutions**, or replacement of the waste that is being formed by other, less problematic one. The substitutions are considered individually in the following cases:

- Sweeping and vacuuming of all dust before wet cleaning (no sludge is formed but solid RW)
- Decontamination of metal waste for disposal in the environment (liquid RW are formed instead of solid ones, therefore also the proportion of surface to mass of the objects is important)
- Optimization of the regeneration of the ion exchanging filters (liquid RW are formed instead of ion exchangers)
- Replacement of polyvinyl chloride by polyethylene (it has been implemented preventively in case that incineration would be used)
- Replacement of common foils by very thin foils where possible.

At the same time it is visible that substitution is not advantageous in all cases.

Repeated use: can be applied with packing (from crates, drums and boxes to plastic bags), further with insulation material (glass wool and aluminium sheet), and also with covering foils.
Recycling: is possible only after perfect sorting of clean objects or those that can be very well decontaminated (metals, plastics, paper, rags, oils).

4. Measures Taken

The system of radwaste management has been complemented by a perfect electronic logging system several years ago. This is a precondition of reaching of system changes. Moreover, selected RW groups have been monitored so that the causes of their production could be described better.

Solid RW

Solid wastes which are formed in the restricted area can be sorted in the carousel and sorting box to clean and contaminated (radioactive) ones. The measurement performed in the restricted area is only a rough one. The final sorting leading to release into the environment is performed out of the restricted area by special technology. The Czech Regulation No. 184/1997 Coll. belongs by its limits to the strictest in the world. That is why the measurement is demanding and costly. The radionuclides are divided into five classes. Each class has different limits for surface contamination and specific activity and so there is no possibility of summary measurement. Moreover, they are different limits for different sorts of release. The strictest ones for release without address for unknown purposes, less strict ones for release to dump or communal incinerating plant. With regard to the strict limits, a considerable portion of waste being formed in the restricted area (up to 30 per cent) remains a part of RW. In the year 1996 the production of solid RW for 11 years of operation was supercompacted and disposed in the radioactive waste repository belonging to the state at present. Another similar campaign lasting about one month cannot be expected until after 2005.
Although the production of solid waste in Dukovany is not a critical one, steps leading to the minimization of its production have been taken. The goal is not only to decrease the quantity of RW, but also of clean waste being formed in the restricted area, because its release is rather costly. For this reason individual objects and waste material are analysed today so that justification of waste production could be evaluated. The effort to minimize often clashes with the striving for maximum reliability of the ageing power plant and also with the elements of visualization (improvement of appearance). Often only today worn-out materials are replaced by more suitable ones with longer service life and lower mass (stainless-steel and plastic tubes instead of black steel and brass and the like). It seems that without considerable restrictions it is not possible to reduce the volume of these wastes. Restrictions are being prepared concerning carrying-in of not necessary objects (plastic foils that are not prescribed by the dosimetric service; excessively packed spare parts; objects not

necessary for work execution – magazines, ...) as well as in the area of replacement of functional but visually defective equipment (partially distorted insulation sheet in spaces with difficult access). Also regular training of all the employees and subcontractors in the area of EMS and waste management are a part of the measures taken.

Liquid RW (Concentrates)

Currently, the power plant stores 2,700 cu. m of liquid concentrates. With regard to the fact that the volume of treatment and processing of liquid RW by bituminization is double of their production, the power plant has freed a half of its storage capacity today. Approximately 8,000 drums with bituminized product have been disposed in the repository in the vicinity of the power plant. Liquid RW, whose stored volume decreases by 300 cu. m yearly, ceased to be the main problem of the waste management in NPP Dukovany.

A decrease in the stored stock does not mean minimization of production of further wastes. That is why an extensive analysis has been performed in Dukovany NPP, which is a detailed time picture of their production and composition at the time of three different overhauls. By linking of this analysis with the recorded activities, a very complicated but also complete database of sources has been created. In other words: We know what volume of liquid waste is formed during different activities inclusive of its composition. With the most important sources, it has been considered whether the waste is not formed unnecessarily.

The problems of liquid waste are very complex ones, but today we know that also without costly technological changes we can spare as much as a half of boric acid and other substances forming waste water. This is why we have postponed the costly implementation of the intent to recycle the boric acid from the formed concentrates.

Ion Exchangers

The power plant design coming from the seventies assumed the use of the then known ion exchangers. The ion exchangers of those times had neither radiation nor mechanical resistance and they had also a lower ion-exchanging capacity. But actually high-quality isospherical ion exchangers with high capacity and stability are used. Also the filter vessels themselves have been manufactured from exceptionally robust materials. Therefore the outdated procedures of checks, regeneration, and replacement of filling could be re-evaluated. Today, samples are taken systematically from the ion exchanger substances and their residual capacity is monitored carefully. Those which are regenerated are regenerated after their real spending. The same holds good for their replacement. The change in the system of inspections of the filter vessels is an important fact. Current technology makes possible to monitor equipment faults without unnecessary discarding (flushing into waste) of ion exchanging substances. Thus lengthening of the intervals between internal inspections of the filter vessels decreases production of RW as well as employees' collective effective dose.

Sludge

It has been determined by studying the composition of the sludge that it is formed by substances of different origin. Its formation in larger quantities was not expected in the power plant design. But while the power plant service life is being prolonged, the solution of the problems with sludge begins to be important. Sludge contains considerable number of dust particles, fibres, fragments of ion exchanging substances, chemical precipitates and sediments. A number of measures in the area of substitution and prevention has been taken to decrease its formation. For instance, ion exchanger traps have been introduced in filters. They prevent flushing out of the ion exchangers which end in waste water and sludge. Systematic sweeping and vacuuming of dirt in rooms before wet cleaning has been introduced. Also a measure has been taken that prevents carrying-in of sediments from the cooling water into the primary circuit floor drainage system. Although these sediments are formed in the restricted area, they are not radioactive. Their flushing into the drainage contaminated them and increased the volume of radioactive sludge. This is why a whole series of operational experiments has been carried out which

have made possible to separate perfectly cold sludge from the radioactive one. The cleaning of opened exchangers is now performed by scraping-off by clean tools into clean plastic bags. The following high-pressure jetting of the exchangers is done in such a way that the flushing water is caught into drums and let to settle down. The cold sludge is, after thorough measurement, disposed of in the same way like other clean waste. The quantity of sludge is measured with great difficulties. But on the basis of the determined data we know today that its quantity has decreased by about 50 per cent.

Oils

The production of waste oils in the restricted area is low. But still lower is the production of oils really contaminated by radionuclides. Our power plant has not either its own or contractor's incineration plant of RW available. A simple equipment has been built which is able to wash the used oils in such a way that they stop to be radioactive. Repeated washing in small quantity of demineralized water is really an effective process leading to minimization of the volume of radioactive oils. On the other hand, washing in service or drinking water would be quite without any effect. With oil washing, the problem of making the washing water harmless had to be solved. It contains, in addition to radionuclides bonded to salts, also traces of oil products. The most suitable solution which does not increase the volume of RW is, under our conditions, to mix the several hundreds of litres of the washing water formed during oil washing with the hundreds of tonnes of liquid concentrates which evaporate negligibly during their storage. The traces of oil products do not impede the subsequent bituminization technology.

5. Conclusion

The duty to minimize the production of radwaste is placed on their producers by legislation. But it also has economic and environmental points. For NPP Dukovany, the implementation of the principles of environmental management, which is closely connected with the minimization, is also the question of the acceptability of the nuclear power engineering by the population. A whole range of measures has been taken in the power plant in connection with the minimization of RW. It will lead to the set goals. The procedures that prevent possible endangering of the operation take precedence during introduction of the minimization measures. Further economically undemanding procedures are implemented that bring about minimization in an effective way. In accordance with the EMS principles it can be expected that the minimizing measures will be implemented also in areas where their greatest contribution will be for the environment. Consequently, also without complying with the condition of economic profitability.

6. Acronyms

EMS	Environmental Management System
ISO	marking of a series of international standards
NPP	Nuclear Power Plant
RW	Radioactive waste(s)
pH	Technical mark for degree of acidity
Coll.	Collection of Laws
SONS	State Office for Nuclear Safety