

EPRI Software for Estimating Decommissioning Waste Volumes - 16046

Richard McGrath *, Richard Reid*

*Electric Power Research Institute, 3420 Hillview Ave., Palo Alto, California.

USA. rmcgrath@epri.com, rreid@epri.com

ABSTRACT

EPRI has adapted computer software that can estimate the volume and activity content of waste resulting from the dismantlement of nuclear facilities. This software, designated as *Automatic Estimation of the Radiological Inventory* or AERI, was originally developed by Iberdrola for use by ENRESA in Spain. The software estimates the radiological inventory for all the components and civil structures of the plant or other facility that are included in the physical inventory. The radiological inventory shows the internal and external surface contamination, as well as the volumetric contamination. The processes of the software are able to estimate both the specific activity levels (in Bq/g or pCi/g) for each radionuclide and the surface activity (Bq/cm² or dpm/100 cm²) for components and civil structures located in the radiological areas.

AERI allows the user to extrapolate, through a statistical approach, the contamination levels obtained by sampling data in specific components and civil structures to the entire facility.

The main benefits and values obtained with AERI are the following:

- The radiological inventory of the plant can be obtained from a limited set of radiological sampling data. Using the mathematical models allows for the optimization of the number of sampling and analysis that needs to be done. The uncertainties of the calculations are reduced with more data. The user must balance the level of uncertainty of the calculations and the number of sample data they will use.
- The automatic management of radiological data in short computing times allows for the execution of several scenarios in a reasonable time. Therefore, different radioactive waste and decommissioning hypotheses can be tested. For example, inventory and data can be split into two different set. One of them can be used for obtaining radiological inventory for early dismantling (3 years, as example) and the second one for deferred dismantling (25 years.)
- The software supports the planning and implementation of decommissioning strategies for nuclear plants. For instance, several decontamination factors can be evaluated, assuming different level for decontamination of materials, and

results for materials from several streams and use of different container types may be included in each evaluation.

INTRODUCTION

The planning and implementation of decommissioning strategies for nuclear reactors require knowledge of the neutron activation and contamination levels which have arisen during operation and remain at shutdown. Radiological inventory due to neutron activation is obtained from theoretical activation analysis, and estimation of contamination levels on building surfaces and components is obtained by statistical approaches using the results of sampling campaigns.

In order to be able to estimate the contamination levels, a Characterization Program needs to be developed. The essential objective of the Characterization Program is to obtain representative calculations, in situ measurements, and sample analysis which provide an understanding of the radiological conditions what will be encountered during decommissioning. Radiological characterization of a facility with the objective of decommissioning can be divided in four phases:

- Initial analysis of available historical data
- Initial characterization before the dismantling execution
- Additional characterization after specific processes (e.g., decontamination)
- Final radiological survey

Sampling and analysis is limited by cost constraints. Therefore the number of samples taken and analysis conducted must be optimized. Estimation of the radiological inventory for all the components and civil structures of the plant can be obtained using statistical mathematical models from the real radiological data of some elements obtained from radiological sampling.

This type of estimation requires the processing of a large quantity of data. For that reason, the manual manipulation of the statistical mathematical models can be difficult to implement. To address this problem, the AERI software application has been developed to automatically calculate an estimate of the radiological inventory for the dismantling of nuclear facilities using statistical mathematical models.

BACKGROUND

The AERI software was originally developed by Iberdrola EC under ENRESA contract to provide a calculation for the estimation of radiological inventory and waste disposal package volume resulting from dismantling of nuclear facilities. The original software was in Spanish and was based on:

- Spanish waste package characteristics
- Calculation using Spanish clearance levels and waste disposal classification limits

EPRI has completed a revision to the software to:

- Enhance generic usability of the software and adapt for international usage;
- Develop a user-friendly interface for the input of physical inventory, radiological data, waste stream limits and waste container characteristics;
- Develop a software installation CD and User Manual in English;
- Allow input of site-specific waste container characteristics;
- Allow input of site-specific clearance levels and waste disposal classification limits; and
- Automatically re-classification of Final Status Survey (FSS) survey unit from available radiological data

DESCRIPTION OF AERI SOFTWARE

This software tool has two modules:

- Inventory Estimation Module
- Materials Management Module.

Through the Inventory Estimation Module, this software tool estimates the radiological inventory for all the components and civil structures of the plant, included in the physical inventory of metal and concrete. The radiological inventory shows the internal and external surface contamination, as well as the volumetric contamination. The processes of the software are able to estimate both the specific levels (per radionuclide) of mass activity concentration (Bq/g) and the surface activity (Bq/cm²) for components and civil structures located in the radiological areas.

Through the Materials Management Module, AERI also makes calculations useful for material management. Material streams and the number of containers required for packaging materials for disposal are estimated.

This software tool does not estimate neutron activation, but it is possible to include those values as input with other data used for the estimation of the radiological inventory.

The software works with a database, estimating the contamination from data contained in the database and saving the results into the same database. Results can also be exported to an external Access database.

The user enters the physical inventory, sampling data from the radiological characterization campaigns, and initial definitions of FSS survey units (SU). The user also enters the preliminary radiological classification of each survey unit. Users can manually type in data through AERI interface windows or import a database file.

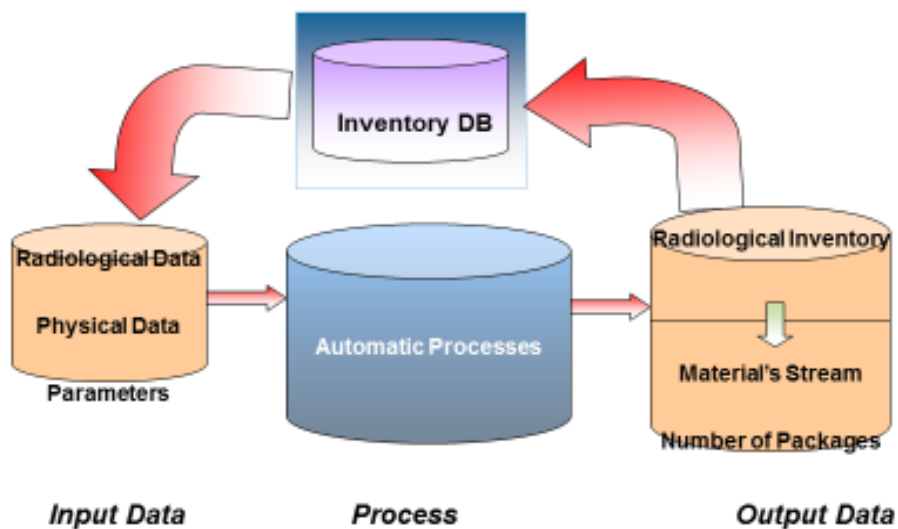


Fig. 1 Conceptual process of Functions Performed by AERI

Figure 1 illustrates conceptually how the AERI software operates. Information is processed and stored in an iterative process as follows:

- Radiological and physical data is input into the software
- The AERI software automatically calculates the radiological inventory which assigns the waste to a selected waste stream which has been entered by the user.
- AERI will also calculate the number of packages that will result from the inventory using user entered data for packages dimensions and waste classification limits
- After each calculation, the inventory database is updated for use in additional calculations

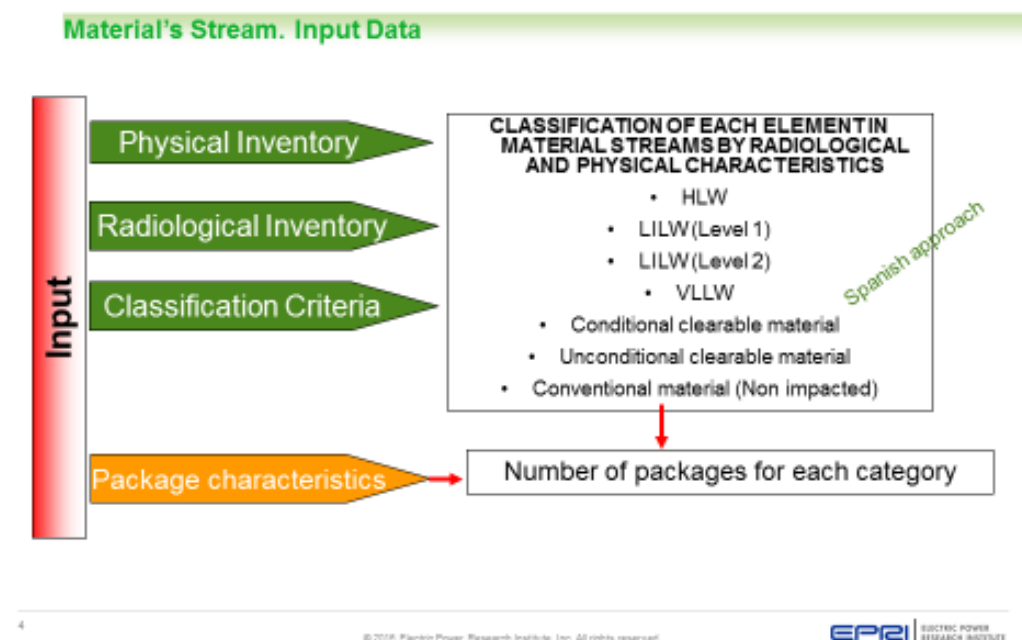


Fig. 2 Example Use of AERI by ENRESA

Figure 2 illustrates how the AERI was used by ENRESA in Spain. Multiple disposition options are available in Spain and are defined by the disposal site at El Cbril. These classifications are as shown in Figure 2 and listed below:

- High Level Waste (HLW) – similar to Greater Than Class C waste in the U.S.
- Low and Intermediate Level Waste (LILW, Level 1) – similar to Class B/C waste in the U.S.
- Low and Intermediate Level Waste (LILW, Level 2) – similar to Class A waste in the U.S.
- Very Low Level Waste (VLLW) – similar to Bulk Survey For Release waste in the U.S.
- Conditional Clearable Material – Material for which disposition is defined such as recycle
- Unconditional Clearable Material – Material cleared for any use
- Conventional Material (Non impacted) – Material is not suspect for contamination

AERI allows the user to extrapolate, through a statistical approach, the contamination levels obtained by sampling data in specific components and civil structures to the entire facility. This computer application includes the statistical functions needed for

the estimation of the central tendency and variability, e.g. mean, median, variance, confidence intervals, variance coefficients, etc.

Determination of MARSSIM Final Status Survey Classifications

The AERI software can also calculate the Multi-Agency Radiological Survey and Site Investigation (MARSSIM) survey area classifications for use during the Final Status Survey of building areas at the facility. This calculation is based on the radiological characterization data input into the program.

Platform and System Configuration Requirements

AERI is a Stand Alone Computer, Single User Application, intended for running on the Windows Operating System.

The software was developed using standard libraries from Visual Basic 6.0 and was tested on Windows XP and Windows 7. No issues are expected for the Windows Vista and Windows 8 platforms. If any issues arise, the tool can be run in "compatibility mode" on these other platforms.

AERI requires 10 MB in the hard disc for installation. Depending of the quantity of data to be managed, an additional space of 100 MB is recommended.

SUMMARY

EPRI has adapted a user friendly and internationally usable software that:

- Estimates the radiological inventory (internal and external surface contamination, volumetric contamination) for all the components and civil structure of the plant included in the physical inventory of metal and concrete.
- Reclassifies the FSS survey units according to the radiological measurement data
- Estimates material streams and number of waste containers needed.

The AERI is currently available to members of the EPRI Decommissioning Program free of charge.

REFERENCES

EPRI Report #3002005799, *Automatic Estimation of the Radiological Inventory (AERI) for the Dismantling of Nuclear Facilities*, December 2015.

US NRC, NUREG-1575, Rev. 1, Multi –Agency Radiation Survey and Site Investigation Manual (MARSSIM), 2002.