Study and development of ALARA support tools and techniques

Scientific Staff

F.Vermeersch
C.Van Bosstraeten
Ph.Antoine

The optimization of the radiological protection of the workers in the nuclear industry is an important part of the safety culture.

The concept of ALARA (As Low As Reasonably Achievable) has become an integral part of the safety approach. In order to perform a good ALARA-study for a planned work, information has to be gathered concerning the site geometry, the distribution of the sources, the work planning, the shielding options, the costs,... All these aspects have to be considered to arrive at an adequate ALARA-decision. The information has to be organized, structured and analyzed to determine to best approach for the planned work.

Tools for supporting the ALARA-analyst are desirable in this context.

Objective

The aim of this study is to provide the ALARA analyst with a set of support tools enabling an efficient ALARA-planning.

Programme

The study involves both own developments and market search to compile an efficient set of ALARA-tools.

A large portion of **ALA**RA is the "**A**s **L**ow **A**s" part concerning the reduction of the dose. This means that the ALARA-analyst must be able to predict the dose in the working area and investigate different shielding options. The first part of our study is therefore aimed at providing a calculational tool for dose assessment. The need for a fast 3D-calculational tool became clear due to the geometrical complexity of many work environments. The development of such a tool became the first priority.

A part of our study is aimed at investigating the available technology to characterize the working area from the radiological point of view. A good characterization leads to a good modelling of the work area. The characterization can be assessed with the use of the standard radioprotection measuring devices such as the dose rate meters, spectral measurements,.... However innovative techniques such as 3D gamma-scanning have reached maturity and it is expected that they will play an increasingly important role in ALARA- practices. During this study we are looking at the applicability and the possible advantages of these devices and the integration of the produced data in planning tools.

The third part of the study is aimed at the "**R**easonably **A**chievable" part of ALA**RA**. Here we want to investigate the influence of the cost of the in the ALARA balance. For this purpose we are also looking at software tools supporting the ALARA decisions such as OPTI-RP (CEPN).

Achievements

We have completed the first version of the VISIPLAN 3D-ALARA planning tool.

This PC-based tool calculates a detailed dose account for different work scenario's defined by the ALARA analyst, taking into account worker position, work duration and subsequent geometry and source distribution changes.

The VISIPLAN methodology is based on four major steps:

- The information gathering and model building stage
- The general analysis stage
- The work planning and the detailed analysis stage
- The follow-up stage

In the first stage the computer model of the environment is built based on the known geometry, the materials information and information about the radiative sources of the site. When the sources are known, a calculation of the field can be performed immediately. When no information about the source intensities are present a source inference algorithm provides the possibility to determine source strengths from a detailed dose mapping of the working area. The mapping together with the information about the history of the site results in pinpointing the position of the main sources which contribute to the field.
The end of this stage results in the basic geometry from which other geometry's, mostly with supplementary shielding, are derived.

In the *general analysis stage*, the calculated field is studied and suggestions about shielding techniques are tested and analysed using calculated dose maps for each of the suggested shielding geometry's.
Once a shielding geometry is chosen a detailed dose calculation can be performed along a *trajectory* which is constituted of a series of tasks each characterized by a position, a task description and a work duration. Several *trajectories* can be calculated in different shielding geometry's.

A set of *scenarii* can then be build from a selection of trajectories in the different geometries. The intercomparison of these scenario's then leads to an optimization of the work to be performed.

In the *follow-up stage,* the dose accounts of the workers are compared with the predictions from the model. When large deviations occur a reassessment of the work can be performed by adapting the model to the new information. This makes it possible to adjust, and thus to further optimize the work during its progress.

The VISIPLAN tool has been applied successfully for work planning and shielding question in the following area's:

- The BR3 decommissioning.
- Sampling works at the GELINA accelerator (IRMM Geel).
- Accident study in the HADES underground laboratory.
- Dose prognoses for work at the BR2 heat exchangers.
- Dose prognoses for Hot Cell decommissioning LHMA.
- Dose prognoses for the mounting of the CORALUS device.
- Dose prognoses for the safety assessment report of the BR3 decontamination area.

The method has shown to be reliable in predicting the doses and also to stimulate, through the 3D -representation, new ideas concerning the planned work.

Gamma camera in ALARA practices

In November 1998 we tested the use of a 3D gamma scanning (RadScan 700 BNFL Instruments) on two sites at the SCK•CEN (i.e. the BR3 decommissioning site and the heat exchanger of BR2).

The results obtained from the scanning are very promising however further study is required to fully couple the scanning results with the 3D modelling in VISIPLAN. The direct results of the scan however revealed interesting data on the hotspot distribution in both area's which could be linked to the source positions in the VISIPLAN models. This resulted in a better modelisation of the sites.

Reasonably Achievable

The VISIPLAN software is capable of examining the *As Low As* part of the ALARA.
If a comparison between the cost of different options has to be made (dosimetric, new investments) different models can be used. These models are generally based on the value of the man*Sv. A software tool OPTI-RP developed CEPN deals with these cost aspects and could then be coupled with the VISIPLAN results. Studies are underway to investigate the usefulness of this scheme.

Perspectives for 1999

Our work will focus on:

- The further development of the VISIPLAN 3D ALARA planning tool
- The development of a VRML output module for VISIPLAN.
- The further investigation of the use of gamma scanning equipment in ALARA planning.
- A report on the integrated use of modelling (VISIPLAN), radiological measurements, gamma scanning and cost benefit analysis (OPTI-RP) in ALARA problems.

Scientific output

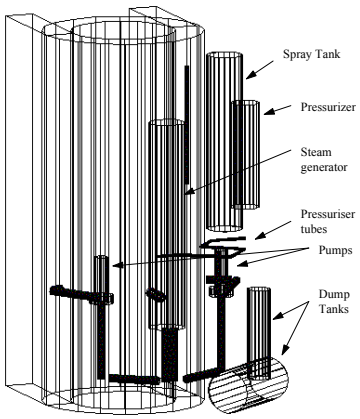
I. F. Vermeersch, C. Van Bosstraeten, "Development of the VISIPLAN ALARA planning tool", Proceeding of the International Conference on Topical issues in Nuclear Radiation and Radioactive Waste Safety, Vienna Austria, 31-August to September 4, 1998.

II. F.Vermeersch, "Experience and plans for the use of Virtual reality", Workshop meeting on "Virtual Reality Applications in Process Industry, Maintenance training, Outage planning, Control Room Retrofits and Design, OECD Halden Project, Halden, Norway, September 17-18, 1998.

Costumers

BelgoProcess, Gravenstraat 73, 2480 Dessel.

(a)



(b)

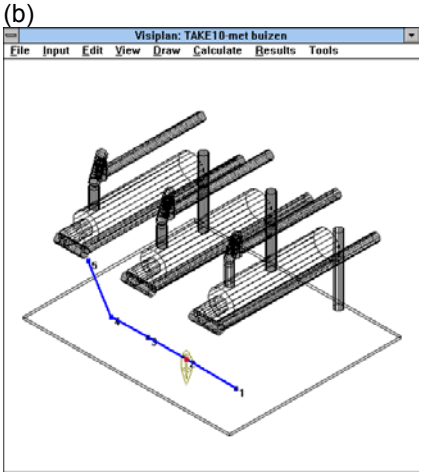
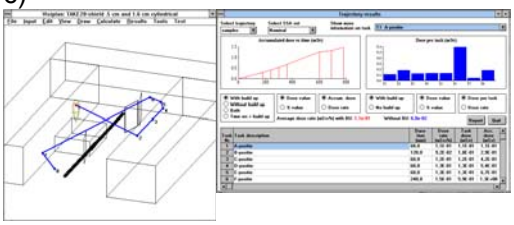


Fig.1.a) VISIPLAN model of the BR3 decommissioning site.

b) VISIPLAN model of the BR2 Heat Exchangers. A trajectory is also plotted on the model.

c)



c) VISIPLAN screen shot for trajectory calculations and results.

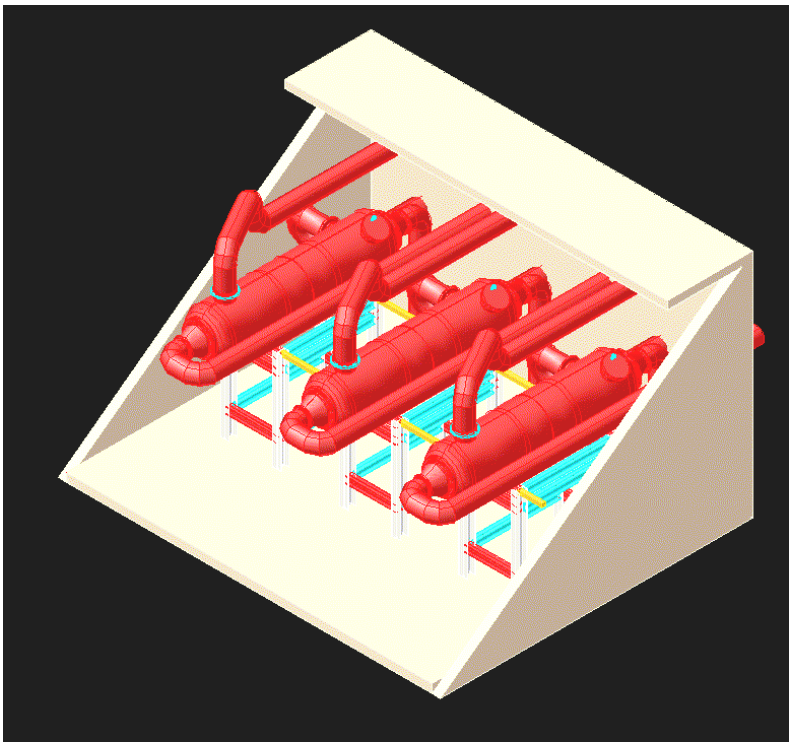


Fig. 2. CADs View of the BR2 Heat Exchangers