

## **Radiological characterisation by means of 3D-laser modelling and positioning of measurements**

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### **Introduction**

AB SVAFO (SVAFO) is a nuclear waste technology and decommissioning company based in Sweden in the scenic surroundings of Studsvik on the Baltic coast. SVAFO is owned by the Swedish nuclear power industry. The company was created in 1992 by Sydsvenska Värmekraft AB, Vattenfall AB, Forsmarks Kraftgrupp AB and Oskarshamns Kraftgrupp AB as a consequence of the Act on the Financing of the Management of Certain Radioactive Waste, etc. from 1988.

SVAFO's main business is to take care of formerly state-owned spent nuclear waste at the site, including small amounts of nuclear fuel. Buildings are also included, mainly nuclear waste storage buildings and a research reactor. Some buildings have already been decommissioned with results of contamination shown in long tables that are difficult to survey.

MultiInfo 3D Laser Scan Solution AB is a technical consulting company focused on the development of 3D laser scanning techniques and their applications in different fields. The specialist in the company has more than 12 years' experience in 3D laser scanning techniques, and has worked on some decommissioning projects in UK in particular, as well as experience of working on the documentation and characterisation of some nuclear facilities like the nuclear plant and the disposal tunnel of nuclear wastes.

In order to prepare better documentation and do a better characterisation of decommissioned (and operative) facilities, the techniques of 3D laser scanning and control surveying are used for a case study. The building was scanned by laser scanning, and all the scanning data was transformed into the Swedish national coordinate system by control surveying, so the 3D model and 3D images of the scanned building are in their real position in space. By using a 3D CAD model together with 3D panoramic laser images, the building can be visualised in 3D in much more detail in reality, and the building and the objects in the building can be digitally viewed in 3D. Therefore, as the location of radiological measurements are known, the contamination of the building can be visualised in 3D CAD models and 3D images with its as-built situation. The results of this case study can be used for upcoming decommissioning projects for documentation and visualisation of dose rates and contamination levels.

3D laser scanning techniques have developed since the late 1990s, and are now more useful for recording the as-built situation of an object in three dimensions. Compared to other techniques, 3D laser scanning can quickly capture the 3D digital data, both 3D coordinates and 3D digital images, with high scanning speed (e.g. up to more than 1 million points per second) and high resolution (at

the millimetre level). By control surveying, the as-built building can be quickly scanned and converted into a global coordinate system, so any objects in the building have their exact position in space. Based upon the laser scanning data, any object can be accurately measured in 3D, and recognised in the high-resolution 3D laser image. In addition, the scanner is developed with infrared laser, so there is no need for illumination during scanning, and the grey-scale laser image can be captured in the dark. By using software, the scanning data can be processed with different results such as a 3D digital model, 2D and 3D laser images, 3D coordinates of a point or an object in a known coordinate system (e.g. national coordinate system), and these results are useful for facility documentation and visualisation in 3D.

For better visualisation of the radioactivity distribution of a decommissioned (or operative) facility, 3D laser scanning techniques are used to capture the scanning point clouds first, and then created both 3D digital models and 3D laser images with software, so any object in a building can be accurately measured in the 3D model and visualised in 3D laser images in a CAD program (e.g. AutoCAD), and then linked to a database (e.g. SVALA), in which the stored measurements of radioactivity are stored.

## Results

By using laser scanning, the building and objects can be scanned and visualised in the as-built model in a 3D CAD model and 3D panoramic images, see Figure 1 and Figure 2, and then the position of any parts of the building and objects can be captured as coordinates and linked to the radiological measurements in the database, SVALA.

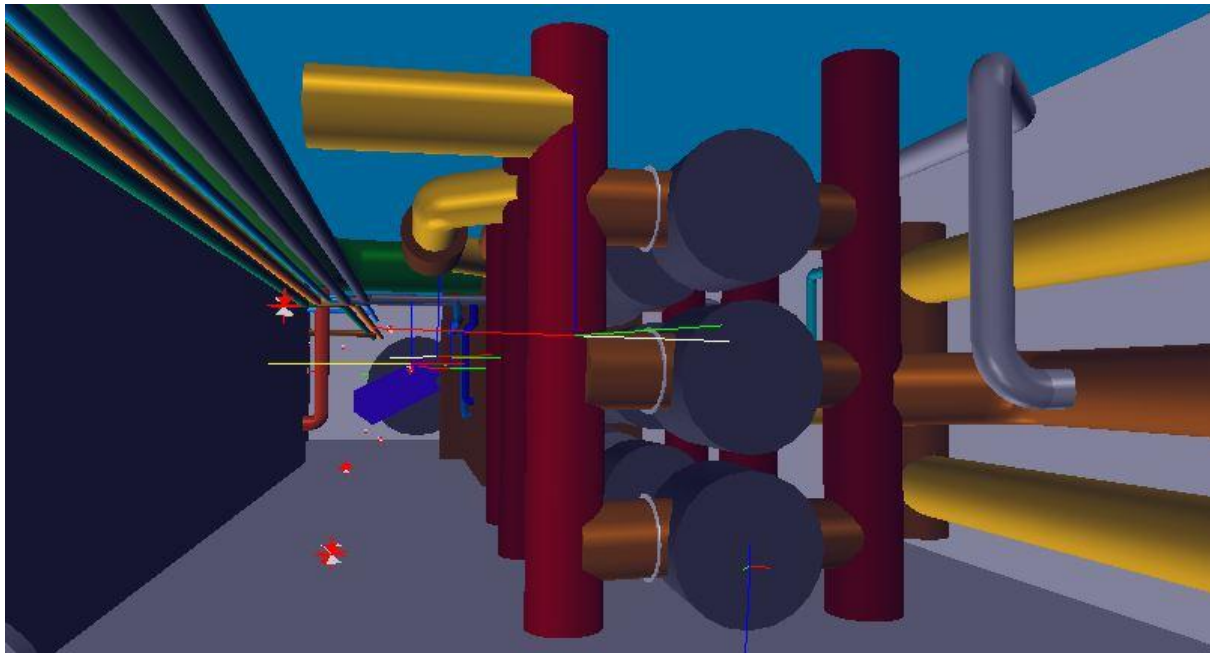


Figure 1. 3D CAD model of a part on the top floor (HM building)



Figure 2. 3D Laser image of a part on the top floor (HM building)

Combining the position coordinates and the radiological measurements, the contamination situation of a building can be visualised in the scanned 3D model with different symbols in colours and sizes, see Figure 3.

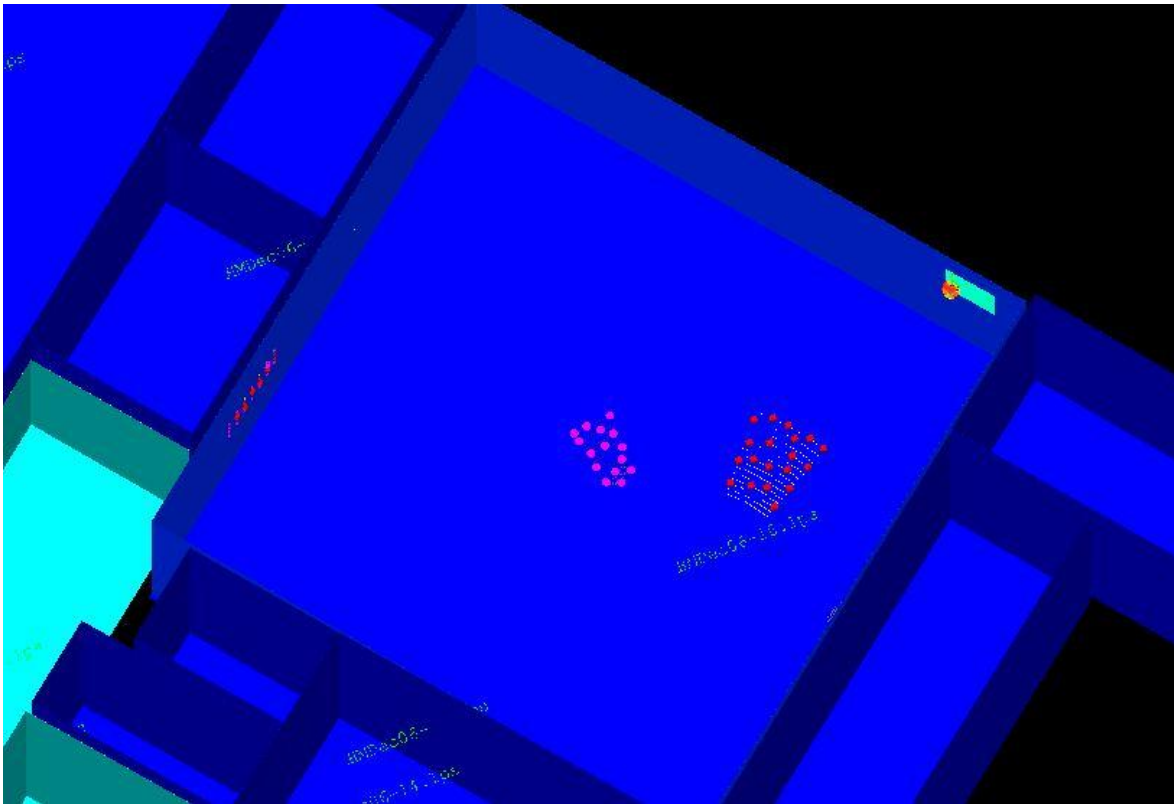


Figure 3. Different symbols show radiological measurements in a 3D model of a room

## Summary

The technique of 3D laser scanning and 3D visualisation methods can be used for upcoming decommissioning projects, and improve the documentation and characterisation methods.

More benefits are provided by using 3D digital models compared to traditional methods, like taking photos and taking notes in a notebook etc. There are also more benefits for project planning and administration.

### Measure distances

The distance between objects can be measured directly on a 3D digital model, and the position of the object can be shown with its coordinates. In addition, if the objects are not physically accessible, like an object on the roof, or thickness of a room, it can be measured in the 3D model.

### Show changes

For a decommissioning project, it is often required to design and optimise the dismantling procedure for a facility. This is often done by obtaining a design model and then conducting simulations with virtual reality software. However, the design model is often quite different from the as-built situation, because many changes and renovations are made during operation. In this case, a 3D model from laser scanning is useful and can provide the detailed information on the as-built situation and even help in updating the dismantling situation in an on-going decommissioning project. The dismantling procedure can then be optimised, and the simulation becomes closer to reality.

### Simulating the dismantling

The laser scanning results can be useful when simulating the dismantling procedure with a 3D CAD model. In a 3D CAD model from laser scanning, any part, like a pipe or a wall, can be removed or hidden (not permanently removed), making it useful in simulating the dismantling procedure.

### Design and optimise

It can also be useful when using scanning data, including point clouds and 3D images, to design and optimise the dismantling procedure. In addition, a 3D CAD model only shows the large parts, but laser scanning can provide the relationship information in a 3D CAD model by linking to point clouds and 3D images, which are important as a reference to show the detailed surroundings. This can help in monitoring the progressing condition and optimising the dismantling procedure.

### Training

A 3D model and laser images can help in training the new employees to be familiar with the environmental conditions in a real situation. After looking through a 3D CAD model, the 3D laser image and point clouds not only show the detailed situation of a facility, but also show the exact position in the model so training can be provided in the virtual reality of the digital model, instead of visiting the place, which can minimise radiation doses. In addition, the as-built situation of a facility is also useful to educate the student and technical personnel to understand the installation and the detailed arrangement of a nuclear facility, because the design model is often different from the as-built model.

### Waste volumes

For a decommissioning project, the scanning results can be used to calculate and estimate the volume of the waste, like volume of pipes and tanks or length of beams, which is useful for waste management. A pipe in a 3D CAD model shows more information, like diameter and length so the volume of the pipe can be calculated.