

## **TOOLS FOR OPTIMAL WASTE AND EXPOSURE REDUCTION**

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### **ABSTRACT**

The INEEL has developed a software called TOWER (Tools for Optimal Waste and Exposure Reduction) to provide a new way to visualize and safely interact with hazardous facilities and equipment. This gives workers a comprehensive tool for planning and executing work in hazardous areas and the dismantling of complex and often dangerous sites. TOWER incorporates innovative technologies that can significantly reduce worker hazardous material doses and decrease the volume of waste going to disposal sites compared with currently used approaches.

TOWER creates a 3-dimensional simulation of a facility that reveals in detail its solid components (pipes, valves, and pumps) as well as its invisible hazards (radiation, chemical, gas, and electric fields). Suggested segmentation can be shown on the facility model. TOWER also lets operators move simulated workers through the work site while monitoring their instantaneous and cumulative hazardous materials doses to help plan the best operational strategies. Because of its ability to visualize complex facilities, chart optimal dismantling and packaging steps, and track worker hazardous material dose, TOWER is a significant new way to plan and document work in hazardous areas including D&D projects, train workers, reduce worker exposure to hazardous materials, and lower project and waste disposal costs.

### **INTRODUCTION**

Currently, there are over 150 excess INEEL buildings and structures with the number expected to increase to 300 by the year 2005. Without demolition activities, facilities will deteriorate at an ever-increasing rate due to the fact that minimal surveillance and maintenance funds have been expended on excess facilities in the past. This compounds the existing environmental, safety, and health concerns. The costs associated with the repair of these deficiencies and with surveillance and maintenance activities will escalate as facilities age. All current and future D&D projects have been prioritized according to existing hazards, programmatic considerations, and cost/benefit by using a parametric model developed for the INEEL. New and innovative ways to reduce risks to workers and accelerate schedules are needed.

The baseline for dismantling contaminated facilities involves segmenting and packaging contaminated items manually. This approach is time consuming and inefficient in terms of achieving high packing density, and results in high worker radiation exposure rates. Typically, the waste containers are only partially filled – void spaces account for a significant portion of the waste volume. When disposal costs are based on volume rather than weight, it is important to fill the waste containers as much as possible. This can be difficult due to the numerous shapes and sizes of the contaminated items. More importantly, workers are exposed to radiation and other hazards during the cutting and packaging process. Therefore, limiting the amount of time spent measuring, cutting and packaging is critical.

## **DESCRIPTION**

TOWER is a suite of software tools to plan worker operations, visualize potential hazards, and reduce worker exposure. It provides a new way to visualize and safely interact with hazardous facilities and equipment.

First, a 3-dimensional model of a facility is created from existing computer-aided design (CAD) files, blueprints, as-built drawings, photographs, laser-scanning techniques, photogrammetry, or manually. Users "walk" or "fly" through the model to become familiar with the surroundings without exposure to the facility hazards. Virtual radiation dose measurement with TOWER is accomplished via a software-based tool. The user can input 3-dimensional hazardous fields in the TOWER simulation model using measurements taken at the facility. TOWER visualizes the hazardous fields superimposed on the solid model. A probe, controlled by the user, can be "walked" or "flown" through the model and the instantaneous hazardous level at the probe and the exposure integrated over time are displayed (Figure 1).

Using this, the dose for a worker can be estimated for work paths and activities in a facility. In the case of radiation fields, the probe can be in the form of a human shape, including multiple measurement regions to determine exposure at the head, midsection and legs to comply with ALARA (As Low As Reasonably Achievable) assessment criteria.

The software determines where to make cuts in solid components to produce optimal size segments for quick dismantlement and efficient packing in waste containers. Constraints may include waste container size, weight, center of gravity or radiation limitations. TOWER also guides the filling of waste disposal containers to maximize packaging density. It keeps a complete manifest/object inventory record. One specific application is for D&D of facilities and equipment. D&D operations necessarily involve considerable cutting, disassembly and equipment and material removal. With TOWER, an operator knows in advance where to make the right cuts to minimize cost and worker radiation exposure based on project-specific constraints

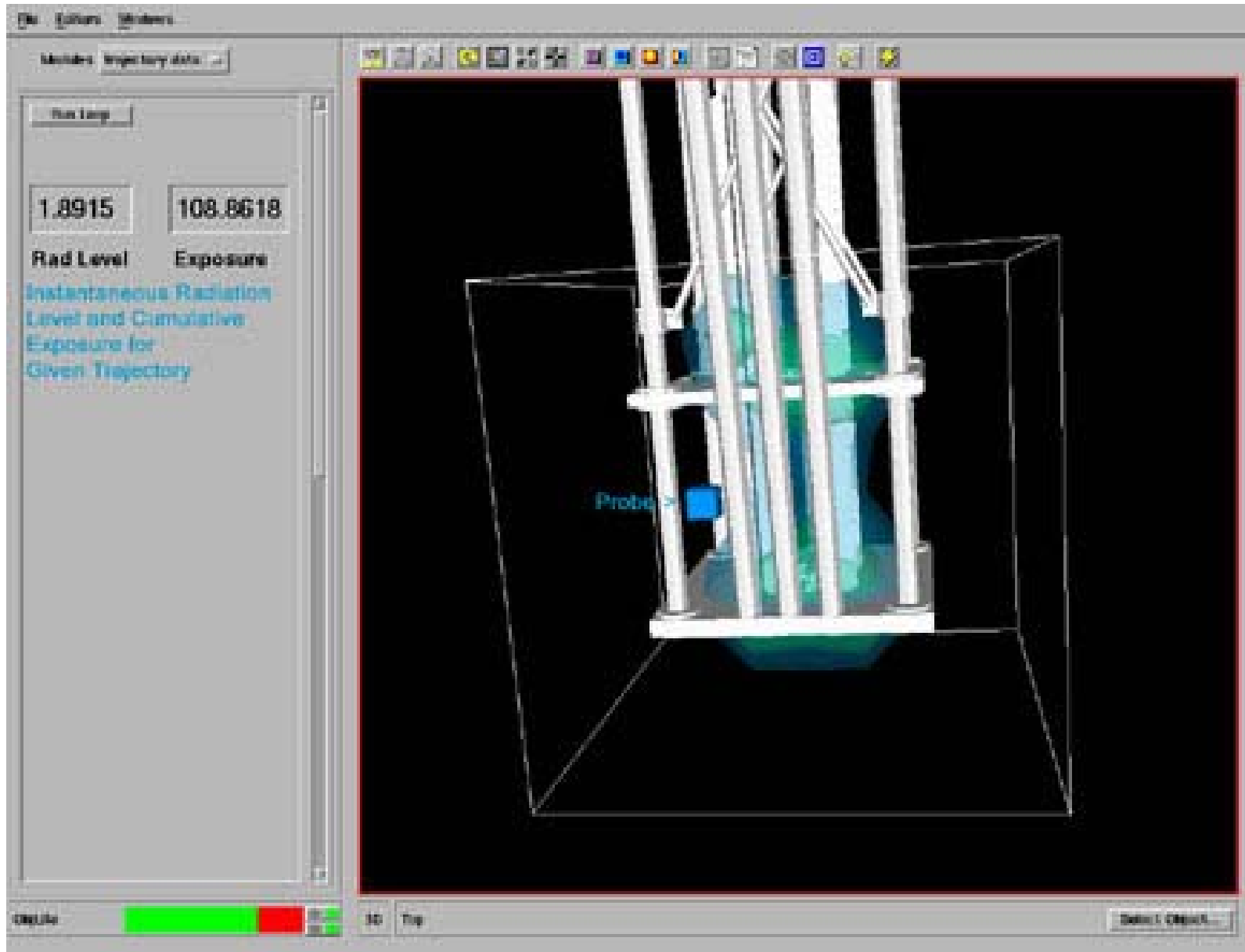


Fig. 1. Hazardous fields are superimposed on a 3-D model of a facility or object.

## **BENEFITS**

In developing TOWER, the principal investigators recognized the need for new technology that significantly reduces the cost and increases the safety of performing hazardous cleanup operations. Compared with today's baseline approach that relies heavily on worker experience and guesswork, TOWER integrates several innovative technologies that help workers dismantling facilities and equipment:

- Potentially cut worker radiation dose in half
- Potentially produce one-third of the waste volume generated by conventional approaches.
- Quickly verify as-built drawings
- Reduce environmental impact
- Create interactive/visual file of facilities as historic record

Although designed for the nuclear industry, it is recognized that the capabilities of TOWER apply to more than nuclear D&D. The same needs exist in any area where workers are exposed to hazardous substances.

The TOWER facility model can also be used to quickly identify discrepancies with existing as-built drawings. TOWER's 3-dimensional visualization allows workers to become familiar with facility interiors without being exposed to hazards associated with the facility. Actual hazardous material levels can be shown within the model by color coding various assembly components, allowing workers to plan cuts and packaging of components in advance to minimize their exposure to hazardous environments.

Unlike today's manual baseline approach, TOWER automatically captures and maintains an improved historic and visual record of the facility, considered vital to updating as-built drawings as well as providing a complete record of the dismantled facilities or equipment.

This hazardous field visualization and dose calculation software can help reduce worker dose, accelerate schedules, and reduce costs because it allows careful preplanning of worker activities and eliminates the need for hand calculation of dose. It also allows the worker to "see" or visualize the hazardous fields they will be working in thus increasing their awareness of the hazardous work environment. With its smart databases, proprietary code and algorithms, geometry model processors, robotic path planners and hazardous field visualization and dose calculators, TOWER helps an operator plan an entire work operation, then train workers prior to actual job initiation.

## **SUMMARY**

Although industry can successfully perform D&D operations by using a variety of baseline techniques, these techniques are labor intensive, expose large numbers of workers to hazardous environments, result in considerable volumes of waste, and are extremely costly. In fact, the operational costs associated with remediating these facilities with baseline technologies has been estimated in excess of \$36 billion.

TOWER technology will allow operators to do things not possible today, dramatically reducing costs and improving worker and environmental safety. Its precision planning capabilities eliminate the guesswork associated with current D&D work. It greatly improves worker safety with the potential to cut worker radiation exposure in half compared with current techniques. It helps maximize the limited space at waste disposal sites and lowers disposal costs by reducing waste volume to 1/2 to 1/3 the volume associated with conventional approaches.

Because of its ability to visualize complex facilities, chart optimal dismantling and packaging steps, and track worker hazardous material dose, TOWER is a significant new way to plan and document work in hazardous areas including D&D projects, train workers, reduce worker exposure to hazardous materials, and lower project and waste disposal costs.