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S. R. Rod

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Pacific Northwest Laboratory
Richland, Washington 99352

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GRAPHICS-BASED SITE INFORMATION MANAGEMENT AT HANFORD TRU BURIAL GROUNDS

Samuel R. Rod
Pacific Northwest Laboratory
370 L'Enfant Promenade, S.W., Suite 900
Washington, DC 20024-2115
(202) 646-5213

ABSTRACT

The objective of the project described in this paper is to demonstrate the use of integrated computer graphics and database techniques in managing nuclear waste facilities. The graphics-based site information management system (SIMS) combines a three-dimensional graphic model of the facility with databases which describe the facility's components and waste inventory. The SIMS can create graphic visualizations of any site data. The SIMS described here is being used by Westinghouse Hanford Company (WHC) as part of its transuranic (TRU) waste retrieval program at the Hanford Reservation. It is being used to manage an inventory of over 38,000 containers, to validate records, and to help visualize conceptual designs of waste retrieval operations.

INTRODUCTION

Both existing nuclear waste management facilities and those that will be built in the future to handle the nation's increasing volumes of low- and high-level radioactive waste face immense data communication tasks. The complex and frequently controversial nature of a nuclear waste site's design and function, along with its need for long term monitoring, call for state-of-the-art data collection and information management. It is now possible to assemble a complete SIMS, custom-made for any given waste facility, from commercially available computer hardware and software.

Although the substantive heart of the SIMS to be discussed in this paper is a comprehensive set of site databases, graphic visualization of information (e.g., facility descriptions, site characterizations, environmental data, waste inventory data, data submittals for regulatory compliance, public information releases, etc.) is emphasized. Graphic representations are a convenient framework for the presentation of site-related data. A graphics-based SIMS vastly improves the clarity of the information presented, permitting all types of site data and project information to be readily located, communicated, and interpreted.[1]

SYSTEM DESCRIPTION

A graphics-based SIMS is designed to be a comprehensive, integrated tool for site data management, meeting the waste management facility's varied needs for data collection, analysis, and dissemination. System requirements include the abilities to:

(1) Efficiently handle large volumes of data;

(2) Produce many different representations of facility and waste inventory data to meet information needs as they arise;

(3) Create a three-dimensional model of the entire waste site, to an arbitrary level of detail, with all information readily accessible to users from all disciplines;

(4) Combine data from different sources, both internal and external to the SIMS, to create customized input data sets for analytical programs;

(5) Produce custom visualizations of the output data from analytical programs; and

(6) Support complete, consistent configuration control for site databases throughout the life of the waste management program.

The computer hardware and software that serve as a foundation for a graphics-based SIMS cover a range of capabilities and costs, depending on the size, complexity, and particular purpose to which the system will be put.[2] Personal computer-based systems have a practical capacity limit of from 50,000 to 100,000 objects in the model (sufficient to model a LLW burial site, specific plant areas, etc.), and have hardware costs of from $8,000 to $20,000 and software costs of from $6,000 to $15,000. Workstation-based systems can model millions of objects (sufficient to model an entire nuclear power plant or a complete high-level waste repository), and have hardware costs of from $25,000 to $100,000 and software costs of from $20,000 to $100,000.

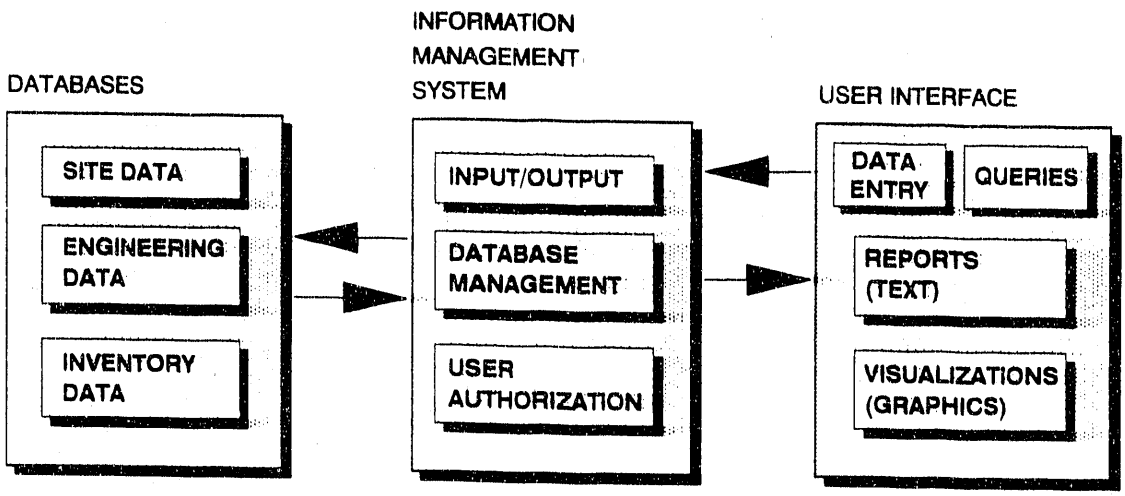

Figure 1. Graphics-Based Site Information Management System (SIMS) Schematic

Figure 1 shows the basic SIMS, which includes a database module, a central information management module, and a user interface. The database module may include tables of information on any pertinent site features or activities. For example, in one recent application,[2] environmental sampling results, facility descriptions, and waste inventory data were compiled in three separate tables within the system's database module. The information management module performs executive and management functions such as interpreting and processing user queries, managing data exchange, maintaining database configuration, and controlling user access. The user interface also includes various text and graphics input and output devices and related software utilities.

The software that makes up the system includes commercial database software, commercial computer-aided design (CAD) software (enhanced with custom-written routines that serve as part of the information management module and the input portion of the user interface), and off-the-shelf word processing and graphics software (serving as the output portion of the user interface).

DEMONSTRATION: TRU BURIAL GROUNDS AT THE HANFORD RESERVATION

Disposal of over 38,000 containers of TRU waste now stored at the Hanford Reservation near Richland, Washington, is required by U.S. Department of Energy (DOE) orders. The TRU waste presently buried or stored in interim storage areas will be retrieved, repackaged as necessary, and shipped to the Waste Isolation Pilot Project in New Mexico. Westinghouse Hanford Company (WHC), DOE's Hanford operations and engineering contractor, is responsible for managing the existing TRU burial grounds and planning the retrieval program.[3] The TRU retrieval program will involve gathering, evaluating, and communicating large amounts of information about numerous waste site features. Pacific Northwest Laboratory (PNL) was contracted by WHC to support the program by identifying specific SIMS requirements, configuring the necessary computer hardware and software, and assisting in creating a three-dimensional model of Hanford's TRU burial grounds with linked site databases.

The prototype system, used for preliminary feasibility studies, consisted of AutoCAD™ (by Autodesk) CAD software and Lotus 123™ (by Lotus Development Corporation) spreadsheet software (adapted as a database) implemented on an IBM PS/2 Model 80 (386) PC. A different hardware and software configuration was chosen for the fully operational SIMS, based mainly on file exchange and multiple platform compatibility issues. The present SIMS consists of MicroStation™ (by Intergraph) CAD software coupled with Oracle™ (by Oracle) database software installed on both a MacIntosh IIfx PC and an IBM PS/2 Model 80 PC.

Initial data entry focused on two current site management requirements --- describing the engineered facilities and the waste inventory. Other site data (geological, hydrological, etc.) will become important later, as the start of the TRU retrieval operation approaches. Figure 2 is a detailed map of Hanford's 200 West area, which includes most of the TRU trenches. This map formed the foundation on which the rest of the SIMS model was built. WHC's original CAD map did not include details of the TRU burial grounds, so PNL's modeling effort began by adding three-dimensional outlines of the TRU trenches. Burial ground 218-W-4C, with 76 trenches, appears in Figure 2 about 4 cm (1.5 in) above the legend.

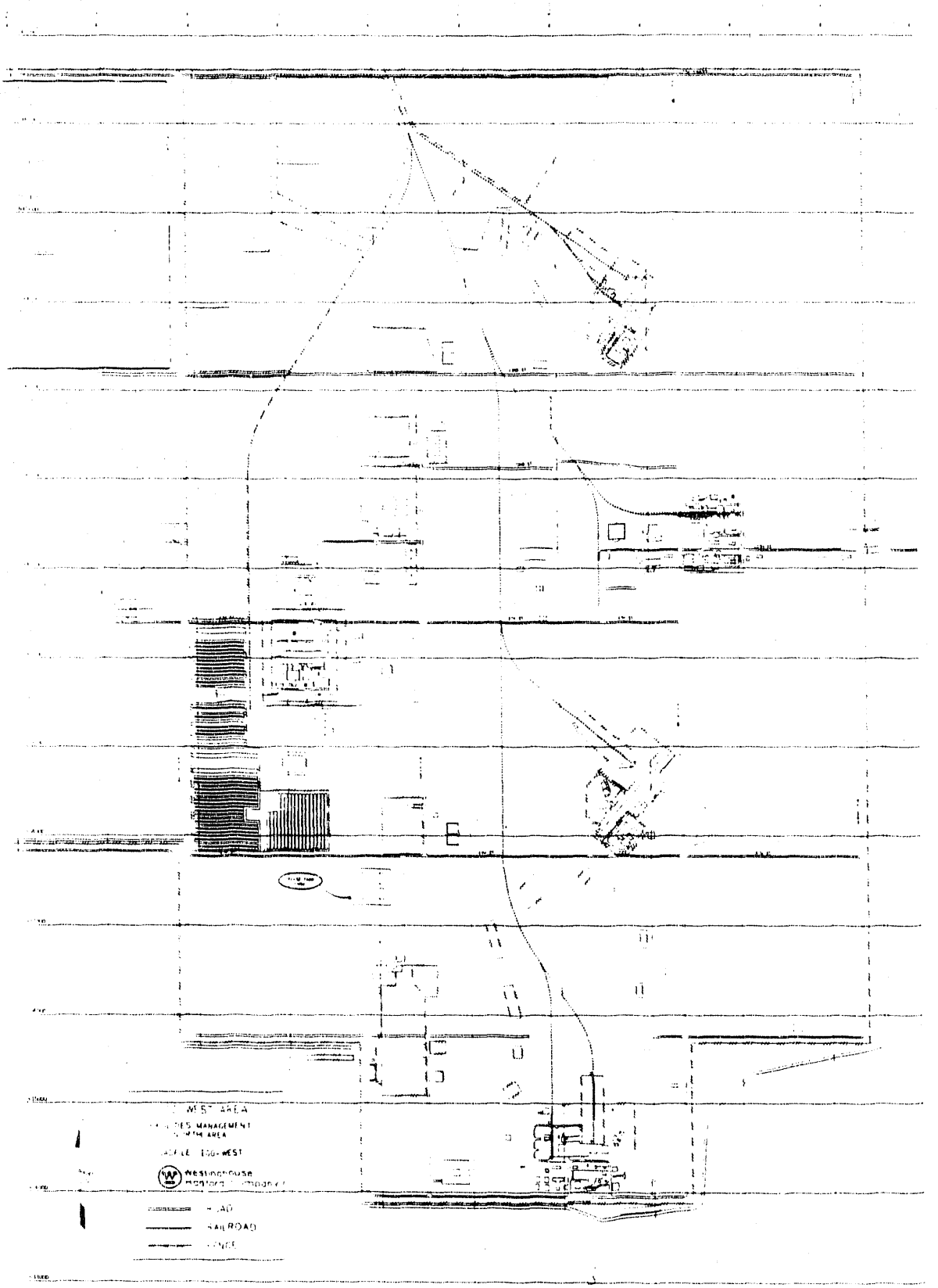

Figure 2. SIMS Model View of the Hanford Reservation 200 West Area
View area: 3,300m (10,000 ft) x 4,600m (14,000 ft)
(drawing by Westinghouse Hanford Company)

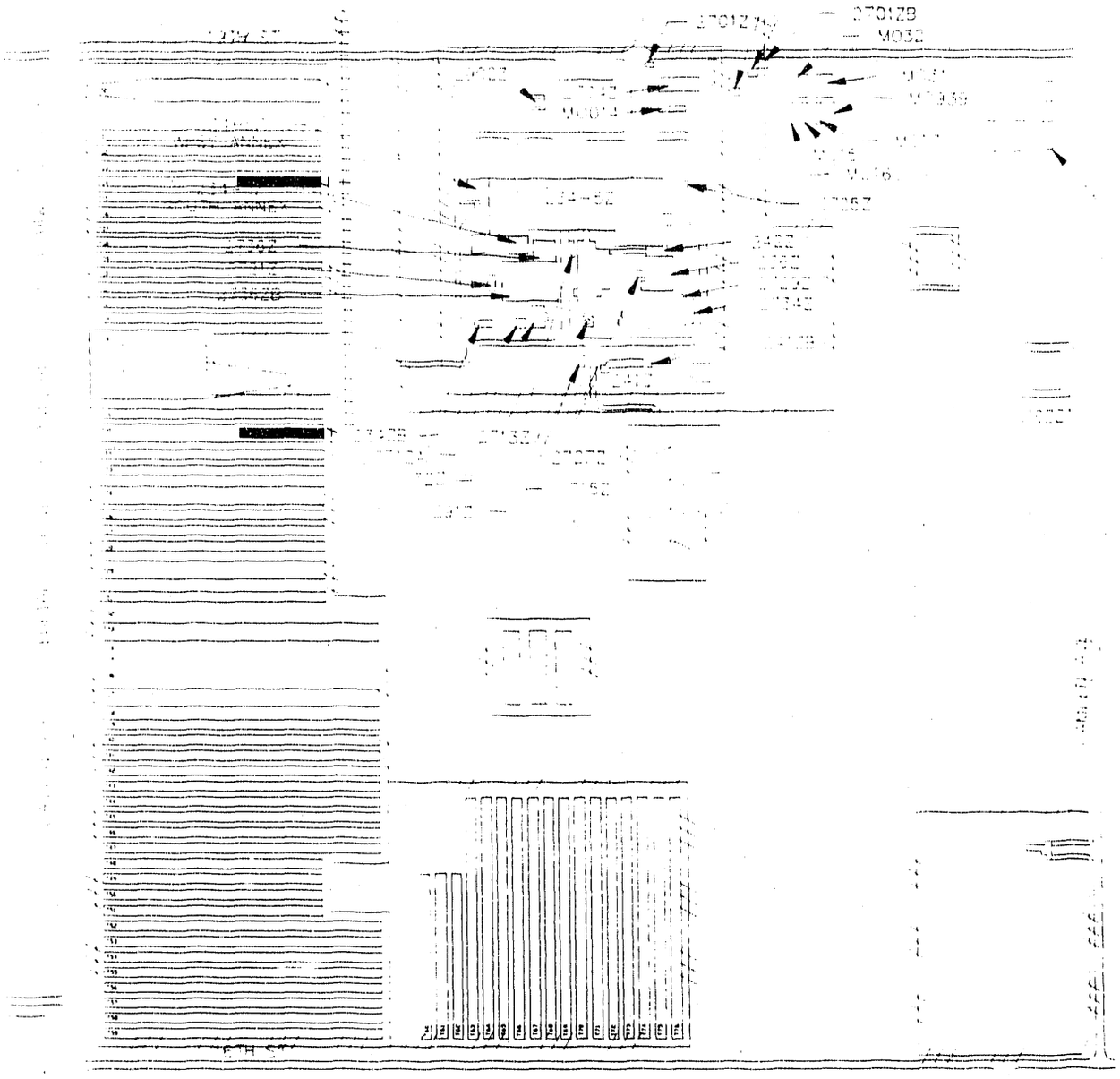

Figure 3. SIMS Model View of Burial Ground and Retrievable Storage Unit 218-W-4C
View area: 820m (2,500 ft) x 820m (2,500 ft)

The main reason for making the three-dimensional site model is to facilitate the creation of arbitrary views, visualizations and representations of the facility as specific information needs arise. Figure 2 comprises an area 3,000m by 4,600m (roughly 2 by 3 miles), but includes objects (notably, over 38,000 TRU waste containers) that are less than 0.7m (2 ft) wide. Further image manipulation is required to reveal the small objects of current interest. The next several figures highlight various custom imaging and database interrogation functions considered important for TRU burial ground management.

Figure 3 is a closeup view of burial ground 218-W-4C and its surroundings. Buildings, streets, trenches, and other features are labeled with information drawn from the site database. At this resolution, individual trenches, each between 160m (500 ft) and 250m (750 ft) long and about 50m (150 ft) wide, are distinguishable. However, the several thousand waste containers in trenches T04 and T20 appear as undifferentiated black bars in the upper left portion of the figure. Zooming in further, as shown in Figures 4 and 5, reveals individual TRU containers, as well as additional trench details.

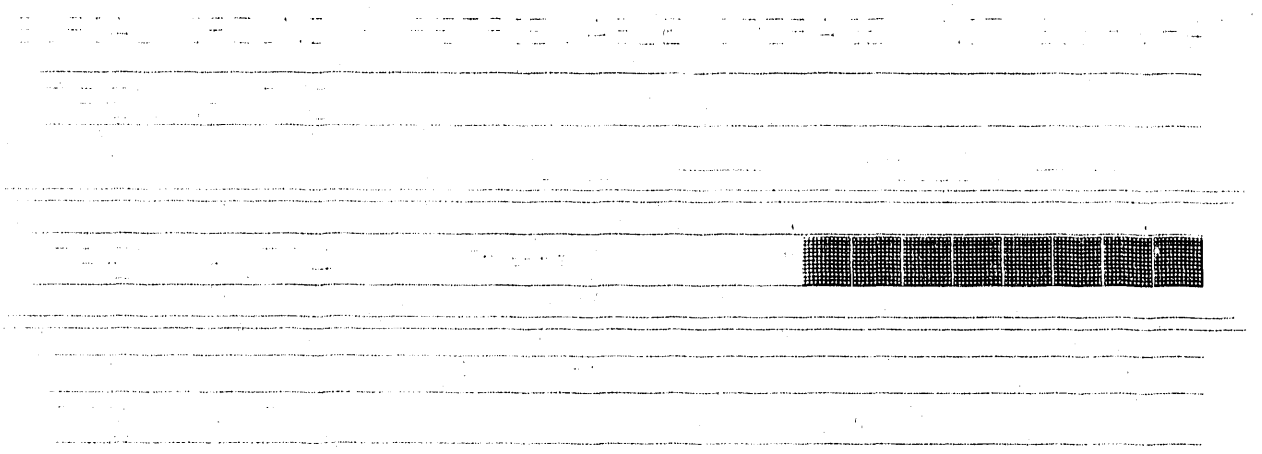

Figure 4. SIMS Model View of Trenches T02, T04, and T06
View area: 200m (600 ft) x 50m (150 ft)

Figure 4 shows the entire length of trenches T02, T04 and T06. Figure 5 shows the eastern end of trench T04 in more detail, including the common burial arrangement of 55-gallon waste drums in "modules" made up of twelve rows of twelve drums each, stacked in four tiers. This modular burial plan is repeated to the extent possible with drums and other containers of various sizes. As shown in the oblique view in Figure 5, waste containers are typically placed on an asphalt slab at the bottom of the excavated trench. Ground level is approximately level with the top of the second tier. An overburden of soil covers the top tiers that actually rest above grade.

DATABASE INTERROGATION THROUGH THE GRAPHICAL INTERFACE

A key feature of the SIMS is its ability to interrogate the site database directly from the graphical CAD program and have answers returned to the display screen without forcing the user to leave the CAD program. Such a "hot-link" between CAD and database software has been implemented on several commercial CAD and database software products, improving the data acquisition and presentation capabilities of both products.

For the purposes of waste site management, two main types of data queries are usually made, (1) one in which characteristics of a single object (or a small group of known objects) are sought, and (2) one in which all the objects that meet a given criterion are sought. In the SIMS environment, for the first type of query, the user employs a pointing device (e.g., a mouse, digitizing tablet, light pen, etc.) to highlight the object(s) of interest. The user then types a database query statement to retrieve the desired data associated with the highlighted object(s). Table 1, for example, lists the results of highlighting the TRU waste drum in trench T20, module 1, tier 3, location C6 and typing the SQL™ (Structured Query Language) statement:

```
SELECT * FROM WGDT20M1
```

In this statement, "*" means "all" and "WGDT20M1" is the name of the table in the Oracle™ database in which the desired data resides. Therefore, all data in table WGDT20M1 associated with the selected drum would be returned. The data in Table 1 would appear in a text window within the SIMS' graphics screen. The entire transaction takes a few seconds.

Table 1. Database Query for Data on TRU Drum in Burial Ground 218-W-4C, Trench T20 Module 1, Tier 3, Row C, Column 6

RECORD_NUMBER	820180
RECEIVING_DATE	01/09/81
DISPOSAL_DATE	07/23/82
WASTE_CODE	1N
AREA	W
BURIAL_GROUND	04C
UNIT (TRENCH)	T20
MODULE	1
TIER	3
LOCATION	C6
NORTH_COORDINATE (FT)	39410
WEST_COORDINATE (FT)	77466
DATA_ERROR?	ERROR

The second type of query involves using a SQL™ query statement as a criterion against which all objects will be compared. Any objects that meet the criterion are automatically highlighted on the graphics screen. This graphics-based search process is especially useful for revealing spatial patterns among multitudes of objects (e.g., 38,000 TRU drums) that would be difficult to discern in text-only data tables.

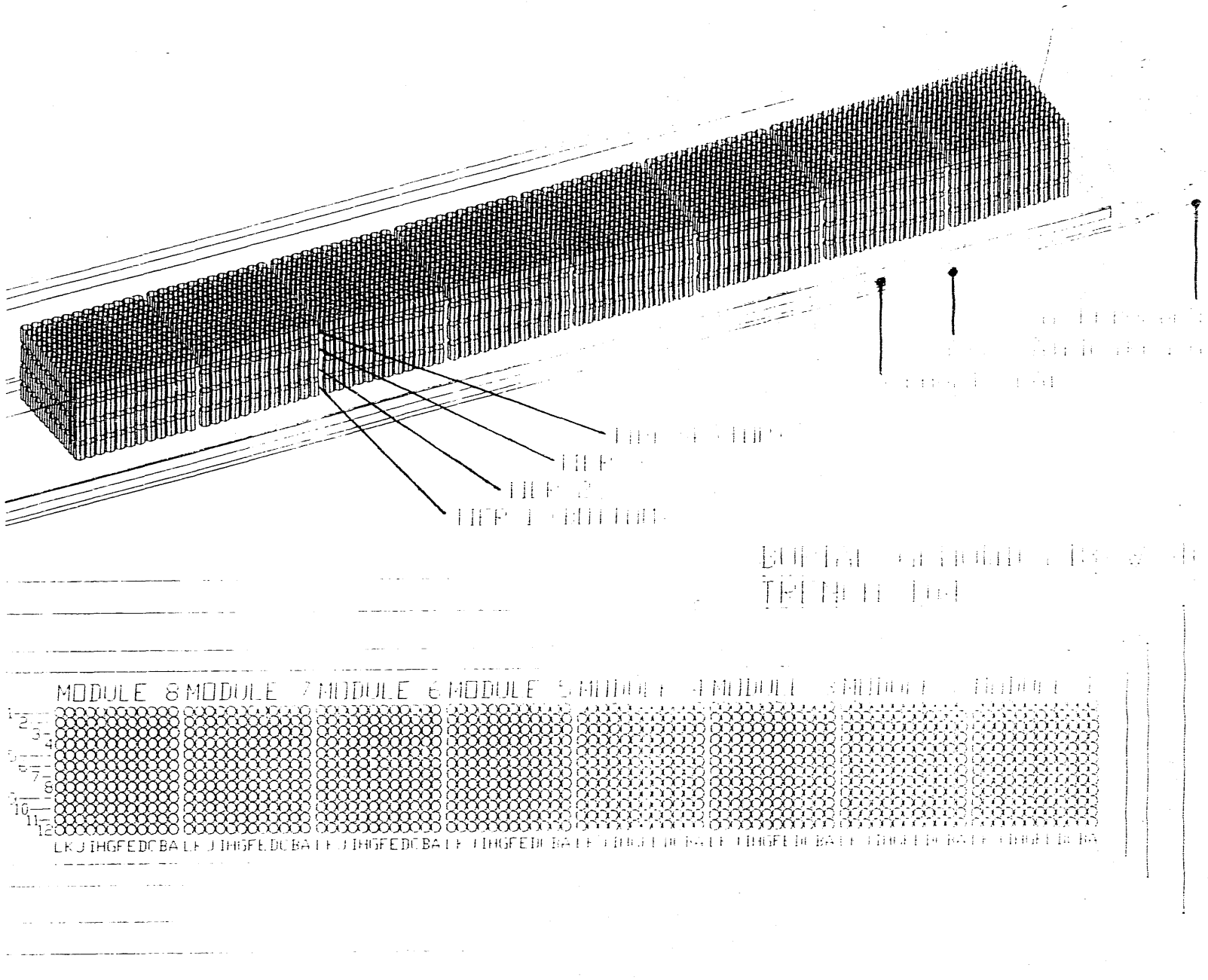

Figure 5. Oblique and Plan Views of Trench T04, with Modules of 576 Waste Drums (12x12x4-high)
View area: 72m (220 ft) x 23m (70 ft)

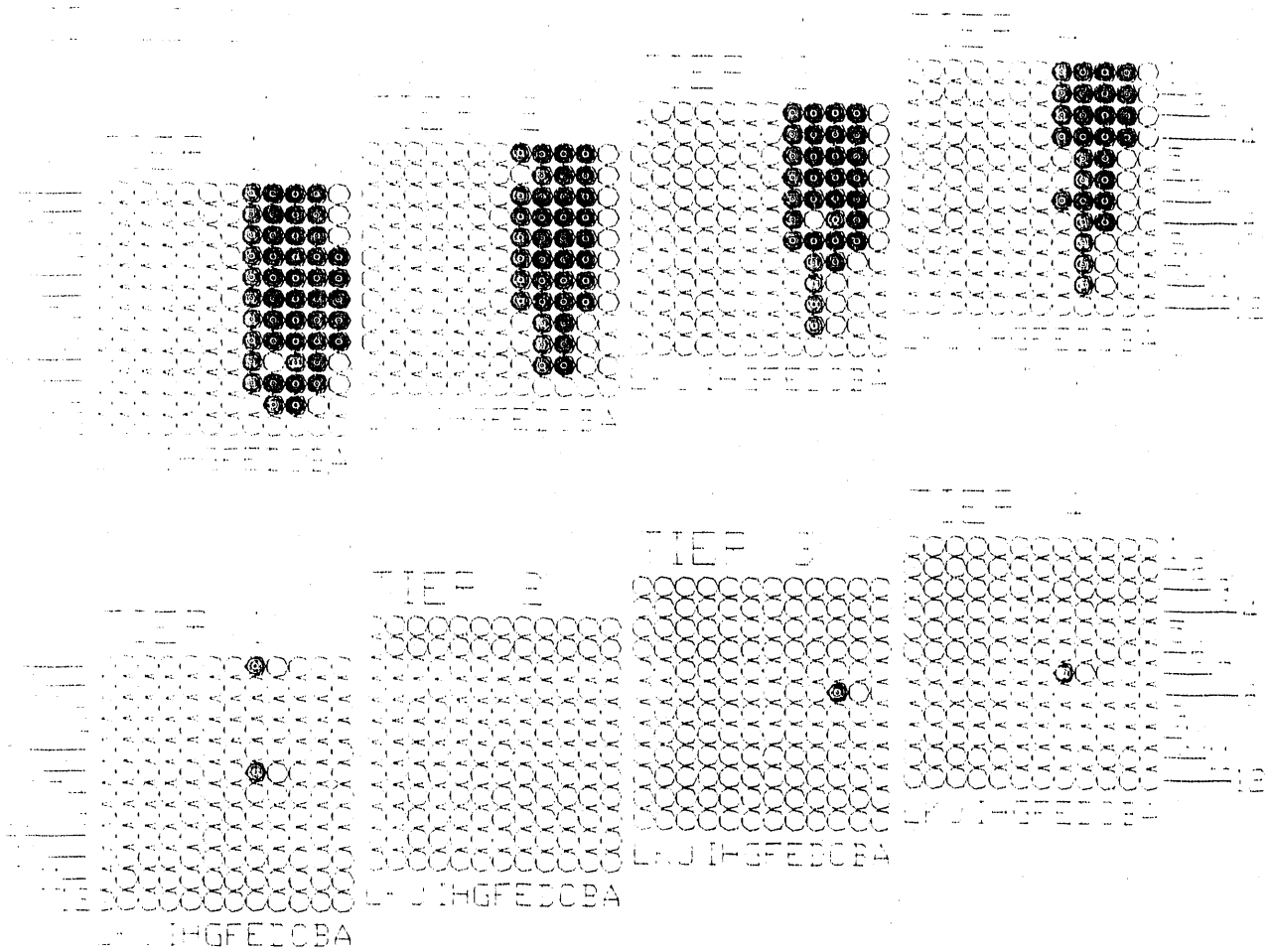

Figure 6. SIMS Data Retrieval and Presentation:

Top - Database Query to Select Drums Containing TRU in T20, Module 1

Bottom - Database Quality Assurance; Results of Query to Show Drums for which Data Errors Exist

Figure 6 shows two examples of such broad searches using object selection criteria. The first query sought drums in trench T20, module 1, listed as containing TRU waste. The second query sought drums in the same module for which known entry errors exist in the database. In both cases, the four tiers were graphically separated for clarity. In the first search, TRU drums are clearly clustered at one end of the module, with implications for retrieval planning. Database errors are revealed in the second search to be relatively few and apparently random.

Figure 7 is an example of the customized representations of site data that can be created for special purposes. Inventory data was superimposed on accurate drum models to produce a realistic visualization of the contents of trench T04, module 8, row A, viewed from the west. A notebook of such images for all rows in a trench could be used by site workers to visually verify inventory as they proceed with trench excavation.

CONCLUSION

A graphics-based waste site information management system was created from commercial computer hardware and software. The system has proved useful in simplifying and expediting many common site management functions at Hanford's TRU burial grounds. Similar systems for more complex sites are elaborations of the basic system, and

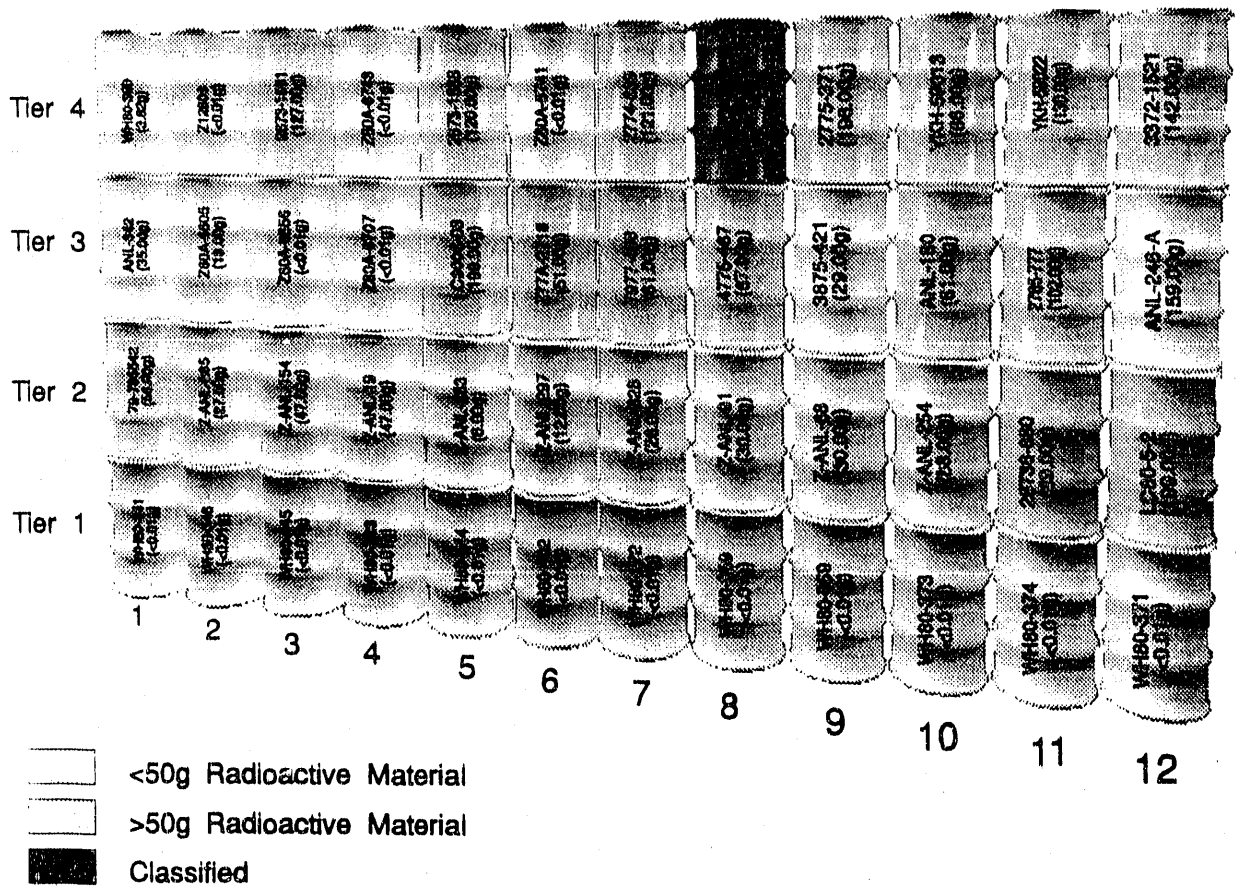

Figure 7. Realistic Visualization of the Contents of Trench T04, Module 8, Row A
View area: 8m (24 ft) x 4m (12 ft)

(From color original. Grayscale does not reveal full color-coding of containers)

can be implemented on existing computer platforms to facilitate management and planning at the largest radioactive waste management facilities.

ACKNOWLEDGEMENTS

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