ENVIRONMENTAL REMEDIATION DATA MANAGEMENT TOOLS

James V. Wierowski, Ph.D., Louis G. Henry and David A. Dooley, Ph.D.
MJW Corporation Inc.
338 Harris Hill Road, Suite 208, Williamsville, NY 14221

ABSTRACT

Computer software tools for data management can improve site characterization, planning and execution of remediation projects. This paper discusses the use of two such products that have primarily been used within the nuclear power industry to enhance the capabilities of radiation protection department operations. Advances in digital imaging, web application development and programming technologies have made development of these tools possible.

The Interactive Visual Tour System (IVTS) allows the user to easily create and maintain a comprehensive catalog containing digital pictures of the remediation site. Pictures can be cataloged in groups (termed "tours") that can be organized either chronologically or spatially. Spatial organization enables the user to "walk around" the site and view desired areas or components instantly. Each photo is linked to a map (floor plan, topographical map, elevation drawing, etc.) with graphics displaying the location on the map and any available tour/component links. Chronological organization enables the user to view the physical results of the remediation efforts over time. Local and remote management teams can view these pictures at any time and from any location.

The Visual Survey Data System (VSDS) allows users to record survey and sample data directly on photos and/or maps of areas and/or components. As survey information is collected for each area, survey data trends can be reviewed for any repetitively measured location or component. All data is stored in a Quality Assurance (Q/A) records database with reference to its physical sampling point on the site as well as other information to support the final closeout report for the site.

The ease of use of these web-based products has allowed nuclear power plant clients to plan outage work from their desktop and realize significant savings with respect to dose and cost. These same tools are invaluable for remediation and decommissioning planning of any scale and for recording of survey data related to building or site decontamination, waste shipments and eventual unrestricted release of entire facilities. This presentation will show the utility of these products in a variety of decontamination, decommissioning and environmental remediation settings including a university research reactor decommissioning project.

INTRODUCTION

The decontamination and decommissioning (D&D) or environmental remediation process for any type of facility or site is comprised of many complex tasks, which comprise four major elements of the project: Planning, Operations, Survey and Measurement, and Documentation. Decommissioning and environmental remediation projects are typically planned and monitored

by teams of individuals working together, but who may not be physically located together. Team members need the ability to understand site conditions, work from common factual databases, and see and appreciate aspects of the project that blueprints and tables do not convey. The ability to perform these activities from any location improves workflow and reduces costs.

Today's information management technology enables the tasks associated with planning, operations, measurement and documentation to be performed in a distributed manner. All relevant data and documentation can be gathered, stored and distributed in a fashion that makes it available wherever and whenever needed. In addition, the data is readily organized and presented in a highly effective manner. This paper will briefly describe two information technology tools developed by MJW Corporation Inc. (MJW) and show how they can be used to benefit D&D and environmental remediation projects.

TECHNOLOGY TOOLS

The Interactive Visual Tour System™ (IVTS™) is a system for cataloging, organizing, and retrieving digital images (pictures) of a remediation site. For purposes of this discussion, "remediation site" refers to any physical space that could be subject to D&D or remediation, such as a structure, portions of a structure, a group of structures, a land area, or even physical components such as trucks, storage or shipping containers, tanks, pumps, etc.

IVTS allows the user to easily create and maintain a comprehensive catalog of digital pictures of the remediation site. IVTS is composed of three main components: the IVTS Editor program, the IVTS Viewer program and the database. The database holds indexing information about the pictures that have been cataloged in the IVTS. Cataloging digital pictures in the IVTS involves a few simple steps. First, the digital pictures are downloaded from the camera onto a server for shared use. The IVTS Editor program is then used to catalog the pictures in the database by dragging-and-dropping thumbnail views of the pictures. During this process each picture is linked to a reference map (floor plan, topographical map, elevation drawing, etc.) to indicate the general location where the picture was taken. Overlaid on the map is an arrow that indicates the precise location where the picture was taken and the direction the camera was facing. These data help ensure that the user is always aware of both their location and orientation at the remediation site, for the image being viewed.

Additional graphical overlays can be added to the map and/or picture. Clickable hyperlink objects can be added to the maps to enable quick and easy navigation across the site. A variety of objects can be added to the pictures to provide supplemental information, highlighting picture details and linking to other pictures in the system. Notes can also be added to each picture to provide additional information for the users. Other information can be easily linked with the images such as dates, physical descriptions or notes, measurement results, etc.

Pictures can be cataloged in groups (termed "tours") that can be organized either spatially or chronologically. Spatial organization enables the user to "walk around" the site and view desired areas or components instantly. Chronological organization enables the user to view the physical results of the remediation efforts over time. The IVTS can be operated over both a Local Area

Network (LAN) as well as across the Internet, allowing local and remote management teams to view these pictures at any time and from any location.

Navigation through the IVTS picture catalog is accomplished using the IVTS Viewer program or the IVTS Web Viewer, and is very easy, using the following options:

- The user can select a desired map from a list, then either click on hyperlinks on the map to "drill down" or navigate to other areas, or click on the tour paths that are displayed on the map to see the pictures
- The user can select a tour from a list. Once the tour is selected the associated map is displayed, along with the first picture in the tour. The user can navigate through the tour by clicking on the navigation buttons or the map.
- The user can enter a component ID and be shown a picture of the component and the map with the location of the component indicated

Fig. 1 presents an example of the IVTS Viewer main screen. This example shows the following major elements of the IVTS Viewer:

- The picture showing various overlay objects
- The reference map showing the tour paths and the arrow showing the location of the current picture and its orientation on the map
- Navigation buttons for moving forward, backward, turning around and looking in alternate directions

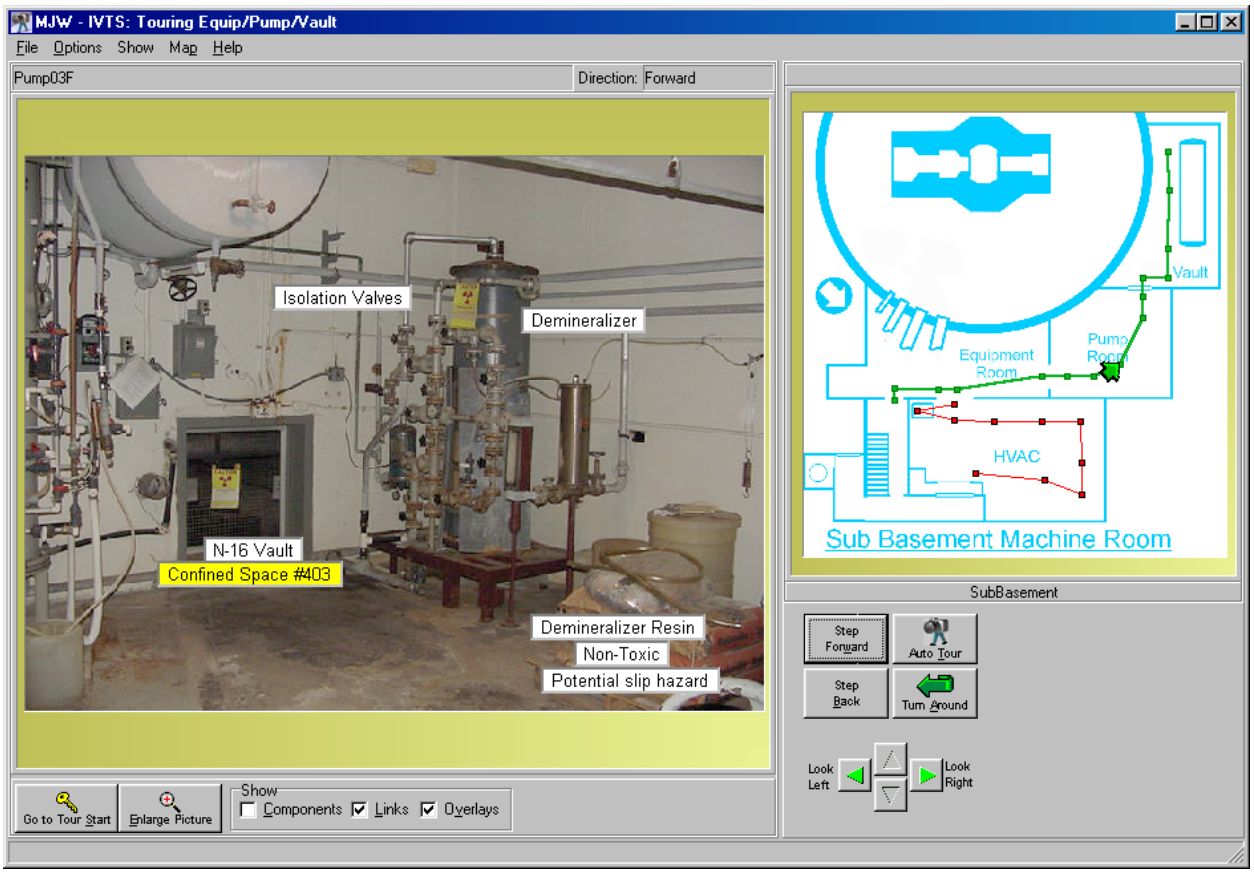

Fig. 1 IVTS Viewer Main Screen

The Visual Survey Data System™ (VSDS™) is a system for capturing radiological (such as dose-rate, contamination and airborne radioactivity data) and other relevant survey data (physical dimensions, weights, temperatures, identification/barcode numbers etc.), storing them in a controlled and efficient manner, and providing distributed access to this important information. The VSDS employs digital images (floor plans, system or component drawings or photographs of areas and/or components) as the background over which the survey data is recorded. Survey locations are identified on the images with unique drag-and-drop graphical symbols that hold the data (dose rate, cpm, etc.).

VSDS contains multi-level security to ensure that only authorized users are able to perform functions such as creating, editing and approving surveys. Once a survey is approved, it is locked and cannot be changed. Images used in the VSDS are kept under version control so that historical data is always available and the technicians always use the current version of the image for documentation. Survey templates can be created to speed data entry and maximize consistency. These templates contain symbols pre-positioned at desired locations to ensure that required data is captured. A variety of data validation and crosscheck parameters can be setup in the program to ensure that data is entered correctly, and that notifications are provided when important set points are reached.

All data is captured and stored in a relational database to enable easy reporting, retrieval and trending. Entry, updating, review, approval, of surveys can be performed from any location on the network. Viewing of the approved surveys can be performed from any workstation on the LAN as well as across the Internet. Casual users are only allowed to view approved surveys.

Utilization of the VSDS enables the remediation team to institute a "paperless" radiological and physical survey program where data entry, review, approval and dissemination to the end users are all performed electronically. As survey information is collected for each area, survey data trends can be reviewed for any repetitively measured location or component. Alternatively data may be profiled across selected dimensions such as concentration vs. depth.

The fact that all data is stored in a Q/A records database with reference to its physical sampling point on the site as well as other information to enables it to support the final closeout report for the site.

Fig. 2 presents an example of the VSDS main screen. This example shows the following major elements of the VSDS:

- The image over which the survey data is recorded. In this example it is a photograph, but could easily be a floor plan map from the IVTS, 3-D diagram, or any other type of image.
- Standard radiological symbols are overlaid on the image. These include dose-rate (blue-bordered square with numbers), hot spots (red-bordered square with numbers), smears (red circles with numbers) and air samples (green triangles with numbers.
- Various annotations, postings, drawing symbols (arrows) and text boxes
- The header and detail information for the survey is available from the panels on the right side of the screen.
- The tool bar at the top of the screen provides access to the overlay objects that can be placed on the image

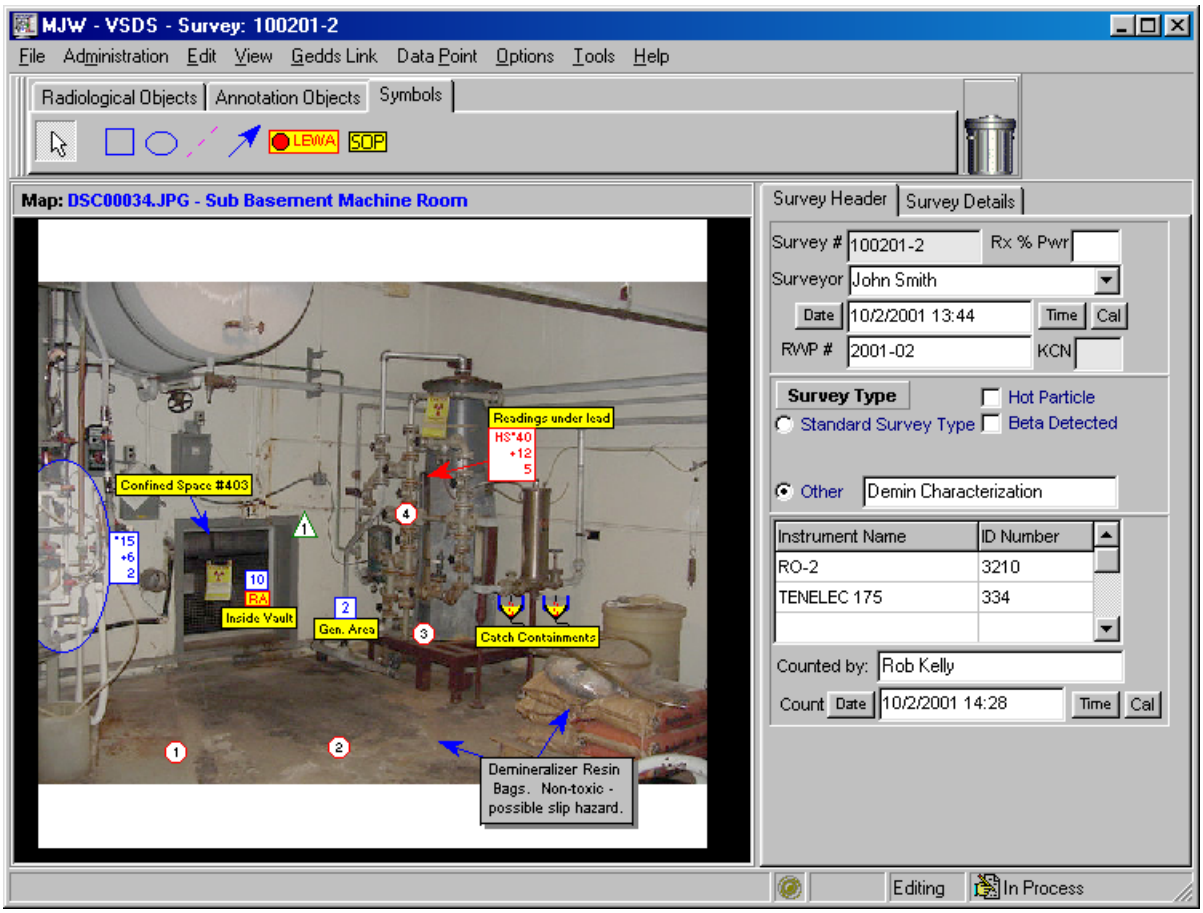

Fig. 2 VSDS Main Screen

Both of these products combine the power and ease of the Microsoft® Windows®[1] environment for editing and have web-browser based user interfaces for easy dissemination of the information, as necessary. The ease of use of these web-based products will allow contractors and site owners to plan remediation work from their desktop and realize significant savings with respect to exposure and cost.

D&D AND REMEDIATION PLANNING

The IVTS can be used to create a comprehensive catalog of digital pictures and maps of the site. VSDS can be used to document the initial site characterization survey. These programs can then be used during the planning process to convey information and train contractors/bidders in subjects such as:

- Quantifying and visually characterizing the presence of lead, asbestos, and similar contaminants
- Confined spaces – tracking hazards, permit requirements, means of entrance and egress and rescue pre-plans

- Information related to fall arrest, scaffolding, and rigging, lift limits on cranes and beams, floor loadings, and overhead electrical hazards
- Useful and important site information such as location of overhead and underground utilities, location of sampling wells, reference markers and landmarks etc..
- Meet hazard communication requirements – location and inventory of hazardous materials, handling and storage rules, and links to Material Safety Data Sheet databases
- Links to historic records such as construction photos, blueprints, etc.
- Site traffic paths, staging areas, storage areas etc.
- Location of emergency stations – eyewash, shower, decon, first aid stations, fire alarm pull stations and extinguishers, emergency phones, etc.
- Lock Out Tag Out Procedures and lock points
- Identifying supervisors responsible for specific areas or equipment
- Location, connection points and capacities for utilities including power, gas, air, waste water, etc.
- Identifying emergency egress paths
- Identifying restricted areas for radiological, safety, or security control

This information is critical to help contractors prepare accurate cost estimates and to educate and train employees during the planning process.

D&D AND REMEDIATION OPERATIONS

As work on the project progresses, IVTS can be continually updated to reflect the changing physical conditions and layout. All team members will have access to the updated pictures so that on-going planning and pre-job briefings will be made with the latest views of the facility. The ability to do this in a distributed environment decreases time and costs such as:

- Time wasted spent traveling to and from the physical work area by enabling visual review of the site/project/job/task from anywhere, at any time
- Reducing protective equipment utilization by eliminating unnecessary trips into the work area
- Decreasing the time required by the workers to find the work area and to perform the work since the workers would have already reviewed the location and physical characteristics of the work area

In addition to VSDS providing a comprehensive system for documenting all survey data, both VSDS and IVTS serve as ALARA tools facilitating the following:

- Preplanning hot operations
- Reducing radiological dose by minimizing planning and review trips into the Radiologically Controlled Area (RCA)
- Similarly reducing exposures to other hazardous substances
- Monitoring trends in "ambient conditions" to identify ALARA targets
- Graphically displaying high and low background areas on an ongoing basis

- Graphically displaying danger areas such as potential collapse areas, High Voltage hazards, areas where combustible gases may be encountered, etc..

Both VSDS and IVTS can be used in emergency response planning, training and operations. They can be used to identify critical systems and equipment, egress pathways, emergency shut-offs and other pertinent data for the facility. During training exercises, both current and historical radiological and Industrial Hygiene data can be accessed to facilitate scenario development. In the event of an actual emergency, the site layout and current environmental data can be viewed by all pertinent responding agencies, from any location. Access to such "real-time" data vastly improves the coordination and effectiveness of the response effort.

D&D AND REMEDIATION SURVEY AND MEASUREMENT

VSDS can be used throughout the project to store, organize, and present survey and measurement data. This can include data acquired with hand held instrumentation or fixed position monitors. Parameters such as radiation exposure rate, radiation effluent concentration, radiological contamination levels, soil contamination levels, Volatile Organic Compound (VOC) concentrations, airborne dust levels, noise levels, etc. can all be recorded and organized using VSDS. Data can be trended, sorted and averaged spatially, and average and peak levels may be determined and displayed.

PROJECT DOCUMENTATION

VSDS and IVTS can be used to support critical documentation needs.

VSDS and IVTS can be used to document and control cost related information associated with the remediation process. These are critical factors, since disputed issues/costs between the owner and the contractors can make or break the budget. Once remediation commences, VSDS and IVTS can be used to irrefutably document cost related information, such as radiation or toxic contaminant levels and dimensions of wastes before shipment, actual component radiation levels vs. projected, etc. These data provide justification backup for the costs of the project and can assist in resolving disputes

VSDS can be used as a part of the critical final site release surveys. All historical and current data for each area of the site are available for review. Since all data is electronic, it can easily be made available to independent contractors, the NRC, and/or DOE to facilitate side-by-side comparison with confirming surveys. Anomalies or discrepancies are quickly identified. The graphical relationship between survey points, the data and the measurement location reduces ambiguity in the data.

VSDS can be used to document information related to the transportation and disposal of waste materials. It can document the contents of containers as they are loaded, and the condition of the materials as they leave the site. In addition VSDS can be used to document the storage of waste materials, it's location within storage facilities, the time it was placed in storage, when it was

shipped, etc. This can assist in meeting applicable environmental laws such as Resource Conservation Recovery Area (RCRA) requirements.

The entire VSDS and IVTS catalogs can be made part of the final report. Any desired surveys and/or pictures could be captured and included in the report. The database can easily be queried to obtain trend, statistical and final data for the report.

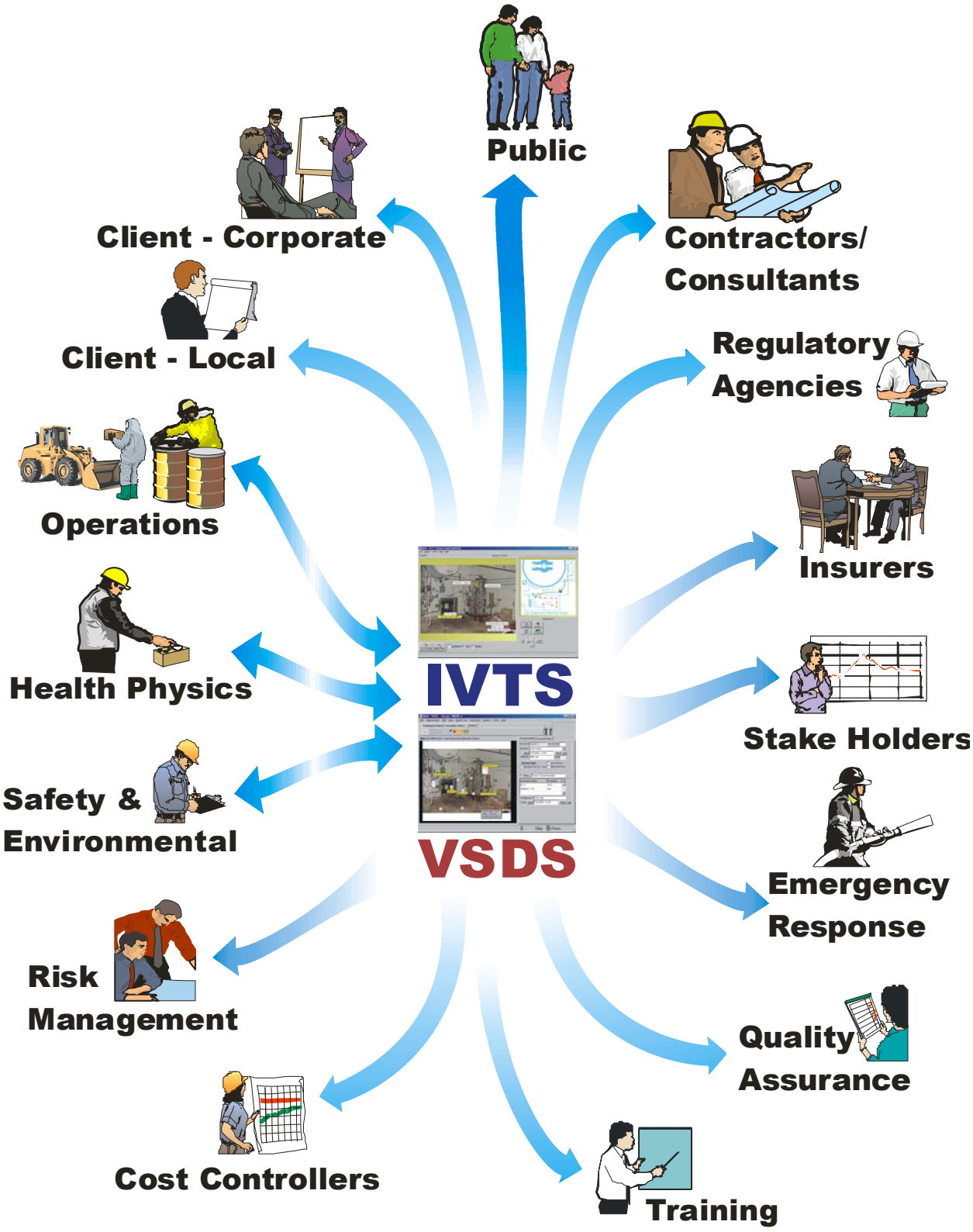

Fig. 3 Data Management and Communication with IVTS and VSDS

EXAMPLES OF APPLYING THE TECHNOLOGY

Example application of IVTS and VSDS to a University Research Reactor Decommissioning Project

The following is a description of how IVTS and VSDS Software might be employed in the decommissioning of a University research nuclear reactor:

A group of consultants from across the United States functions as a team to create for the University an analysis of the best options and methods to decommission the reactor and to estimate of the resources that will be required. Digital cameras will be used to extensively and thoroughly photograph the site. The photographs will be cataloged and maintained in the IVTS to visually characterize the site. The existing radiological conditions of the site will be characterized using VSDS. The consultant team will spend minimal time on site, but will grow to understand the plant layout and the existing radiological conditions by accessing the IVTS picture catalog and the VSDS survey database across the Internet.

The pictures and data contained in the IVTS and VSDS will be used to develop and specify a radiological and hazardous materials sampling plan, and to document and convey the sample results to the team, the university and to regulators. A useful database of survey information is developed easily, linked to digital images of the facility. This includes not only radiological data, but also the results of asbestos, lead, and other hazardous materials testing. Public stakeholders are also educated about the site and proposed actions, in a meaningful and understandable way, with minimal "on-site" presence.

A Decommissioning Plan is developed and submitted to the NRC using IVTS/VSDS. IVTS/VSDS allows NRC officials to better understand the characterization data, grasp site conditions and layout, and understand key elements of the decommissioning plan including sequence of operation, ALARA planning and exposure projections, and waste management. Various officials, at various levels of the organization can better understand the site and the decommissioning plan, without having to visit.

Bid documents and contract specifications are developed using IVTS/VSDS. Bidders learn about site conditions and specifications before pre-bid walkthroughs are conducted, allowing them to be better prepared. Members of the bid team who are not able to visit the site virtually visit. Bid specifications are more precise and easy to understand. By better understanding the site, bidders reduce their contingency expenses. This same information is rolled into contract documents with the successful bidder.

As decommissioning is conducted IVTS/VSDS is used to document progress and site conditions, periodically brief regulators and the public, and to document and compare actual verses anticipated physical and radiological conditions. Data generated is retained for use in periodic and final project reports. IVTS/VSDS is also be used to convey important information to other contractors such as radioactive waste management and disposal facilities. It is used to support documentation of critical unit price cost data such as cubic feet of waste shipped and disposed.

The trending of exposure data contributes to meeting ALARA goals. Images and data are used to develop work permits and procedures for the most complex tasks. New employees and contractors are effectively trained on site safety and emergency procedures. Incidents and accidents are documented.

IVTS/VSDS is also used to conduct and document free release surveys, and to brief regulators regarding the methods used and results. Confirming third party surveys are better planned and compared to licensee surveys using the software.

Finally, IVTS/VSDS is used to create a final report and historical record of the decommissioning project. If the endpoint of the project includes a requirement for continued monitoring, the software will also facilitate this process.

Example application of IVTS and VSDS to a Remediation Project

The following is a description of how IVTS and VSDS might be applied in a remediation project:

A large industrial site handles ore materials that contain naturally occurring radioactivity. In the processing of the ore, multiple hazardous materials are employed. Sludge and other waste products are formed in the process, including miscellaneous materials and contaminated equipment. These materials are temporarily stored in an on-site repository and periodically shipped for disposal.

The owner wishes to decommission the temporary storage facility, remediate any residual contamination, dispose of the waste, and construct a new storage facility on the same site. The owner has retained the services of a contractor who will employ IVTS and VSDS throughout the project.

The contractor first conducts a survey of the site and an inventory of the waste materials that are present. Diagrams of the site are generated, digital images are incorporated, and a database of survey information and materials inventory are readily developed and related to the images and diagrams.

Without needing to visit the site, engineers and managers at the contractor's home office, develop a sampling plan for the waste materials and design a project environmental monitoring program. They submit to the client a proposed work plan to conduct the job, a cost estimate, a waste management plan and a Q/A plan. These plans include images and graphics and data developed and organized using the IVTS/VSDS software. The client in turn is able to share the contractor proposals with corporate headquarters, where senior managers again can tour the site and project virtually.

Similarly, presentations are developed for the regulatory agencies with jurisdiction over the project, for local citizens and stakeholders, and for the local fire department and ambulance company.

Before project operations begin, the contractor uses IVTS and VSDS to create the project health and safety plan, safety and site security training lesson plans, and emergency response procedures. Project staff and subcontractors can be effectively trained, before they set foot on site.

Next, execution of the project begins. IVTS and VSDS are used throughout the project. For each waste unit sampled, the radiological and chemical test results are related to the materials and their location. As the waste is relocated into a temporary storage structures, the data easily moves with the materials. At any moment, the contractor can show the regulator, the client, and emergency responders, what materials are in each temporary storage unit.

Grid lines are established on the floors of the temporary repository building. The location of stains on the floor, and other physical evidence are photographed and mapped. As the surface of each segment of the floor is decontaminated, the post decontamination radiation levels are recorded. Other information entered into the database includes the results of air samples, instrument calibration information, work permit information, and what workers performed specific tasks.

Based upon the survey information, the contractor is able to determine "average" contamination levels, and determine which floor materials may be released as non-regulated waste, and which materials need to go to a licensed disposal facility. When the floor sections are broken up, contractor employees work from diagrams, which direct them where to stage each section of broken up concrete. The materials destined for licensed disposal are staged, and the data is sorted, in the specific combinations that will be loaded into shipping containers. The weight and average concentration in each shipping container is thus easily determined, and is well documented.

Images of the waste materials, and the radiological data are provided to potential disposal facilities to gain acceptance of the waste and determine disposal and shipping costs. The disposal facilities have high confidence that they understand the physical and radiological characteristics of the waste materials, thus avoiding "surprises" when the material arrives at the disposal site.

A second sampling campaign is conducted to determine conditions beneath the floor. Again managers and scientists at the home office develop sampling plans and work procedures without having to visit the site. Patterns in the floor contamination levels are used to bias the sub-floor sampling plan. Again, the data may be shared with regulators, corporate managers, and the public. Again IVTS and VSDS are used to catalog data, to segregate and characterize wastes, and to streamline the acceptance of the waste materials at disposal facilities.

The costs associated with unexpected conditions that were encountered during the project are easily negotiated because both the contractor and the owner have clear information available to them, in which they have mutual confidence. A final map and photos of site conditions are created, before the new facility is constructed.

A final report of the project is developed again using VSDS and IVTS. Copies are provided to the regulator, the client, and stakeholder representatives. The regulators and stakeholders have higher confidence that the site was competently and completely cleaned, because they better understand the process, and have higher confidence in the data because they were virtually present throughout the project.

OVERALL BENEFITS

IVTS and VSDS can reduce liability associated with any decommissioning or environmental remediation project by better documenting radiation exposures and similar data, and conveying the potential for exposure to other hazards (asbestos, lead, hazardous atmospheres) to the workers.

VSDS reduces technician dose by streamlining survey data collection and documentation. Additional dose reductions can be realized through analysis of collected data so that subsequent surveys can focus on needed attention areas. VSDS also improves clarity and consistency of the survey results.

IVTS and VSDS can be used as public information tools to educate the general public and public officials about the decommissioning process. They can also be used to periodically provide "visual" report progress.

Due to their interactive nature, IVTS and VSDS can also be used to explain/report progress or problems to regulators.

IVTS and VSDS can reduce the overall cost of the project by directly impacting a broad range of individual cost elements including, but not limited to:

- Reducing personnel travel through electronic information sharing
- Reducing redundant work by keeping teams better informed as work progresses
- Reducing overall staff requirements because more can be done with less
- Avoiding enforcement actions by keeping regulators well informed and facilitating preemptive feedback
- Monitoring contractor progress
- Improving the accuracy of cost estimation and reducing cost estimate rework
- Reducing inspection costs by enabling much of the data to be examined remotely, thus decreasing the number of site visits by regulators
- Improving efficiency and avoiding unnecessary project delays thus enabling the project to be completed in less time

CONCLUSIONS

Collection, organization and easy access to the vast amounts of data collected in the course of a D&D or remediation project is critical to the success and cost-effectiveness of the project. IVTS and VSDS are powerful software applications that can support many aspects of D&D and

environmental remediation projects. They may be employed in a variety of ways to improve quality, reduce cost, document critical information, and convey information to employees, contractors, regulators, and the public. This paper has attempted to provide a brief introduction to these software applications, their capabilities, and two basic examples of how they can be utilized. The extent of usage of these systems far exceeds what can be described here, and is only limited by the imagination and creativity of their users.

FOOTNOTES

1. Microsoft and Windows are registered trademarks of Microsoft Corporation