NEW APPROACHES TO SOLVE REMEDIATION CHALLENGES USING TECHNOLOGICAL APPLICATIONS AT THE SANDIA NATIONAL LABORATORIES CHEMICAL WASTE LANDFILL

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The Chemical Waste Landfill (CWL) at Sandia National Laboratories, New Mexico (SNL/NM) is a 1.9 acre site used for the disposal of chemical wastes generated by many of SNL/NM research laboratories from 1962 until 1985. SNL/NM, in conjunction with URS, began excavating the landfill in 1998. The remediation project includes waste segregation, characterization, and appropriate storage for future treatment and disposal of excavated material. Many of the technological advances implemented at the site were derived from in-field experience and evaluation of new approaches and engineering designs to meet remediation challenges associated with the project. Five technically significant achievements are examined: (1) The process of screening debris from excavated soils has experienced successful improvements through field evaluations of a series of site-built and commercially designed applications; (2) The debris segregation process enhancements are a reflection of practical design modifications; (3) Explosion protection equipment and practices have advanced as a result of the application of technology-based assessment and modeling tools; (4) The use of smoke grenades as a practical and effective emergency response indicator for site workers and neighbors; and (5) The study of actual heat stress potential through comprehensive field assessments and the use of commercially available heat stress reduction equipment and techniques.

The process of screening debris from excavated soils has experienced successful improvement through the evolution of a series of engineering technologies based on field evaluations of site-built and commercially designed applications. The initial technology used was a pair of site-built “truck bar screens”. These devices were designed and built to allow a dump truck to be positioned below a slanted (35-40°) bar screen (2” X 2”) to capture soil after the excavator distributed excavated material onto the screen surface. To be reasonably effective, the excavator (Track-hoe) bucket had to be used to rake material over the top of the screen. It was quickly recognized that this process was slow and not extremely effective as a soil/debris separation technique. Difficulties controlling dust and maintaining container integrity posed additional concerns.

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The second generation screening technique engaged the use of a site-built “table screen” which was located at ground height. This method allowed for personnel to sort through material on the screen, though it continued to require the Track-hoe bucket to grade material through the screen to facilitate soil separation. The subsequent addition of two conventional concrete vibrators served to allow soil to be separated more effectively though these were dependant on a gas-powered generator to operate and commonly experienced mechanical problems such as overheating, and equipment failure. Frequent vibrator clamp failure was a continual problem because they were located on the screening surface. As a continual improvement effort, an electric side-mounted hopper vibrator replaced the concrete vibrators.

Although more successful, the table screen technology presented several efficiency and safety concerns. The table screen had to be continually moved after a fairly limited amount of soil accumulated (~10 yards) on the ground beneath the screen. Personnel sorting material/debris were required to wear Level B protection with backpack 1-hour self-contained breathing apparatus (SCBA) cylinders. These individuals often stood on screened soil that provided an uneven surface while conducting sorting activities. The sorting process was time consuming and labor intensive, which required potential heat stress conditions to be continually mitigated. The ergonomic significance of these operations was considerable. Both vibrator types were extremely loud and were sensitive to water, which was regularly used to suppress dust generation. In addition, personnel were located in close proximity to newly and rigorously disturbed chemical containers, gas cylinders, and potentially explosive materials.

After a year into the process, a commercially available Read Screen-All® material separator, the current technology used today, was implemented.. This approach was adopted after sufficient excavation experience could be evaluated to justify the application of the more efficient screening technology while preserving and/or enhancing environmental, health and safety aspects of the project. Ultimately, the “Screen-All” has demonstrated an increase in soil excavation efficiency of greater than four-fold, and has mitigated a number of safety concerns by providing significant operator distances from the vibrator separation process. The new process has added valuable dust suppression effectiveness, permitted the expanded use of supplied-air rather than SCBA respiratory protection, and has reduced the workforce requirements and overall physical demands on field technicians. A dramatic safety benefit has been that the “Screen-All” allows material to be screened and re-screened, which provides opportunities for chemical or energy material reactions to occur prior to personnel handling activities.

The implementation of the “Screen-All” created a waste stream management opportunity where a more dedicated and controlled process for segregating debris into respective debris categories could be achieved. A dome tent was constructed to accommodate the debris segregation process and offer vital protection against adverse weather conditions. The benefits of a commercially available conveyor were immediately realized as a substitute to the table screen segregation process. A hopper and chute were built to more effectively and safely deliver materials onto the belt conveyor for distribution prior to frisking, sorting, and segregation management. At the same time, a box for the collection of rocks was installed at the end of the conveyor to allow for loader collection. In addition, inline supplied-air respiratory protection was installed which provided an option of supplied-air, rather than SCBAs, that could be selected by operators depending on job responsibilities. Conveyor modifications were made to control height and

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work space ergonomic issues. Later, 1-cubic-yard hoppers were used to collect and store specific types of debris in which swipe samples could be collected and analyzed for radioactive contamination prior to placing the materials (non-radioactive) into the larger specific roll-off containers. Lastly, a comprehensive explosive hazard assessment of the project (summarized later) demonstrated the need to implement process engineering and administrative controls in the debris segregation area. These included the use of an alternative extended-arm loader, personnel blast protection, and debris management procedures to mitigate the potential affects of a detonation event.

Based on heightened concerns associated with excavation of a region of the CWL with an unknown disposal history, a comprehensive hypothetical explosion modeling assessment was conducted assuming a sodium-potassium (NaK) material detonation event. The Department of Defense Safety Board Blast Effects Calculator (Version 4) was employed to model the overpressure blast effects as a function of distance associated with a TNT-equivalent detonation. The Department of Energy (DOE) Blast Resistance Window Program (BLASTOP Version 1.5) was used to model window and Lexan® shielding effects including material deflection and failure probabilities associated with overpressure values. The most significant technology advancements were the blast shielding design modifications and secondary pressure effects mitigation to avoid failure of glass (i.e. windshields) located behind Lexan blast shielding. The results of this assessment were responsible for significant engineering and administrative controls to protect site workers, equipment, facilities and CWL neighbors.

In the event of an emergency at the CWL, response of the personnel associated with site operations, administrate functions, and neighboring facilities is dependent on the type of incident, its location and the prevailing wind direction. Colored smoke grenades have demonstrated to be a valuable visible indicator to designate the source of the emergency and identify the migration pathway for downwind airborne concentrations of potentially toxic substances. The ability to use the smoke has enhanced awareness of the evacuation provisions of the project's emergency response and contingency plan.

A comprehensive heat stress study was conducted to determine the reliability of using the 1999 American Conference of Governmental Industrial Hygienist (ACGIH) heat stress Threshold Limit Value (TLV) using Wet Bulb Globe Temperature (WBGT) Index for site workers in Level B personal protective equipment. According to ACGIH, an individual's core (deep) body temperature should not exceed a rise of 1.0° C (or not exceed 38° C) during a work period, providing the proper work rest/regime is implemented based on work energy expenditure, WBGT values, and the level of personal protective equipment worn. The study involved using VitalSense Telemetric Heat Stress Monitoring to evaluate (estimate) employee core body temperature, and other significant biological indicators during CWL work activities in June (Albuquerque, NM) while adhering to the ACGIH heat stress guidelines. The study showed that the ACGIH TLV guidelines did not adequately protect operators from exceeding the core body temperature of 38° C (100.4° F) and a more protective work/rest regime had to be developed at the CWL based on the work activity, the level of protection (PPE) and environmental WBGT values. Commercially available heat stress reduction equipment, such as personal ice cooling systems (PICS) have been essential in offering site worker comfort alternatives and allowing specific work on certain days and times in the summer months.

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