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Contamination Control During In Situ Jet Grouting For Application In A buried Transuranic Waste Site

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CONTAMINATION CONTROL DURING IN SITU JET GROUTING FOR APPLICATION IN A BURIED TRANSURANIC WASTE SITE

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ABSTRACT

Engineers at the Idaho National Engineering and Environmental Laboratory (INEEL) have developed means of contamination control associated with jet-grouting buried radioactive mixed waste sites. Finely divided plutonium/americium oxide particulate can escape as the drill stem of the jet-grouting apparatus exits a waste deposit in preparation for insertion in another injection hole. In studying various options for controlling this potential contamination, engineers found that an elaborate glovebox/drill string shroud system prevents contaminants from spreading. Researchers jet-grouted a pit with nonradioactive tracers to simulate the movement of plutonium fines during an actual application. Data from the testing indicate that the grout immobilizes the tracer material by locking it up in particles large enough to resist aerosolization.

INTRODUCTION

Testing has demonstrated that in situ grouting can stabilize buried transuranic waste in pits and trenches. This grouting encapsulates radioactive waste, significantly reducing groundwater infiltration and minimizing contaminant migration. Engineers developed the jet-grouting technology at the INEEL for in situ treatment of buried transuranic-contaminated waste. The technology can also be applied for buried low-level waste material. In situ grouting serves as a practical, cost-effective way to treat radioactive waste to protect citizens and the environment.

In its simplest form, jet grouting of transuranic waste involves placing a glovebox-like assembly atop a buried waste site and drilling with a shroud-encased drilling system through prefabricated holes of the glovebox to inject grout into the waste beneath. Called a "thrust block," the glovebox is recessed on the bottom to contain grout that returns to the surface under injection pressure.

The grouting rig injects grout directly into the waste at pressures up to 400 bar. The objective is to fill void spaces in the transuranic waste and soil in order to form a monolith to prevent groundwater infiltration. This in situ grouting is expected to both stabilize the waste against subsidence and to provide containment against migration of waste to the Snake River Plain Aquifer, a huge water resource that lies 150–200 m below the waste.

The INEEL has move than 56,000 cubic meters of transuranic waste commingled with a similar amount of soil in a land burial site 3–5 m deep referred to as Waste Area Group 7. Since this buried waste has been declared on the National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), it is being managed as a superfund site.

Under CERCLA, options for the waste include capping and continued monitoring, retrieval and ex situ management of the retrieved waste, in situ stabilization by vitrification or grouting, in situ thermal desorption, or some combination of these options. The INEEL has conducted a treatability study (1) of in situ grouting to collect technical, implementation, and performance data.

Essential to grouting is controlling the spread of finely divided plutonium/americium oxide particulate in the waste debris. Since the jet-grouting process involves drilling directly into the waste, there is potential for contamination to spread as the drill stem is withdrawn. This paper describes various options for controlling the spread of contamination and gives the results of grouting a simulated pit with nonradioactive tracers to simulate movement of plutonium fines during an actual application.

In Situ Grouting

Researchers at the INEEL first developed in situ grouting as an aid to the retrieval process (2,3) and then as a stand-alone application to facilitate in situ disposal (4,5). By jet grouting the buried waste first with unique grout materials such as molten paraffin or latex modified cement, the plutonium fines are agglomerated into larger less easily aerosolized particles such that when excavated, there is less spread of materials. During the early field demonstrations (2,3), it was found that there was a marked reduction in dust spread during these retrieval studies when applying the jet grouting prior to retrieval. It was observed, during the retrieval studies, that the monolith formed by the jet-grouting operation was cohesive and stand-alone in nature and seemed to be ideally suited to leaving the material in situ for disposal rather than to retrieve it.

During these early studies, tracers were employed in the waste, and high-volume air monitors were employed to measure the tracer (three micron-sized rare-earth oxides) spread during grouting. In these early studies, the grouting process was performed with literally no engineered contamination control devices. It was found that there was no spread of tracer to the high-volume monitors during the grouting process, which was attributed to the fact that the grout returns to the surface and the surface of the drill steel were a wet slurry mix that fixed the contaminants in place.

In situ grouting developed at the INEEL involves high-pressure (400 bar) nonreplacement jet grouting into the waste to create, once cured, a solid monolith out of the waste pit or trench. “Nonreplacement” means that the jet grouting is accomplished with minimal to no grout returns to the surface, thus minimizing contamination spread. The grout is delivered via a rotating drill string that is first driven through the waste to the desired depth. At this point, the high-pressure grout is injected through small (2-3 mm) nozzles at the bottom of the drill string. During grouting, the drill string is raised in precise increments or steps (nominally 5 cm) with a predetermined “dwell” time on a step. By injecting grout on an approximately 50-cm triangular pitch, the resultant circular columns are interconnected to form a solid monolith.

The CERCLA treatability study was performed in a simulated pit. However, regulatory agencies mandated that the process would have radiation control engineering endorsement for hot application. To achieve this goal, an extensive contamination control strategy for grouting was established involving grouting in an essentially glovebox environment. The technology uses a thrust block (see Fig. 1) to both contain grout returns and, along with a shroud around the drill steel, to create a glovebox like environment for the grouting process. The thrust block is a metal box placed over the area to be treated, and the top surface doubles as a flat working area for the drilling operation. The top surface has predrilled holes, and each hole through the thrust block has a removable lid and a plastic diaphragm seal, which is penetrated during the grouting process (see Fig. 2). Coming out of each hole in the thrust block are a double set of plastic sleeves that can seal to the drill string shroud assembly to form a tight glovebox-like fitting. The thrust-block and plastic gloveport assemblies are under negative pressure using a high-efficiency particulate air (HEPA) filtration system and a shroud assembly around the drill stem, which is also HEPA filtered. Once a hole is grouted, the drill steel is withdrawn into the shroud and the glove sleeves are twisted, taped, and cut (see Fig. 3). The cut portion of the double gloveport is placed down into the thrust block, and the removable lid is replaced.

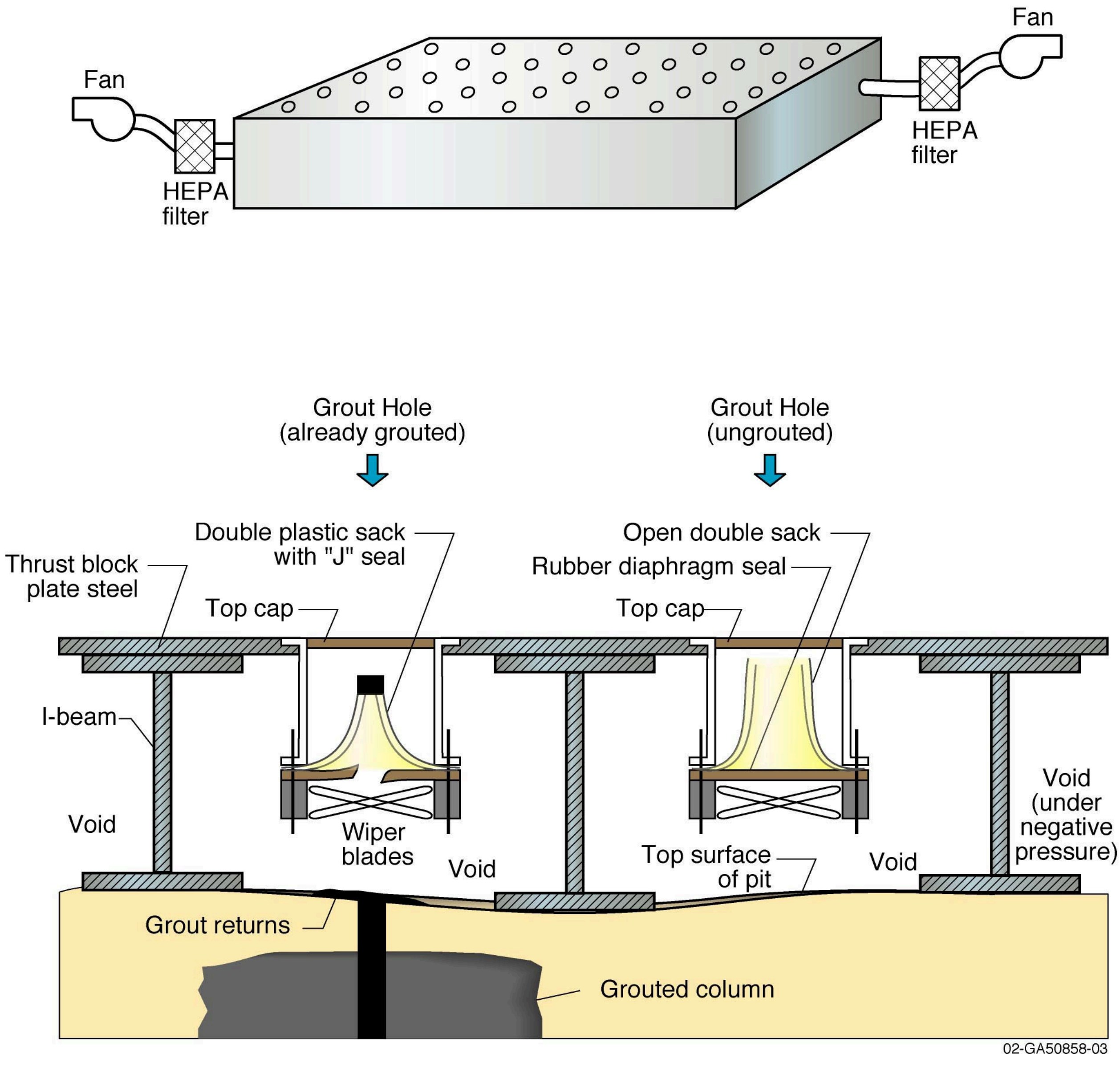

Fig. 1. Basic design of the thrust block.

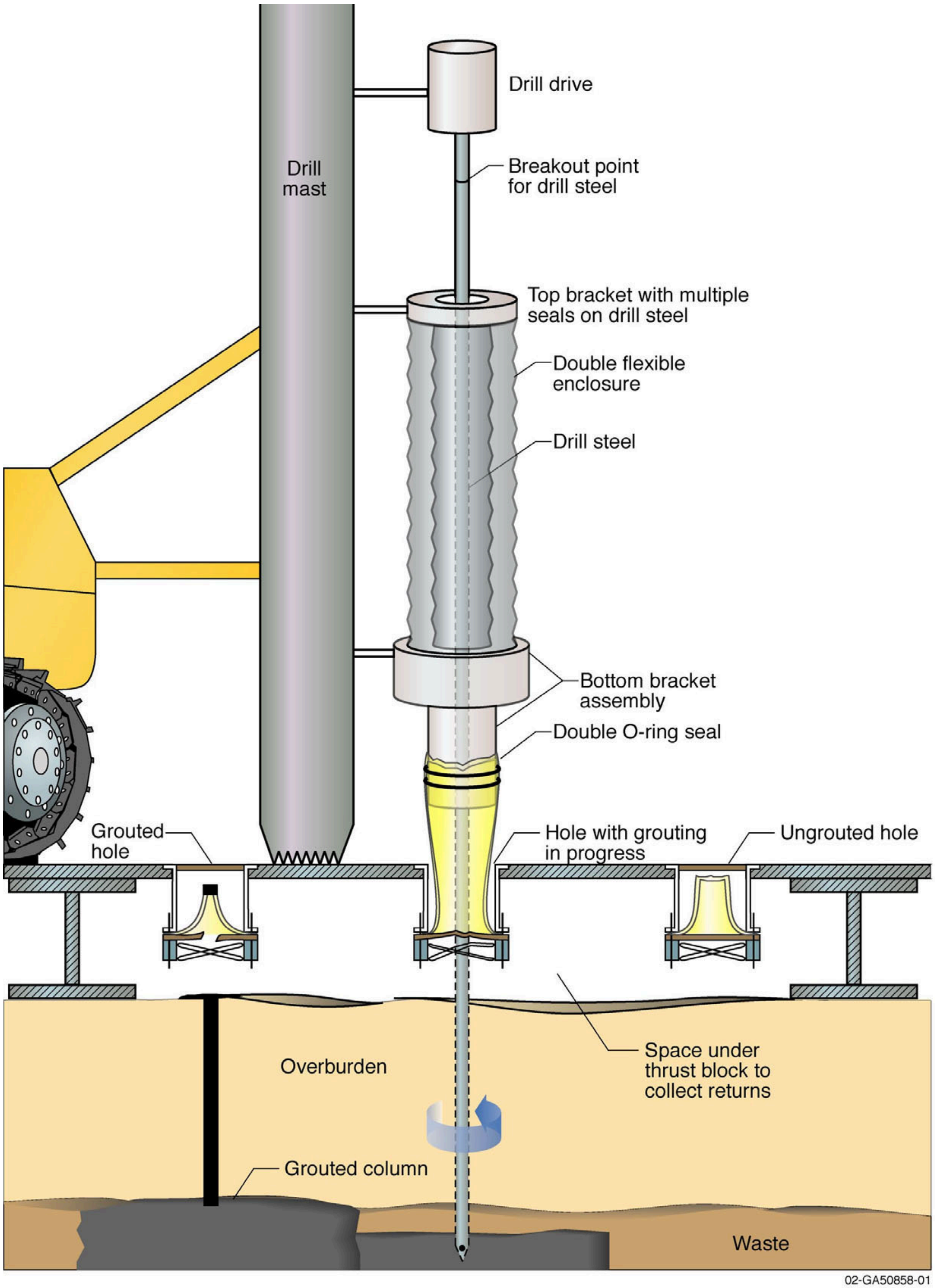

Fig. 2. Grouting process with contamination control.

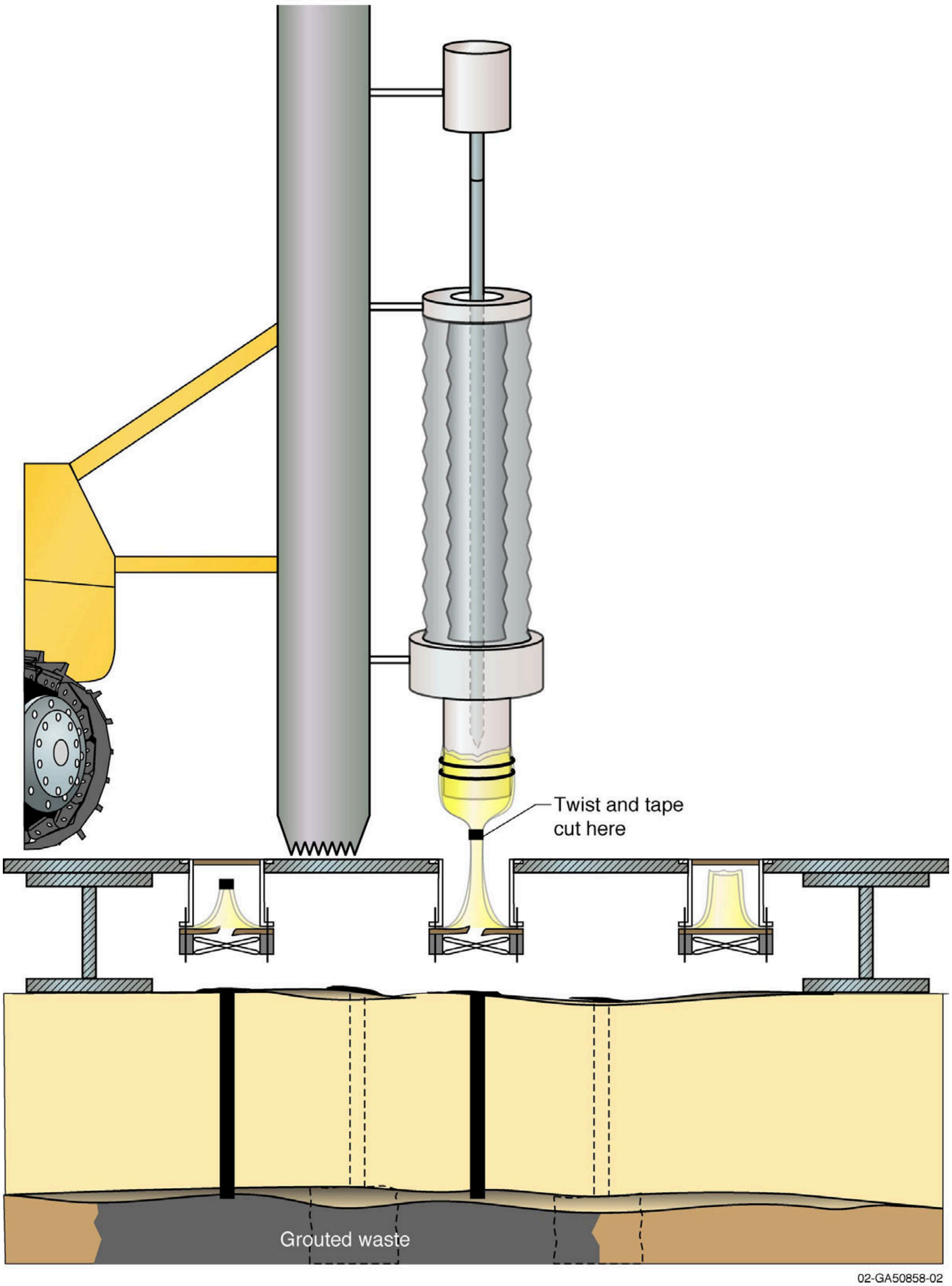

Fig. 3. Drill string withdrawn—preparing to move to a new hole.

Full-Scale Field Application

Using the glovebox contamination control apparatus described above, 12 holes were grouted in a simulated buried waste condition. In the simulated buried waste pit, each waste container had up to 200 g of terbium oxide tracer as a stand-in for plutonium. Although the rare earth oxides do not replicate the complicated valence states found in plutonium, in separate effects studies (6) it has been shown that the plutonium oxide particulate moves like the rare earth tracers if the aerodynamic mean diameter of the particles are similar. Prior to the full-scale field grouting, 11 independent backgrounds were obtained using seven high-volume filters staged strategically around the grouting operation. Taking a relatively large background allows a better statistic. In addition to obtaining air samples, 100 cm^2 smears where taken on the top surface of the thrust block and on parts of the drill string shroud assembly. HEPA filtration systems were destructively sampled and samples of grout returns were obtained under the thrust block. The whole process was performed inside a weather structure to minimize the effects of wind on the collection of the tracer on the samplers. All samples were evaluated for terbium using Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS). Data in the report will show that there was terbium tracer inside the drill string shroud and in a limited number of grout returns under the thrust block; however, no terbium above background was spread to the strategically placed high-volume air monitors located around the grouting operation.

EVALUATION OF CONTAMINATION CONTROL DURING FIELD TESTING

Contamination control of the finely divided plutonium particles was a central thrust of the treatability study. Operating with no spread of the terbium tracer above background was considered the performance standard of the thrust-block/glovebox approach. To assess this, a series of smears and air monitoring with high-volume filters, were obtained as part of the grouting procedure. In addition, smears on the top surface of the thrust block were obtained. Other data included taking a smear sample on the inside surface of the drill steel (inside the shroud), a smear sample on the outside surface of the inner shroud, a smear sample on the inside surface of the outer shroud. Other data included an extensive background for the local air for terbium tracer. Eleven individual backgrounds were obtained using the seven high-volume samplers located around the thrust block and during grouting there was a composite of the 6 high-volume filters taken for each day of grouting for comparison to the background. Finally, what little grout returns came to the surface were evaluated for the presence of total organic compounds and the terbium tracer as a stand-in for plutonium. There were several events that could have adversely affected the contamination control data (meaning terbium above background appearing on the top surface of the thrust block or in the air samplers). These events included a spill of neat grout as the twisted-off plastic sleeve filled with grout in the drill stem that was not drained and several minor drips of the same grout that occurred due to poor draining of the drill steel prior to the “bag-out” procedure.

What follows is a discussion of the results of the contamination control data.

Results of Thrust Block and Drill String Smears

Table I below summarizes the ICP-MS evaluation of smears taken before, during and after grouting. The smears were standard 100 cm^2 swipes of surfaces using a standard fiber smear material. Smears were taken on the top surface of the thrust block, the outside surface of the drill string, the outside surface of the drill string shroud, the outside surface of the inner shroud, and the inside surface of the inner shroud. When a value of the smear is expressed as less than 11.8 ng/smear it means the reading is at the detection limit for that run based on the use of known tracers in the ICP-MS system. Examination of Table I shows that the smears taken before grouting on most surfaces showed a ICP-MS reading of “less than 11.8 ng/smear except for one smear that had 16.3 ng/smear on the north edge of the thrust block. Either this was a residual particle of terbium from the pit construction process or a statistical representation of a

Table I. Summary of ICP-MS evaluation of smears.

Location of Smear (100 cm^2)	Terbium Concentration (ng/smear)
Thrust block background-north edge	16.3
Thrust block background-center	Less than 11.8
Thrust block background-south edge	Less than 11.8
Drill String Background no 1-entire surface	Less than 11.8
Drill String Background no2-entire surface	Less than 11.8
Drill String Background no 3-entire surface	Less than 11.8
Drill String Shroud Background –Shroud 1	Less than 11.8
Drill String Shroud Background-Shroud 2	Less than 11.8
Drill String Shroud Background-Shroud 3	Less than 11.8
Above Shroud Grease Fitting no 1	Less than 11.8
Above Shroud Grease Fitting no 2	Less than 11.8
Above Shroud Grease Fitting no3	Less than 11.8 plus dup at less than 11.8
On Top Surface of Thrust Block Hole#1	Less than 11.8
On Top Surface of Thrust Block Hole#3 (near spill)	21.5
On Top Surface of Thrust Block Hole#4	35.2
On Top Surface of Thrust Block Hole#7	Less than 11.8
On Top Surface of Thrust Block Hole#10	14.2
Inside Surface Outer Shroud (Shroud no 1-shroud used for holes 1-12)	Less than 11.8
Outside Surface Inner Shroud (Shroud no 1)	Less than 11.8
Inside Surface Inner Shroud (Shroud no 1)	21.8
Collected above Shroud no 1 Grease Fitting –contained grease	Less than 11.8
Collected above Shroud no 1 Grease Fitting-second sample	Less than 11. 8
Top of Used Drill String no 1 first sample	Less than 11.8
Top of Used Drill String no 1 duplicate of first sample	32.2
Top of Used Drill String no 1 second sample	Less than 11.8
Middle of Drill String no 1 first sample	Less than 11.8
Middle of Drill String no 1 second sample	28.0
Bottom of Drill String no 1 first sample	Less than 11.8
Bottom of Drill String no 1 second sample	Less than 11.8
Bottom of Drill String no 1 third sample	12.2
Water Sample from cleanout of first days operation	0.88 ng/ml

real background. At this point, it is assumed to be the upper limit of background smears taken prior to grouting. In general, the number is “no higher than 11.8 ng/g.

The smear taken after grouting hole number 1 showed a similar terbium concentration as the background as expected. This was expected in that the glove sleeves on the drill string and drill string shroud were designed to contain the movement of any tracer. In general, however, after the plastic bag (formed by the twist-off of the plastic thrust block sleeves) filled with grout and fell onto the top surface of the thrust block, the smears taken on the top of the thrust block were elevated in terbium reading relative to the background. The readings for these post spill thrust block smears varied between 14.2 to 35 ng/smear compared to the background values of “less than 11.8 ng/smear.” The spilled material was primarily neat grout; however, material on the outside surface of the thrust block was potentially contained terbium tracer due to the fact that the drill string was driven into the simulated waste containers and could have been immersed in neat grout held back by the bag.

Likewise, some of the smears taken on the drill string when drill string shroud no 1 was destructively examined show elevated values (12.2-32.2 ng/smear) as expected since the drill string was driven repeatedly through the simulated waste containing the terbium tracer. However, half of the readings on the used drill string were at background type levels indicating that the drill string wiper material was partially effective in wiping off the "soilcrete" mud-like material on the outside surface of the drill string.

Smears were taken before and after grouting on the surfaces above the grease seal at the top of the shroud and it was found that even though grease was present after use on this top surface, the after grouting ICP-m^3 terbium reading was at the background type reading. This is important in that it means the grease seal was working to contain the spread of terbium tracer around the rotating drill string.

It appears that even though the shroud basically separated at the top and was worn through the inner shroud as the drilling proceeded (due to rubbing of the inside surface of the inner shroud on the drill string), the smears taken on the inside surface of the outer shroud and the outside surface of the inner shroud showed only background type readings. However, when examining the inside surface of the inner shroud, the ICP-MS values of the smear was elevated (21.8 ng/smear) relative to background as expected.

In summary, evaluation of the smears show that the shroud/thrust block contamination control system appears to work as designed as long as fluid in the drill string can be drained to disallow filling of the bag formed by twisting off the plastic sleeve with grout. In addition, even though the inner shroud was worn by rubbing on the drill steel, there was not a spread of contaminants outside the shroud and the in depth contamination control strategy afforded by the thrust block/drill string shroud system worked as planned.

Results of Contaminant Spread to the Thrust Block HEPA Filter

The HEPA filtration system for the thrust block was dismantled and samples of the filter were processed for ICP-MS evaluation for terbium tracer. Table II shows the results of this evaluation. This data set is inconclusive in that there is no established background sample for the ICP-MS run; however, the data are presented as a reference for future reference for any follow-on work involving in situ grouting contamination control studies. It is noted that there is a large variation in the HEPA pre filtration in that the third sample shows a factor of almost 5 in terbium concentration over the first sample. This indicates that most likely terbium tracer had advanced from under the thrust block to the prefilter of the HEPA filtration system. Also, since the three evaluations of the HEPA system are essentially identical, it is most likely that no tracer advanced past the pre filter material. Even thought the HEPA values are elevated above the pre filter values, this represents a variation in the ICP-MS process for digesting the filter materials in that the prefilter is of different material from the HEPA filter.

Table II. ICP-MS evaluation of thrust block HEPA filtration system.

Location in Thrust Block HEPA System	Terbium Concentration (micro g/g)
HEPA prefilter no 1	0.017
HEPA prefilter no 2	0.038
HEPA prefilter no 3	0.063
HEPA filter no 1	0.177
HEPA filter no 2	0.175
HEPA filter no 3	0.174

Results of Air Monitoring

During the grouting operation, air samples were taken using seven strategically located samplers around the grouting area. The filters used in these high-volume air samplers were composted and evaluated for terbium tracer using ICP-MS as one sample. The results were expressed as ng/g of filter per average cu. ft. of air that passed through the seven high-volume samplers. Table III presents the results of the ICP-MS evaluation for samples taken during grouting (one set of seven per day) along with 14 background air samples. The average or mean background reading of terbium concentration per air volume for the 14 backgrounds was 0.026 ng/g/cu. ft. of air with an average deviation from that mean of 0.059 ng/g/cu. ft. of air. This means that the reading during grouting was between 0.015 to 0.0378 ng/g/ cu. ft. then there is a 2-sigma or 95% confidence that the reading is at background levels. If the reading during grouting was between 0.02 to 0.032 ng/g/cu. ft. of air than there is a one-sigma or 67% confidence that the reading is at background.

Examining Table III on day 1 and day 2 of grouting (0.015 and 0.012, respectively), there is a 95% confidence that the air monitoring at background levels meaning no spread of contaminants. This is significant in that there was a definite spill of potentially terbium contaminated material on the top of the thrust block during these two days of testing that could have dried and been aerosolized by the continual personnel travel on the top surface of the thrust block. For day 3 (there was no grouting that day only set-up leading to the accident), the air monitoring reading was 0.021 ng/g/ cu. ft., which is below the mean value of 0.026 ng/g/cu. ft. The day three value however is only within one sigma or 67% confidence that the reading is at background. It is noted that the drill string No. 1 shroud was mechanically disassembled exposing the drill string to the inside the weather structure at the end of the day 2 grouting and this was a possible source of a higher reading than for day 1 and 2 during which there was continual personnel traffic inside the weather structure and on the top of the thrust block that was not seen on day 3.

Results of Contamination in the Grout Returns under the Thrust Block

Post grouting grab samples of returned grout material in the vicinity of select grout holes where obtained, analyzed by ICP-MS for terbium tracer and compared to a similar analysis for soil samples and a neat grout sample. Showing the terbium tracer content in the grout return samples under the thrust block reflects on the expected amount of contamination that might be expected during a hot operation. Table IV shows the results of ICP-MS analysis for the common soil samples, neat grout samples and the grout return samples for holes numbered 5,6,7,9,10,11,and 12. These holes displayed some visual evidence of grout returns using the remotely controlled camera and therefore were targeted for analysis.

The surface soil samples and neat grout samples were averaged to obtain a background of 0.687 microgram Tb per gram of sample (with an average deviation from the mean of 0.013 microgram/g). Table IV shows that for holes 5,6,7,9,and 10, the readings for the grout return samples were at background meaning no release of the terbium tracer, which is located in each container except the nitrate salt drums. However, the measurement of the terbium content for hole 12 showed elevated levels (levels beyond the average background and average deviation from the average). It is noted that for hole 12 there was a small 6” cone of “viscous” returns came to the surface meaning that a simulated waste drum containing the Tb tracer had been penetrated. Grout returns showing terbium tracer were expected for all holes except the holes directly over the nitrate salts. Grout returns with terbium tracer was anticipated for those holes over an organic sludge drum (there was maximum terbium tracer and essentially zero voids in the organic sludge material). During a destructive examination of the grouted and cured pit, the resulting monolith was exhumed and drums containing terbium tracer were observed to have been penetrated by the drill string and filled with grout as shown on Fig. 4. The drum shown on Fig. 4 was a drum containing combustible material and originally had 100 g of terbium oxide tracer in a fine flour form (nominally 3 microns in size).

Table III. Results of air monitoring for terbium tracer.

Sample Collection Period	Average Total Air Flow (ft3)-Average of Seven High-Volume Filters	Terbium Concentration in the Composite Filters (Ng)	Terbium Concentration Weighted by the Air Flow (ng/g-ft3)
Background Run No. 1-9/13/01	6539	176.4	0.027
Background Run No. 2-9/13/01	6827	172.2	0.025
Background Run No. 3-9/18/01	6970	137.9	0.019
Background Run No. 4-9/18/01	6366	172.7	0.027
Background Run No. 5-9/19/01	7113	137.2	0.019
Background Run No. 5dup-9/19/01	7113	181.4	0.025
Background Run No. 6-9/24/01	7865	197.3	0.025
Background Run No. 7-9/24/01	6712	86.3	0.012
Background Run No. 8-9/25/01	9071	132.2	0.014
Background Run No. 9-9/25/01	6521	188	0.028
Background Run No. 10-9/26/01	9885	194.3	0.019
Background Run No. 11-9/26/01	5407	183.4	0.039
Background Run No. 12-9/27/01	7828	170.0	0.022
Background Run No. 12dup-9/27/01	7828	164.7	0.021
Background Run No. 13-9/27/01	7346	192.6	0.026
Background Run No. 14-10/01/01	8709	170.5	0.019
Sampling First Day of Grouting 10/11/01	15,404	233.6	0.015
Sampling Second Day of Grouting 10/12/01	17820	218.0	0.012
Sampling Third Day of Grouting 10/15/01	8772	191.0	0.021

Table IV. ICP-MS analysis of soil and neat grout backgrounds compared to grout returns under the thrust block.

Sample Location	Terbium Concentration (Tb micro g/g)
Surface Soil in Weather Structure	0.660
Surface Soil in Weather Structure	0.719
Average Soil in Weather Structure (background)	0.689
Neat Grout Sample 1	0.693
Neat Grout Sample 2	0.676
Neat Grout Sample 3	0.690
Average Clean Soil/Grout Samples (Considered Background)	0.687+/-.013
Grout Return Hole 5 (West Side of Hole)	0.686
Grout Return Hole 5 (East Side of Hole)	0.619
Grout Return Hole 5 (SW side of Hole)	0.665
Grout Return Hole 6 (N side of Hole)	0.673
Grout Return Hole 6 (SW side of Hole)	0.665
Grout Return Hole 6 (E side of Hole)	0.696
Grout Return Hole 7 (E side of Hole)	0.660
Grout Return Hole 7 (S side of Hole)	0.706
Grout Return Hole 7 (W side of Hole)	0.668
Grout Return Hole 9 (N side of Hole)	0.702
Grout Return Hole 9 (E side of Hole)	0.649
Grout Return Hole 9 (SE side of Hole)	0.667
Grout Return Hole 10 (N side of Hole)	0.136
Grout Return Hole 10 (SW side of Hole)	0.554
Grout Return Hole 10 (E side of Hole)	0.696
Grout Return Hole 12 (N side of Hole)	0.688
Grout Return Hole 12 (SW side of Hole)	0.808
Grout Return Hole 12 (NW side of Hole)	0.731

Fig. 4. Grouted drum containing combustibles.

The conclusion reached in these data is that the grout returns have the terbium tracer and if more of the pit had been grouted, it is anticipated that more of the returns would have shown tracer. The fact that holes 5,6,7,9, and 10 show no tracer is mainly due to the fact that these first holes are more on the edge of the pit and further grouting would have shown movement of the tracer material to the surface in the form of grout returns.

Comparison of Cleanout Water Samples to Background Water Samples

Water used to clean the drill steel of grout material originated in a Rain for Rent container. Background water samples from this Rain for Rent system were evaluated for terbium tracer and a comparison was made to a single data point obtained during the grouting operation of a drill stem cleanout water. A single sample of the cleanout water was taken during the grouting operation and is reported on Table V as 0.00088 micro grams/g (0.88 ng/ml). When comparing the background water samples to this single data point it could be concluded that there was terbium tracer in the cleanout water. However, the extremely small numbers reported in this background and in the cleanout water sample stress the detection limit of the system and the conclusion is that "no terbium" is present in the cleanout water. To make definitive statements about terbium in the cleanout water would require a better statistic. During the Acid Pit Grouting Project (5), no contaminants were detected in the cleanout water and a similar procedure was followed.

Table V. Results of the ICP-MS evaluation of cleanout water samples.

Location of Sample	Terbium Concentration (micro g/g)
Rain for Rent Sample no 1	Less than 0.0002
Rain for Rent Sample no 2	Less than 0.0002
Rain for Rent Sample no 3	Less than 0.0002

Discussion of Contamination Control Results

Based on grouting 12 holes, it is concluded that the contamination control system worked as planned. Terbium tracer was found in those parts of the system within the glovebox of the thrust block/drill string shroud assemblies but not on parts of the system associated with manned entry. In addition, during a destructive examination of the grouted pit following curing, drums containing up to 100 g of terbium oxide tracer had been penetrated with the drill string and filled with grout suggesting that the tracer material was indeed available for travel up the drill string to positions below the thrust block. Even though there was terbium tracer under the thrust block, there was no terbium tracer spread to the high-volume air monitors, even though neat grout with potential terbium contamination was spilled onto the top surface of the thrust block (when the sack containing grout drippings fell off the drill string stinger). In fact, ICP-MS of smears taken on the top surface of the thrust block following cleanup of the spill showed terbium contamination. However, even with eventual extensive foot traffic and movement of the drill rig, there was no spread to the high-volume filters. The idea is that the grout locks the tracer material up in larger, less easily aerosolizable particles. It is speculated that if the bag had not dropped, there would only have been terbium tracer within the containment of the drill string shroud and under the negative pressure of the thrust block.

OTHER APPLICATIONS OF THE IN SITU GROUTING TECHNOLOGY

Even though the in situ grouting technology was developed for buried transuranic waste, the technology has in fact been applied in other buried waste scenarios. At the INEEL Acid Pit, which is a buried mixed waste contaminated soil site, a specialty grout was jet grouted to form a monolith. Cores of the monolith showed that the injected grout sequestered the main contaminant of concern enough to pass the Universal Treatment Standard for Mercury.

At the INEEL Subsurface Disposal Area along with the transuranic pits and trenches, there are also low-level waste pits and trenches and a series of soil vaults containing activated reactor parts and other low-level waste debris. Application of the in situ grouting technology to these low-level waste buried waste conditions for both subsidence control and sequestering of contaminants of concern (Sr-90, Cs-137, Tc-99, C-14, and H-3) is being considered along with the applications in the transuranic pits and trenches. In fact, the Record of Decision for Waste Area Group 7-13/14 (the INEEL Subsurface Disposal Area) will most likely recommend grouting for much of these buried low-level waste materials. Because of this, an early response to grouting a buried low-level waste site may happen prior to issuance of the Record of Decision, perhaps as early as Fiscal Year 2005.

The contamination control features demonstrated in this paper for transuranic waste applications also apply to this low-level waste material in that the contaminants tend to be locked into the slurry matrix of grout and grout mixed with soil. The main difference in application would be radiation control issues with penetrating radiation from beta and gamma emitters associated with the low-level waste. Most likely, for applications in low-level waste, a mobile, remotely controlled grout delivery system would replace the fixed thrust block concept. However, any mobilization of low-level waste materials is still expected to be controlled by the fact that material brought to the surface is locked in the slurry mix of grout and soil.

CONCLUSIONS

A contamination control strategy has been developed for application in jet-grouting buried transuranic waste sites. A series of 12 holes were jet grouted in a full-scale simulated buried transuranic waste pit and select contamination control data were taken to determine the spread of small particulate rare earth tracers located within containers in the pit. These data indicate that the elaborate glovebox/drill string shroud system works as designed in that there was no spread of contaminants beyond the confines of the glovebox system.

As expected, there was no terbium tracer spread to the high-volume air monitors even though neat grout with potential terbium contamination was spilled onto the top surface of the thrust block when the sack containing grout drippings fell off the drill string stinger. In fact, ICP-MS of smears taken on the top surface of the thrust block following the cleanup of the spill showed terbium contamination. However, even with eventual extensive foot traffic and movement of the drill rig, there was no spread to the high-volume filters. The conclusion is that the grout locks the tracer material up in larger less easily aerosolizable particles. It is also concluded that application of the jet grouting technology in low-level waste pits and trenches would exhibit similar contamination control features in that the contaminants are again expected to be immobilized by the slurry of grout into larger less aerosolizable particles during operations.

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