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A Quality Control Program for Waste Disposal Vault Closure

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TWENTY-FIRST ANNUAL NATIONAL ENERGY AND
ENVIRONMENTAL QUALITY DIVISION CONFERENCE

HAZARDOUS WASTE STORAGE
MANAGEMENT

A QUALITY CONTROL PROGRAM FOR WASTE
DISPOSAL VAULT CLOSURE

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ABSTRACT

This paper provides a review of the quality control program employed for closure of a radioactive waste disposal vault at Hanford Washington. The major elements of the program are discussed, as well as the testing results and lessons learned.

At the U.S. Department of Energy's Hanford Reservation, near Richland, Washington, a partially filled underground waste disposal vault required closure. The vault, approximately 15m wide, 10m deep, and 38m long, contained approximately 6000 cubic meters of solidified radioactive waste. During disposal operations, the facility was managed as a surface impoundment, which required that the vault only be filled to within 1 meter of the top. After the waste in the vault solidified, the vault was to be closed under landfill requirements. This required filling of all void space within the vault. A grout slurry, developed by the

U.S. Army Corps of Engineers (1) was used as the void-fill material. The grout slurry was pumped into the vault (2) through a series of risers in the vault roof that were specially designed for this purpose. These risers, 24 in all, were spaced approximately every 4 meters, in three rows 5 meters apart. The grout was required to flow up to 6 meters without segregating or setting up. Thus, the flow characteristics of the grout, as a function of time, were very important in both the mix design process and actual placement. Additionally, the grout could not shrink as it cured, as this would leave void space and allow future subsidence of the overburden. In order to minimize shrinkage, the grout was to be placed in four layers. By allowing the grout to cure before placing the next layer, any shrinkage could be compensated for by the succeeding layer.

An additional constraint was imposed by the grout vendor. Because the grout mix contained large amounts of clay, it would interfere with their normal operations. Residual grout left in the mixer would affect the quality of normal concrete. Therefore, all void-filling batching and placement activities were conducted at night. This allowed the plant to reduce mixer washing, there was less traffic on the road which improved delivery times, and more trucks (10) were available. Because of the distance between the batch plant and the point of placement, trucks were taking 45 minutes on each leg of the trip. Added traffic during the day time would have made the transit time unacceptable.

Table 1 details the design requirements for the grout.

Table 1. Void Fill Grout Design Requirements

Requirement	Method	Specification
Flow	ASTM C-939	15 - 18 sec
Compressive Strength	ASTM C-109	400 psi @ 28 Days
Bleed Water	GEL-37	Zero
Length Change	ASTM C-157	<0.1%

Prior to initiating closure activities, a Quality Control Program was needed to ensure that the materials, grout batch plant, and placement methods and procedures would produce a grout that met design requirements, and that placement and QC personnel were properly trained, equipped and prepared to support vault void filling operations.

A written quality control plan (3) was prepared and approved to guide the field operations. The plan detailed the following activities:

Safety
Pre-Placement Qualification
Equipment Demonstration
QC Inspector Requirements
Placement Quality Activities
Post Placement Activities
Records

Safety

Although no unique safety concerns were identified, personnel were briefed on the Batch Plant and Vault Operations. In addition, hazards associated with heavy equipment (noise, pinch points) were reviewed. Radiation exposures were detailed, and higher hazard areas were roped off and clearly posted.

Pre-Placement Qualifications

Pre-Placement QC activities were used to verify that appropriate materials were available and that the batch plant, transport, and placement operations and equipment would not negatively affect the quality of the void-fill grout. The pre-placement QC activities consisted of the following:

- Obtaining Certified Material Test Reports (CMTRs) for the cement, flyash, bentonite clay, and admixtures. The CMTRs must verify that the materials meet the specifications.
- Test sand for conformance with ASTM C404, Natural Sand Size No. 2. No material may be retained by a No. 8 Sieve. Verify that the sand is obtained from the Hanford Area.
- Obtain archive samples of each materia.
- Document National Ready Mix Concrete Association (NRMCA) Certification of batch plant vendor.
- Conduct a batch plant inspection to verify the batch plant equipment, materials handling practices, records, and personnel are adequate to support the project.

Equipment Demonstration

A small demonstration placement was used to test batching, transport, and placement equipment prior to actual void-fill material placement at the grout vault. Quality Control testing was used during the demonstration to verify

that the batch plant, transport, and placement equipment can be used to produce a consistent void-fill material meeting the required specifications. For this reason, all reasonable efforts were taken to ensure that the demonstration placement conditions replicate those anticipated for the vault placement (e.g., materials, transport time, placement equipment, and temperature). Table 2 identifies the QC tests that were conducted during the demonstration placement.

Table 2. Quality Control Testing During Demonstration Placement

QUALITY CONTROL TEST/ACTIVITY			PROCEDURE	ACCEPTANCE SPECIFICATION
	BATCH	PLACEMENT		
Unit Weight	3/Batch	3/Truck	GEL-11	TBD
Flow	3/Batch	3/Truck	GEL-12	15-18 sec.
Compressive Strength	3/Batch	3/Truck	GEL-05	400 psi at 28 day
Temperature	3/Batch	3/Truck	GEL-12	<90 C
Sand Suspension	3/Batch	3/Truck	N/A	N/A
Sand Moisture	2/Day	N/A	GEL-11	N/A

Quality Control Inspector Requirements

The QC plan spelled out the QC Inspector responsibilities, qualifications, and authority. The inspectors were responsible for all sampling, testing, and inspections. They were trained to written procedures and were required to demonstrate proficiency prior to conducting QC testing. This was documented during the equipment demonstration, at both the batch plant and field locations. Two lead inspectors were designated to approve or reject grout materials, and batches, and could specify additional testing requirements as necessary.

Placement Quality Control

Placement QC activities were used to ensure that (1) batch plant, transport, and placement activities are conducted appropriately; and (2) the delivered grout material is within the specified criteria. Testing and surveillance were conducted both at the batch plant and at the placement site. During placement, a quality control inspector was maintained at the batch plant at all times. Table 3 identifies the testing that was conducted at the batch plant during placement.

Table 3. Quality Control Testing During Void-Fill Placement

QUALITY CONTROL TEST/ACTIVITY			PROCEDURE	ACCEPTANCE SPECIFICATION
	BATCH	PLACEMENT		
Unit Weight	50 Yd ³	50 Yd ³	GEL-11	TBD
Flow	50 Yd ³	50 Yd ³	GEL-12	15-18 Sec.
Temperature	50 Yd ³	50 Yd ³	GEL-12	<90 F
Sand Suspension	50 Yd ³	50 Yd ³	N/A	N/A
Sand Moisture	2/Day ³	N/A	GEL-11	N/A
Bleed Water	N/A	50 Yd ³	GEL-XX	Zero
Shrinkage	N/A	50 Yd ³	GEL-21	<0.1%
Compressive Strength	N/A	50 Yd ³	GEL-05	400 psi at 28 Days

Post-Placement Activities

Post-placement QC activities consist of (1) completing the bleed water, length change, and compressive strength tests initiated during placement, and (2) preparing the final QC report. The laboratory tests were completed in accordance with the procedures identified in Table 3. The content of the final QC report was specified.

Records

Copies of all pertinent records were maintained in the project file in accordance with DOE Records Management Program. A copy of all records were included in the final QC report. These records included:

- Certified Material Test Reports for the void fill grout
- Documentation of the batch plant NRMCA certification
- Documentation of the batch plant inspection results
- Calibration records for batch plant and testing equipment
- Test data sheets and records
- Field notes recorded during batching and placement
- Training records for all QC inspections

Results

The results of the quality control tests are shown in tables 4, 5, 6, and 7 for each of the four placements.

It can be seen that some of the flow times were out of specifications. These batches were accepted as is, due to the difficulty in performing this test. During mixing, some of the clay was left in small lumps, which clogged the flow cone, resulting in the flow time appearing longer than acceptable. These grout loads were accepted, based on visual inspection of the grout in the pump hooper, and by observing the grout flowing inside the vault via remote camera.

For the October 10 placement, excessive shrinkage was experienced. These were accepted as is. The placement cured for eleven days before the next pour, thereby compensating for the shrinkage.

Lessons Learned

Dealing with a clay-rich grout caused some problems in the field, especially dealing with lumps of clay. The decision was made to strain all grout prior to testing to eliminate these lumps, but this was not representative of actual placement conditions.

More testing to develop better mixing and batching methods would probably reduce this problem. Some modifications to the batching sequence were tried, but standard concrete batching equipment is not the best for this type of grout. Few noticeable changes occurred due to changes in batching sequences, or mixing durations.

Table 4. October 05 Placement Test Results

Sample #	28 Day Compressive Strength	Expansion	Flow	Free Water
3	1020 psi ¹	0.02%	14.0 s ²	0
4	1080 psi	0.005%	18.5 s	0
5	1100 psi	0.10%	15.5 s	0
6	1150 psi	0.03%	17.0 s	0
7	840 psi	0.04%	13.8 s	0
8	750 psi	0.015%	14.5 s	0
9	1070 psi	0.14%	13.1 s	0
10	710 psi	0.05%	15.0 s	0
11	790 psi	0.00%	16.1 s	0

¹ pounds per square inch

² seconds

Table 5. October 10 Placement Test Results

Sample #	28 Day Compressive Strength	Expansion	Flow	Free Water
12	670 psi ¹	-0.995%	14.0 s ²	0
13	770 psi	-0.88%	17.4 s	0
14	1090 psi	-0.505%	15.0 s	0
15	810 psi	-1.03%	17.0 s	0
16	1260 psi	-1.01%	18.5 s	0
17	820 psi	-0.03%	15.2 s	0
18	850 psi	NT ³	15.0 s	0
19	795 psi	NT	19.5 s	0
20	680 psi	NT	16.6 s	0

¹ pounds per square inch² seconds³ no test - specimen broke during de-molding

Table 6. October 21 Placement Test Results

Sample #	28 Day Compressive Strength	Expansion	Flow	Free Water
21	960 psi ¹	0.23%	16.2 s ¹	0
22	590 psi	0.15%	24.3 s	0
23	620 psi	0.28%	16.0 s	0
24	650 psi	NT ³	13.5 s	0
25	750 psi	0.43%	15.8 s	0
26	760 psi	NT	15.8 s	0
27	660 psi	NT	13.5 s	0

¹ pounds per square inch² seconds³ no test - specimen broke during de-molding

Table 7. October 28 Placement Test Results

Sample #	28 Day Compressive Strength	Expansion	Flow	Free Water
28	800 psi ¹	0.05%	15.5 s ²	0
29	800 psi	0.08%	14.0 s	0

¹ pounds per square inch

² seconds

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