TECH MEMO

207C STABILIZATION RESULTS

FROM INITIAL PHASES OF TESTING

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1.0 INTRODUCTION

The purpose of this report is to summarize the results of 207C treatability studies to date, and to use this data to select the batches for the final phase of regulatory testing. Because of the schedule limitations and the limited sample of 207C sludge/water/crystals remaining, the data must be thoroughly evaluated and a decision quickly made.

Preliminary testing began in November 1991. The results of this testing, which involved testing mixes with lime/flyash/cement, showed that the mixes tested could meet TCLP requirements, reach relatively high UCS levels, and withstand the majority of wet/dry and freeze/thaw durability cycles (See Appendix A). Therefore, the focus of additional testing was to achieve better durability results.

The testing summarized in this report include the following mixes:

- Lime/cement/flyash
- Lime/cement/flyash + plastic fibers
- Lime/cement/flyash + sodium silicate
- Lime/cement/flyash + Latex 2000 system
- Lime/cement/flyash + HR-25
- Lime/cement/flyash + HR-4

It should be noted that the testing involved accelerated 48-hour cures, as well as accelerated freeze/thaw and wet/dry testing. Therefore, there is always the possibility that the results from the final phase, which will involve full testing, might differ due to the modifications employed.

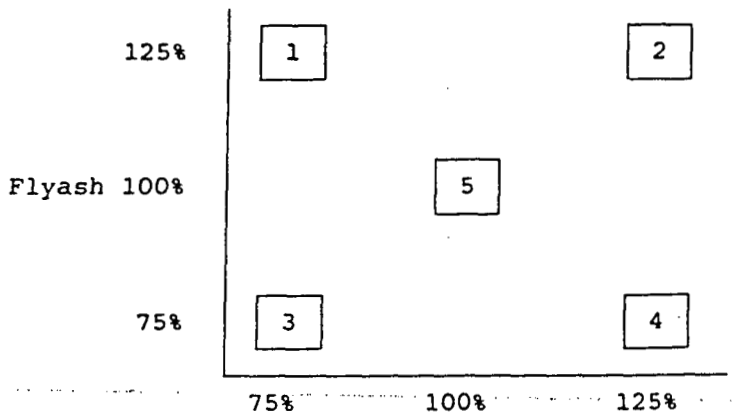
2.0 STABILIZATION OF POND 207C - LIME/CEMENT/FLYASH

2.1 PURPOSE

The purpose of this series of tests was to define baseline ratios of cement (Type V) and flyash (Type C) utilizing factorial experimentation (2x2) around a previously defined center point. This experiment is conceptually illustrated in Figure 2-1. Results from preliminary stabilization tests of Pond 207C indicate UCS and TCLP criteria can be met, therefore, the emphasis of this testing was increased durability (i.e. freeze/thaw and wet/dry). Also, this testing should provide a baseline ratio of cement/flyash to which additives can be incorporated to inhibit unfavorable phenomena which may occur (i.e. efflorescence, crystal growth).

FIGURE 2-1

FACTORIAL EXPERIMENT OF CEMENT/FLYASH RATIOS



2.2 PROCEDURE

Initially a sludge mixture was made using 5 parts pond water, 1 part crystal, and 1 part underlying sludge (by volume). This ratio of the "sludge mixture" was held constant for all 5 batches. The batches that were mixed are defined in Table 2-1 with Batch #5 being the previously defined center point.

Hydrated lime was used to achieve an initial pH of 11.5 to 12 for the sludge mixture. Following the pH adjustment, Type V cement and Type C "pawnee" flyash were added. The mixtures were wet mixed for 5 minutes.

Eight cylinders were made for each batch. After curing, products were tested for UCS using ASTM Method C39-86. TCLP extraction and metals analysis were also conducted on the accelerated cure cylinders. The freeze/thaw and wet/dry durability test procedures were modified to enable the testing to be completed prior to the start of the final phase. The control cylinder (i.e. volume and moisture loss specimen) was omitted, thus only one cylinder was submitted for each test. The dimension measurements and the weighing of the cylinders were also omitted. Brushing of the cylinders was as specified in the methods. The freeze/thaw procedure was accelerated by reducing the time of freezing from 24 hours/cycle to 12 hours/cycle. The wet/dry procedure was accelerated by decreasing the drying period from 42 hours to 19 hours and the time of submergence from 5 hours to 4 hours. Table 2-2 defines curing times and the cylinders required for each test.

TABLE 2-1

BATCHES FOR 207C STABILIZATION - LIME/CEMENT/FLYASH

	Sludge Mixture	Cement	Flyash
Batch 1	2000g	625g	2084g
Batch 2	2000g	1041g	2084g
Batch 3	2000g	625g	1250g
Batch 4	2000g	1041g	1250g
Batch 5	2000g	833g	1667g

TABLE 2-2

SUMMARY OF TESTING SCHEDULE
207C - LIME/CEMENT/FLYASH

Curing Time	UCS	TCLP (Metals)	Freeze/Thaw + UCS	Wet/Dry + UCS
48 hrs*	1	1	1	1
7-day	2	NA	NA	NA
14-day	1	NA	NA	NA
28-day	1	NA	NA	NA

* Accelerated Cure
NA: Not Analyzed

2.3 RESULTS

Table 2-3 summarizes the TCLP metals data for the 48-hour accelerated cure samples. All samples were below LDR and toxicity characteristic standards. It should be noted that lower pH in the TCLP extract (Batches 1 and 3) resulted in higher leachate values of cadmium and nickel, clearly showing the dependency on pH adjustment to pass the TCLP test.

Table 2-4 summarizes all available UCS data (28-day regular cure data are not yet available). As can be seen, all but Batch 3 (lowest flyash and cement dosages) achieved close to or greater than 600 psi after 7 days of regular curing, and all reached this level after 14 days. The maximum UCS that can be determined with the laboratory equipment is approximately 600 psi. All accelerated cures achieved >500 psi UCS.

Table 2-5 summarizes durability data from the freeze/thaw and wet/dry tests performed on the accelerated cure cylinders. The weight loss is approximate because the initial weight for the durability test cylinders was obtained from the one cylinder following 48-hour accelerated cure that was tested for UCS, not the actual durability test cylinders. It was assumed that all cylinders following the accelerated cure have approximately the same weight.

As expected, Batch 3, with the lowest concentrations of cement and flyash, showed the greatest weight loss and the lowest UCS following both durability tests. Batch 2, with the highest cement and flyash concentrations, performed the best. After the freeze/thaw cycling, Batch 1 showed a better UCS than Batch 4, possibly indicating that the total weight of pozzolans (cement + flyash) is an important factor in predicting performance.

TABLE 2-3

48-hr ACCELERATED CURE TCLP RESULTS (mg/L)
207C - LIME/CEMENT/FLYASH

ANALYTE	BATCH #1	BATCH #2	BATCH #3	BATCH #4	BATCH #5	TOXICITY CHARACTERISTIC STANDARD	NONWASTEWATER LDR STANDARD
Arsenic, Leachable (As)	0.123	0.176	0.193	0.160	0.293	5.0	---
Barium, Leachable (Ba)	0.663	0.664	0.667	0.562	0.421	100.0	---
Cadmium, Leachable (Cd)	0.0550	0.0290	0.0320	0.0190	0.0050	1.0	0.066
Chromium, Leachable (Cr)	0.519	0.592	0.575	0.576	0.203	5.0	5.2
Lead, Leachable (Pb)	<0.02	<0.02	<0.02	<0.02	<0.02	5.0	0.51
Mercury, Leachable (Hg)	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.2	---
Selenium, Leachable (Se)	<0.08	<0.08	<0.08	<0.08	<0.08	1.0	---
Silver, Leachable (Ag)	0.0190	0.0170	0.0180	0.0130	<0.003	5.0	0.072
Nickel, Leachable (Ni)	0.252	0.0310	0.137	<0.03	<0.03	---	0.32
pH after TCLP extraction	6.9	8.6	7.5	9.7	12.1	---	---

TABLE 2-4

UCS RESULTS (psi)
207C - LIME/CEMENT/FLYASH

Mix	48 Hr.*	7-Day	7-Day (Dup.)	14-Day	28-Day
Batch 1	>631	>637	>637	>637	
Batch 2	>631	>637	>637	>637	
Batch 3	>631	92.0	55.1	568	
Batch 4	578	>637	>637	>637	
Batch 5	>631	>637	>637	>637	

* Accelerated Cure
Dup. - Duplicate cylinder

TABLE 2-5

207C SLURRY WITH LIME/CEMENT/FLYASH
DURABILITY TEST RESULTS

		FREEZE/THAW		WET/DRY	
	UCS Before Durability Testing (psi)	% Wt. Loss	UCS After Durability Test (psi)	% Wt. Loss	UCS After Durability Test (psi)
Batch 1	>631	23	>637	24	>637
Batch 2	>631	19	>637	17	>637
Batch 3	>631	29	325	32	531
Batch 4	578	24	561	27	>637
Batch 5	>631	23	421	25	560

NOTE: All cylinders passed the required 12 cycles for the durability test unless otherwise noted.

All testing was performed on 48-hour accelerated cure samples.

% weight loss is approximated and is a combination of any moisture loss plus mass loss as a result of the brushing after each cycle.

3.0 STABILIZATION OF POND 207C - LIME/CEMENT/FLYASH + PLASTIC FIBERS

3.1 PURPOSE

The purpose of these tests is to analyze the effect of adding plastic fibers to the previously established mixtures of lime/cement/flyash. The same 2 by 2 factorial experiment utilized for lime/cement/flyash was incorporated for these mixtures. The plastic fibers should act as a reinforcing additive to help the mixtures during durability testing.

3.2 PROCEDURE

Initially, a sludge mixture was made using 5 parts pond water, 1 part crystal and 1 part underlying sludge (by volume). This ratio of the "sludge mixture" was held constant for all 5 batches. The batches that were mixed are defined in Table 3-1, with Batch #5 being the previously defined center point.

Hydrated lime was used to achieve an initial pH of 11.5 to 12 for the sludge mixture. Following the pH adjustment, Type V cement, Type C "comanche" flyash and plastic fibers were added. The mixture was wet mixed for 5 min.

Plastic fibers were added at approximately 0.025% of the total weight of the pozzolanic material in the mixture as specified by vendors literature.

Eight cylinders were made for each batch. After curing, products were tested for UCS using ASTM Methhod C39-86. TCLP extraction and metals analyses were also conducted on the accelerated cure cylinders. The freeze/thaw and wet/dry durability test procedures were modified to enable the testing to be completed prior to the start of the final phase. The control cyclinder (i.e., volume and moisture loss specimen) was omitted, thus only one cylinder was submitted for each test. The dimension measurements and the weighing of the cylinders was done as specified in the methods. The freeze/thaw procedure was accelerated by reducing the time of freezing from 24 hours/cycle to 12 hours/cycle. The wet/dry procedure was accelerated by decreasing the drying period from 42 hours to 19 hours and the time of submergence from 5 hours to 4 hours. Table 3-2 defines curing times and the cylinders required for each test.

TABLE 3-1

BATCHES FOR 207C STABILIZATION
LIME/CEMENT/FLYASH + PLASTIC FIBERS

	Sludge Mixture	Cement	Flyash	Plastic Fibers
Batch 1	2000g	625g	2084g	0.75g
Batch 2	2000g	1041g	2084g	0.87g
Batch 3	2000g	625g	1250g	0.52g
Batch 4	2000g	1041g	1250g	0.64g
Batch 5	2000g	833g	1667g	0.69g

TABLE 3-2

SUMMARY OF TESTING SCHEDULES
207C - LIME/CEMENT/FLYASH + PLASTIC FIBERS

Curing Time	UCS	TCLP (Metals)	Freeze/Thaw + UCS	Wet/Dry + UCS
48 hrs*	1	1	1	1
7-day	2	NA	NA	NA
14-day	1	NA	NA	NA
28-day	1	NA	NA	NA

* Accelerated Cure
NA: Not Analyzed

3.3 RESULTS

Table 3-3 summarizes the TCLP metals data for the 48-hour accelerated cure samples. All samples easily passed TCLP requirements for the LDRs and the characteristic of toxicity. It is noted that the pH of the TCLP extract was consistently greater than 10.

Table 3-4 summarizes all available UCS data (28-day regular cure data are not yet available). All cylinders achieved >600 psi with the exception of Batch 3, 7-day duplicate, and Batch 5, 14-day. Both of these results appear to be anomalous readings based on the other available data.

TABLE 3-3

48-hr CURE ACCELERATED TCLP RESULTS (mg/L)
207C - LIME/CEMENT/FLYASH + PLASTIC FIBERS

ANALYTE	BATCH #1	BATCH #2	BATCH #3	BATCH #4	BATCH #5	TOXICITY CHARACTERISTIC STANDARD	NONWASTEWATER LDR STANDARD
Arsenic, Leachable (As)	0.130	0.119	0.155	0.155	0.120	5.0	---
Barium, Leachable (Ba)	0.653	0.550	0.540	0.540	0.499	100.0	---
Cadmium, Leachable (Cd)	<0.005	<0.005	<0.005	<0.005	<0.005	1.0	0.066
Chromium, Leachable (Cr)	0.352	0.391	0.373	0.373	0.416	5.0	5.2
Lead, Leachable (Pb)	<0.02	<0.02	<0.02	<0.02	<0.02	5.0	0.51
Mercury, Leachable (Hg)	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.2	---
Selenium, Leachable (Se)	0.108	0.114	<0.08	<0.08	0.108	1.0	---
Silver, Leachable (Ag)	<0.003	<0.003	<0.003	<0.003	<0.003	5.0	0.072
Nickel, Leachable (Ni)	<0.03	<0.03	<0.03	<0.03	<0.03	---	0.32
pH after TCLP extrn.	10.1	10.2	10.4	10.4	10.5	---	---

TABLE 3-4

UCS RESULTS (psi)
207C - LIME/CEMENT/FLYASH + PLASTIC FIBERS

Mix	48 Hr.*	7-Day	7-Day (Dup.)	14-Day	28-Day
Batch 1	>631	>637	>637	>637	
Batch 2	>631	>637	>637	>637	
Batch 3	>631	>637	325	>637	
Batch 4	>631	>637	>637	>637	
Batch 5	>631	>637	>637	392	

* Accelerated Cure
Dup. - Duplicate

Table 3-5 summarizes durability data from the freeze/thaw and wet/dry tests performed on the accelerated cure cylinders. As with the straight lime/cement/flyash mixes, Batch 2 (highest cement and flyash concentratons) produced the best results. The results shown in Table 3-5 roughly parallel those in Table 2-5, which indicates no benefit for durability from the addition of plastic fibers.

TABLE 3-5

207C SLURRY WITH LIME/CEMENT/FLYASH/PLASTIC FIBERS
DURABILITY TEST RESULTS

		FREEZE/THAW		WET/DRY	
	UCS Before Durability Testing (psi)	% Wt. Loss	UCS After Durability Test (psi)	% Wt. Loss	UCS After Durability Test (psi)
Batch 1	>631	26	>637	25	>637
Batch 2	>631	20	>637	16	>637
Batch 3	>631	34	379	30	142
Batch 4	>631	27	220	23	565
Batch 5	>631	25	337	20	>637

NOTE: All cylinders passed the required 12 cycles for the durability test unless otherwise noted.

All testing was performed on 48-hour accelerated cure samples.

% weight loss is approximated and is a combination of any moisture loss plus mass lost as a result of the brushing after each cycle.

4.0 STABILIZATION OF POND 207C
LIME/CEMENT/FLYASH + SODIUM SILICATE

4.1 PURPOSE

The purpose of this series of tests is to analyze the effect of adding sodium silicate to the previously established mixtures of lime/cement/flyash utilizing factorial experimentation (3x2). This experiment is conceptually illustrated in Figure 4-1.

4.2 PROCEDURE

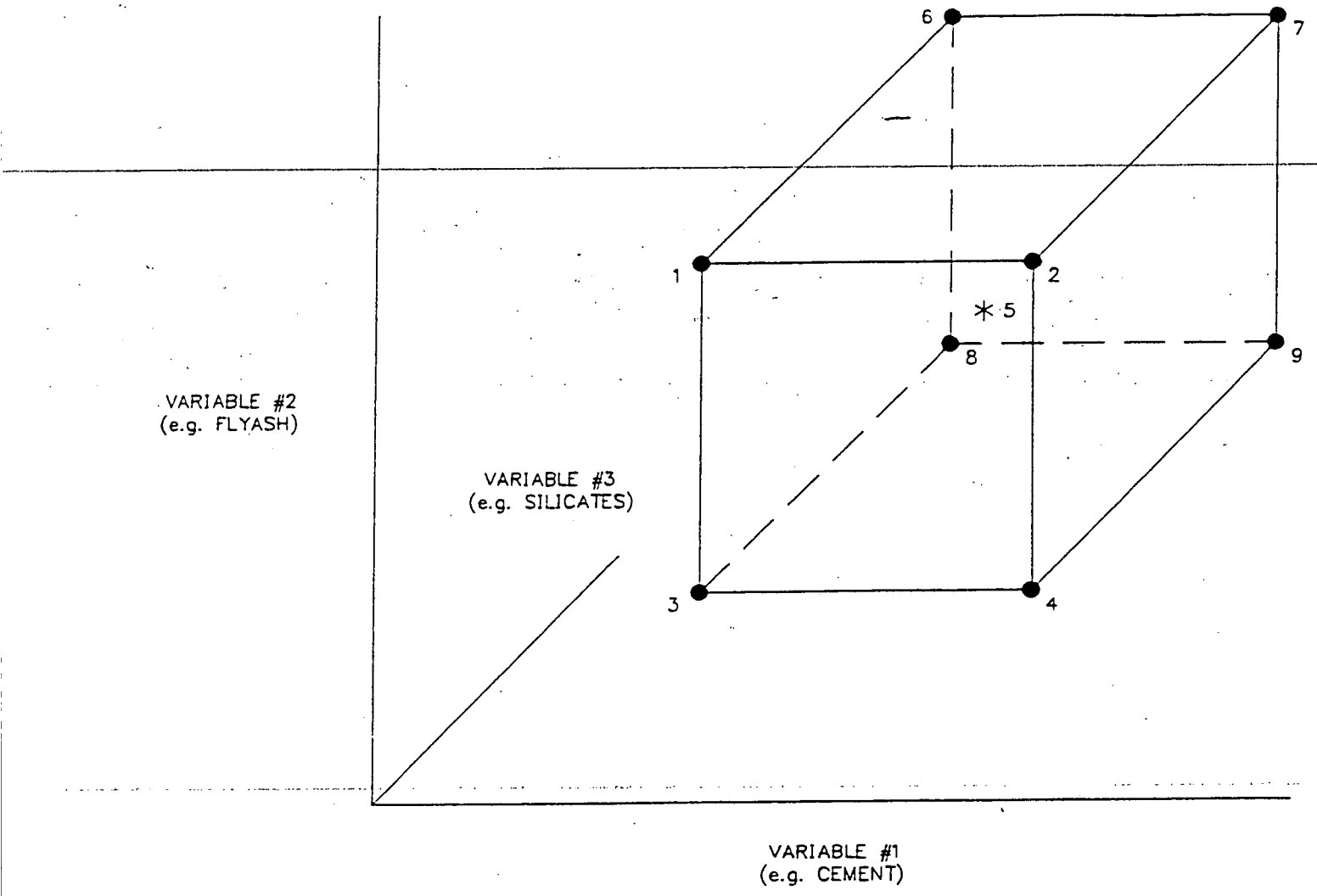
Initially a sludge mixture was made using 5 parts pond water, 1 part crystal, and 1 part underlying sludge (by volume). This ratio of the "sludge mixture" was held constant for all 9 batches. The batches that were mixed are defined in Table 4-1 with Batch #5 being the previously defined center point.

Hydrated lime was used to achieve a pH of 11.5 to 12 in the sludge mixture. Following the pH adjustment, Type V cement, Type C "pawnee" flyash, and sodium silicate were added. The mixture was wet mixed for 5 min.

The mixtures incorporated sodium silicate at 5% to 15% of the total weight of the pozzolanic material in the mixture.

Eight cylinders were made for each batch. After curing, cylinders were tested for UCS using ASTM Method C39-86. TCLP extraction and metals analysis were also conducted. The freeze/thaw and wet/dry durability test procedures were modified to enable the testing to be completed prior to the start of the final phase. The control cylinder (i.e., volume and moisture loss specimen) was omitted, thus only one cylinder was submitted for each test. The dimension measurements and the weighing of the cylinders was done as specified in the methods. The freeze/thaw procedure was accelerated by reducing the time of freezing from 24 hours/cycle to 12 hours/cycle. The wet/dry procedure was accelerated by decreasing the drying period from 42 hours to 19 hours and the time of submergence from 5 hours to 4 hours. Table 4-2 defines curing times and the cylinders required for each test.

FIGURE 4–1



LEGEND

* CENTER POINT CONCENTRATION

● CONCENTRATIONS ± %
AROUND CENTER POINT

TABLE 4-1

BATCHES FOR 207C STABILICATION
LIME/CEMENT/FLYASH + SODIUM SILICATE

	Sludge Mixture	Cement	Flyash	Sodium Silicate
Batch 1	2000g	625g	2084g	31.25g
Batch 2	2000g	1041g	2084g	52.05g
Batch 3	2000g	625g	1250g	31.25g
Batch 4	2000g	1041g	1250g	52.05g
Batch 5	2000g	833g	1667g	83.3g
Batch 6	2000g	625g	2084g	93.75g
Batch 7	2000g	1041g	2084g	156.15g
Batch 8	2000g	625g	1250g	93.75g
Batch 9	2000g	1041g	1250g	156.15g

TABLE 4-2

SUMMARY OF TESTING SCHEDULE 207C
LIME/CEMENT/FLYASH + SODIUM SILICATE

Curing Time	UCS	TCLP (Metals)	Freeze/Thaw + UCS	Wet/Dry + UCS
48 hrs*	1	1	1	1
7-day	2	NA	NA	NA
14-day	1	NA	NA	NA
28-day	1	NA	NA	NA

* Accelerated Cure
NA - Not Analyzed

4.3 RESULTS

Table 4-3 presents the TCLP data for the accelerated cure samples using lime/cement/flyash with sodium silicate. All batches passed both LDR standards and toxicity characteristic standards. The data show sensitivity to the pH of the TCLP extract, where the extract concentrations of certain metals (cadmium, nickel) approach their respective LDR standards when the pH drops below 8-9.

Table 4-4 summarizes available UCS data (28-day regular cure data are not available). The data clearly show a pattern of UCS strength directly related to the total amount of pozzolan added (Batches 2,7 > 1,6 >5 > 4,9 > 3,8). When batches of equal pozzolan addition are compared (for instance Batches 2 and 7), with the only variable being the amount of sodium silicate added, the results appear to be comparable. Therefore, the concentration of sodium silicate (5% to 15% of cement by weight) appears to have little effect on the UCS results. When these results are compared to those for straight lime/cement/flyash (see Tables 2-2 and 2-4), no advantage is shown by the addition of silicates at all concentrations, and some disadvantage is noticed on some of the accelerated cures.

Table 4-5 summarizes the durability test data. Only Batches 2 and 7, with the highest cement and flyash concentrations, passed both tests while maintaining their UCS. Comparison of the data on Table 4-5 seems to show a decrease in final UCS at the 15% silicate concentrations vs. the 5% concentrations. Comparison of data in Table 4-5 to data in Table 2-5 (straight lime/cement/flyash) clearly shows that the addition of silicates at all concentrations tested reduces the strength at the end of durability testing, as measured by UCS.

TABLE 4-3

48 hr ACCELERATED CURE TCLP RESULTS (mg/L)
207C - LIME/CEMENT/FLYASH + SODIUM SILICATE

ANALYTE	BATCH #1	BATCH #2	BATCH #3	BATCH #4	BATCH #5	BATCH #6	BATCH #7	BATCH #8	BATCH #9	TOXICITY CHARACTER-ISTIC STANDARD	NONWASTE-WATER LDR STANDARD
Arsenic, Leachable (As)	0.285	0.141	0.150	0.179	0.249	0.160	0.163	0.186	0.155	5.0	---
Barium, Leachable (Ba)	0.381	0.610	0.722	0.524	0.437	0.648	0.695	0.799	0.630	100.0	---
Cadmium, Leachable (Cd)	0.0070	0.0300	0.0430	0.0210	0.0070	0.0420	0.0370	0.0450	0.0270	1.0	0.066
Chromium, Leachable (Cr)	0.198	0.626	0.616	0.626	0.271	0.605	0.648	0.622	0.648	5.0	5.2
Lead, Leachable (Pb)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	5.0	0.51
Mercury, Leachable (Hg)	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.2	---
Selenium, Leachable (Se)	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	1.0	---
Silver, Leachable (Ag)	0.0030	0.0190	0.0210	0.0140	0.0030	0.0210	0.0200	0.0200	0.0160	5.0	0.072
Nickel, Leachable (Ni)	<0.03	0.0860	0.270	0.0400	<0.03	0.293	0.200	0.264	0.0450	---	0.32
pH after TCLP extraction	11.9	8.0	7.1	9.7	12.1	7.1	7.6	7.2	8.8	---	---

TABLE 4-4

UCS RESULTS (psi)
207C - LIME/CEMENT/FLYASH + SODIUM SILICATE

Mix	48 Hr.*	7-Day	7-Day (Dup.)	14-Day	28-Day
Batch 1	612	>637	236	>637	
Batch 2	>631	>637	>637	>637	
Batch 3	393	587	387	443	
Batch 4	412	>637	>637	>637	
Batch 5	486	>637	>637	>637	
Batch 6	448	>637	395	>637	
Batch 7	>625	>637	>637	>637	
Batch 8	278	197	344	623	
Batch 9	310	505	539	>637	

* Accelerated Cure
Dup. - Duplicate

TABLE 4-5

207C SLURRY WITH LIME/CEMENT/FLYASH/SILICATE
DURABILITY TEST RESULTS

	UCS Before Durability Testing (psi)	FREEZE/THAW		WET/DRY	
		% Wt. Loss	UCS After Durability Test (psi)	% Wt. Loss	UCS After Durability Test (psi)
Batch 1	612	25	160	24	>637
Batch 2	>631	20	>637	21	>637
Batch 3	393	33	275	37	73
Batch 4	412	25	457	27	405
Batch 5	486	26	258	27	613
Batch 6	448	25	347	26	361
Batch 7	>625	24	>637	22	>637
Batch 8	278	41	115	--	Failed in cycle
Batch 9	310	28	350	31	241

NOTE: All cylinders passed the required 12 cycles for the durability test unless otherwise noted.

All testing was performed on 48-hour accelerated cure samples.

% weight loss is approximated and is a combination of any moisture loss plus mass lost as a result of the brushing after each cycle.

5.0 STABILIZATION OF POND 207C
LIME/CEMENT/FLYASH + LATEX 2000 SYSTEM

5.1 INITIAL MIXES

5.1.1 Purpose

The purpose of this series of tests is to analyze the effect of adding the Latex 2000 system to the previously established mixtures of lime/cement/flyash, further utilizing factorial experimentation (3x2). This experiment is conceptually illustrated in Figure 5-1. The Latex 2000 system uses Latex 2000, Stabilizer 434B, and D-AIR 3 to encapsulate the cement matrix. The addition of these latex and surfactant additives should provide additional durability to the cylinders.

5.1.2 Procedure

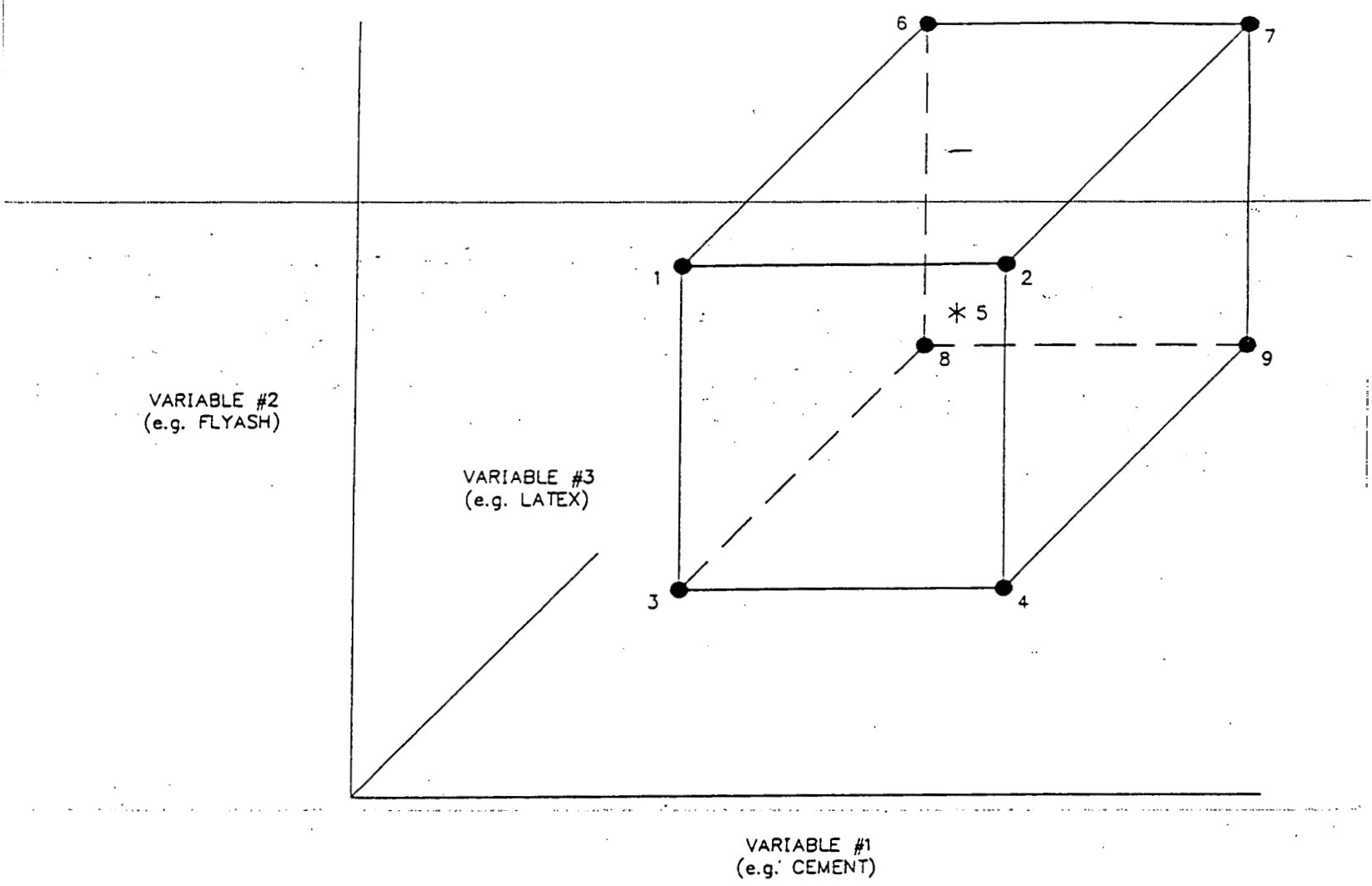
Initially a sludge mixture was made using 5 parts pond water, 1 part crystal, and 1 part underlying sludge (by volume). This ratio of the "sludge mixture" was held constant for all 9 batches. The batches that were mixed are defined in Table 5-1 with Batch #5 being the previously defined center point.

Hydrated lime was used to achieve a pH of 11.5 to 12 in the sludge mixture. After the pH adjustment, the Latex 2000 system was added in the following order: D-AIR 3, Stabilizer 434B, and Latex 2000. Next the Type V cement and Type C "comanche" flyash was added. The mixture was wet mixed for 5 min.

The mixtures incorporated the Latex 2000 at 5% to 15% by weight of the cement in the mixture. Stabilizer 434B was added at 15%, and D-AIR 3 at 4%, of the Latex 2000.

Eight cylinders were made for each batch. After curing, products were tested for UCS using ASTM Method C39-86. TCLP extraction and metals analysis were also conducted. The freeze/thaw and wet/dry durability test procedures were modified to enable the testing to be completed prior to the start of the final phase. The control cylinder (i.e., volume and moisture loss specimen) was omitted, thus only one cylinder was submitted for each test. The dimension measurements and the weighing of the cylinders were also omitted. Brushing of the cylinders was done as specified int he methods. The freeze/thaw procedure was accelerated by reducing the time of freezing from 25 hours/cycle to 12 hours/cycle. The wet/dry procedure was accelerated by decreasing the drying period from 42 hours to 19 hours and the time of submergence from 5 hours to 4 hours.

FIGURE 5–1



LEGEND

* CENTER POINT CONCENTRATION

● CONCENTRATIONS ± %
AROUND CENTER POINT —

TABLE 5-1

BATCHES FOR 207C STABILIZATION
LIME/CEMENT/FLY ASH + LATEX 2000 SYSTEM

	Sludge Mixture	Cement	Flyash	Latex 2000	Stabilizer 434B	D-Air 3
Batch 1	2000g	625g	2084g	32.00g	5.00g	1.00g
Batch 2	2000g	1041g	2084g	52.00g	8.00g	2.00g
Batch 3	2000g	625g	1250g	32.00g	5.00g	1.00g
Batch 4	2000g	1041g	1250g	52.00g	8.00g	2.00g
Batch 5	2000g	833g	1667g	83.00g	13.00g	3.70g
Batch 6	2000g	625g	2084g	94.00g	15.00g	4.20g
Batch 7	2000g	1041g	2084g	156.00g	25.00g	7.00g
Batch 8	2000g	625g	1250g	94.00g	15.00g	4.20g
Batch 9	2000g	1041g	1250g	156.00g	25.00g	7.00g

TABLE 5-2

SUMMARY OF TESTING SCHEDULE
207C - LIME/CEMENT/FLYASH + LATEX 2000 SYSTEM

Curing Time	UCS	TCLP (Metals)	Freeze/Thaw + UCS	Wet/Dry + UCS
48 hrs*	1	1	1	1
7-day	2	NA	NA	NA
14-day	1	NA	NA	NA
28-day	1	NA	NA	NA

*Accelerated Cure

Table 5-2 defines curing times and the cylinders required for each test.

5.1.3 Results

Table 5-3 summarizes the TCLP metals data for the 48-hour accelerated cure samples. All samples passed TCLP requirements for the LDRs and the characteristic of toxicity.

Table 5-4 summarizes all available UCS data (28-day regular cure data are not yet available. The data suggests a slight deterioration of UCS at 15% latex vs. 5% latex, when comparing Batches 8 and 9 to Batches 3 and 4. When data on Table 5-4 are compared to Table 2-4, to evaluate the mixes with and without the Latex 2000 system, no clear conclusions can be drawn. It appears that the addition of Latex 2000 helped Batch 3, but hurt Batches 5 and 9.

Table 5-5 summarizes the durability test data. Only Batch 2 retained its original UCS after freeze/thaw testing. The high flyash batches (1, 2, 6 and 7) plus Batch 4 retained their UCS after wet/dry testing. When data on table 5-5 are compared to Table 2-5, more than half the test cylinders showed decreased UCS values after testing. This effect was more pronounced after the freeze/thaw testing.

TABLE 5-3

48 hr ACCELERATED CURE TCLP RESULTS (mg/L)
207C - LIME/CEMENT/FLYASH + LATEX 2000 SYSTEM

ANALYTE	BATCH #1	BATCH #2	BATCH #3	BATCH #4	BATCH #5	BATCH #6	BATCH #7	BATCH #8	BATCH #9	TOXICITY CHARACTER -ISTIC STANDARD	NONWASTE -WATER LDR STANDARD
Arsenic, Leachable (As)	0.118	0.0860	0.149	0.139	0.111	0.159	0.149	0.117	0.125	5.0	---
Barium, Leachable (Ba)	0.663	0.461	0.432	0.411	0.486	0.698	0.465	0.603	0.426	100.0	---
Cadmium, Leachable (Cd)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	1.0	0.066
Chromium, Leachable (Cr)	0.417	0.424	0.480	0.478	0.434	0.425	0.438	0.441	0.470	5.0	5.2
Lead, Leachable (Pb)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	5.0	0.51
Mercury, Leachable (Hg)	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.2	---
Selenium, Leachable (Se)	<0.08	<0.08	<0.08	<0.08	<0.08	0.165	0.104	0.0900	<0.08	1.0	---
Silver, Leachable (Ag)	<0.003	<0.003	<0.003	0.0040	<0.003	<0.003	<0.003	<0.003	<0.003	5.0	0.072
Nickel, Leachable (Ni)	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	---	0.32
pH after TCLP extraction	9.9	9.8	10.4	10.7	9.9	9.6	10.3	9.9	11.0	---	---

TABLE 5-5

207C SLURRY WITH LIME/CEMENT/FLYASH/LATEX 2000 SYSTEM
DURABILITY TEST RESULTS

	UCS Before Durability Testing (psi)	FREEZE/THAW		WET/DRY	
		% Wt. Loss	UCS After Durability Test (psi)	% Wt. Loss	UCS After Durability Test (psi)
Batch 1	>625	26	421	21	>637
Batch 2	>630	20	>637	15	>637
Batch 3	568	23	112	33	416
Batch 4	>631	29	295	20	>637
Batch 5	>625	37	160	21	252
Batch 6	>625	25	508	18	>637
Batch 7	>631	23	152	14	>637
Batch 8	503	39	117	25	593
Batch 9	>625	32	261	20	535

NOTE: All cylinders passed the required 12 cycles for the durability test unless otherwise noted.

All testing was performed on 48-hour accelerated cure samples.

% weight loss is approximated and is a combination of any moisture loss plus mass lost as a result of the brushing after each cycle.

5.2 SUPPLEMENTAL MIXES

5.2.1 Purpose

Additional mixes were prepared to expand the range of the Latex 2000 system used in the factorial experiments.

5.2.2 Procedure

Initially, a sludge mixture was made using 5 parts pond water, 1 part crystal and 1 part underlying sludge (by volume). This ratio of the "sludge mixture" was held constant for both batches. The batches that were mixed are defined in Table 5-6.

Hydrated lime was used to achieve a pH of 11.5 to 12 in the sludge mixture. After the pH adjustment, the Latex 2000 system was added in the following order: D-AIR 3, Stabilizer 434B, and Latex 2000. Next, the Type V cement and Type C "pawnee" flyash were added. The mixture was wet mixed for 5 min.

The mixtures incorporate the Latex 2000 at 50% and 100% by weight of the cement in the mixture. Stabilizer 434B was added at 15%, and D-AIR 3 at 4%, of the Latex 2000.

Three cylinders were made for each batch. After accelerated curing, specimens were tested for UCS using ASTM Method C39-86. The freeze/thaw and wet/dry durability test procedures were modified to enable the testing to be completed prior to the start of the final phase. The control cylinder (i.e., volume and moisture loss specimen) was omitted, thus only one cylinder was submitted for each test. The dimension measurements and the weighing of the cylinders were also omitted. Brushing of the cylinders was done as specified in the methods. The freeze/thaw procedure was accelerated by reducing the time of freezing from 24 hours/cycle to 12 hours/cycle. The wet/dry procedure was accelerated by decreasing the drying period from 42 hours to 19 hours and the time of submergence from 5 hours to 4 hours. Table 5-7 defines curing times and the cylinders required for each test.

5.2.3 Results

Neither of the supplemental batches solidified. The obvious conclusion is that the high dosages of Latex 2000 System used retarded the cement.

TABLE 5-6

SUPPLEMENTAL BATCHES FOR STABILIZATION
LIME/CEMENT/FLYASH + LATEX 2000 SYSTEM

	Sludge Mixture	Cement	Flyash	Latex 2000	Stabilizer 434B	D-Air 3
Batch 1	800g	333g	667g	166g	26.00g	6.50g
Batch 2	800g	333g	667g	333g	52.00g	13.00

TABLE 5-7

SUPPLEMENTAL LATEX 2000 SYSTEM TESTING SCHEDULE

Curing Time	UCS	TCLP (Metals)	Freeze/Thaw + UCS	Wet/Dry + UCS
48 hrs*	1	NA	1	1
7-day	NA	NA	NA	NA
14-day	NA	NA	NA	NA
28-day	NA	NA	NA	NA

* Accelerated Cure
NA - Not Analyzed

6.0 STABILIZATION OF POND 207C LIME/CEMENT/FLYASH + HR-25

6.1 PURPOSE

The purpose of this series of tests is to analyze the effect of adding the HR-25 to the previously established mixtures of lime/cement/flyash, further utilizing factorial experimentation (3x2). This experiment is conceptually illustrated in Figure 6-1. HALLIBURTON SERVICE'S HR-25 is an additive for the control of efflorescence in salt solutions. HR-25 is also a cement retarder. The effect on strength, durability, and TCLP leachability of previously tested mixes was monitored.

6.2 PROCEDURE

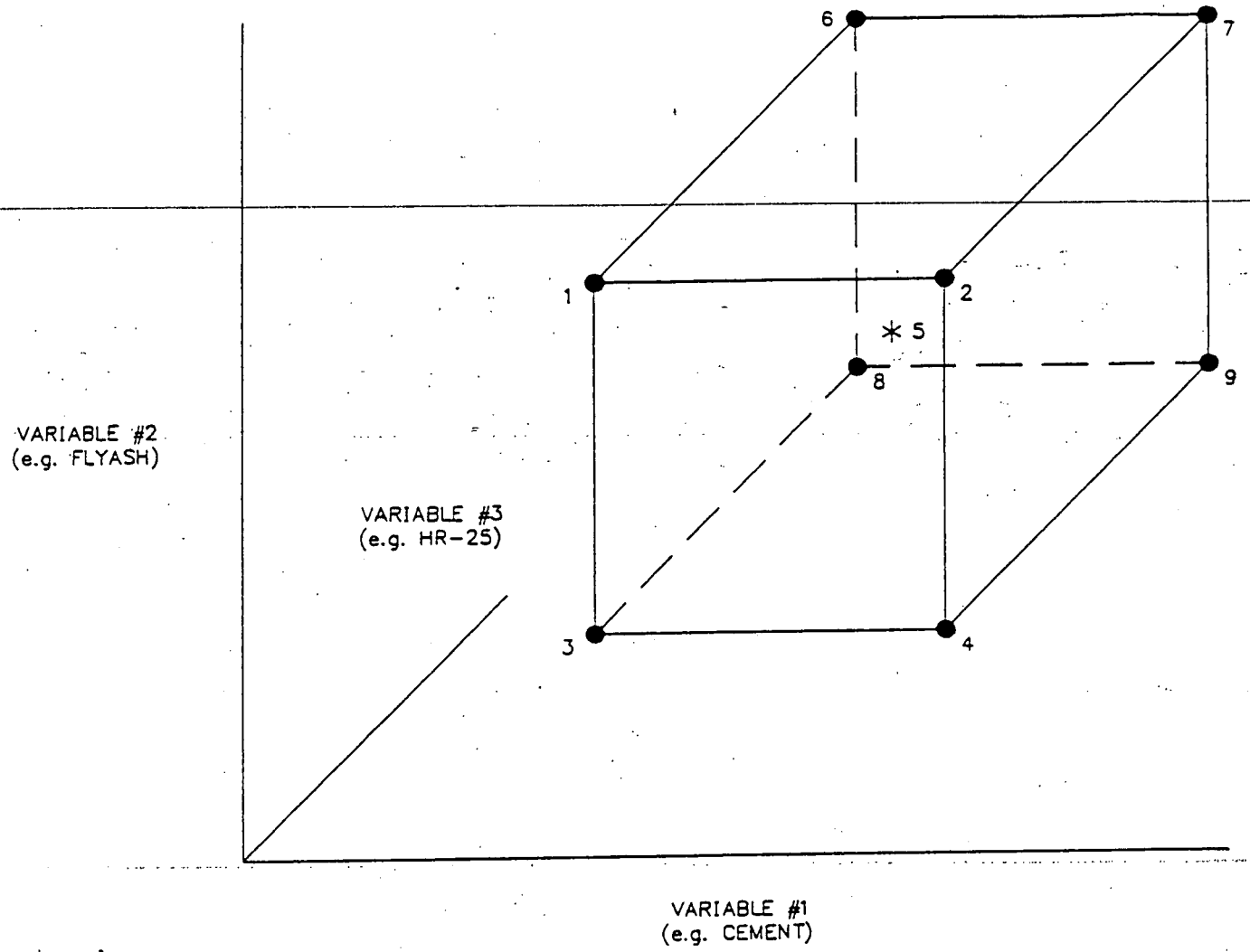
Initially, a sludge mixture was made using 5 parts pond water, 1 part crystal and 1 part underlying sludge (by volume). This ratio of the "sludge mixture" was held constant for all 9 batches. The batches that were mixed are defined in Table 6-1 with Batch #5 being the previously defined center point.

Hydrated lime was used to achieve a pH of 11.5 to 12 for the sludge mixture. After the pH adjustment, the HR-25, Type V cement and Type C "comanche" flyash was added. The mixture was wet mixed for 5 minutes.

The mixtures incorporated the HR-25 at a range of 20.00g to 40.00g.

Eight cylinders were made for each batch. After curing, cylinders were tested for UCS using ASTM Method C39-86. TCLP extraction and metals analysis were also conducted. The freeze\thaw and wet\dry durability test procedures were modified to enable some of the testing to be completed prior to the start of the final phase. The control cylinder (i.e., volume and moisture loss specimen) was omitted, thus only one cylinder was submitted for each test. The dimension measurements and the weighing of the cylinders were omitted. Brushing of the cylinders were done as specified in the methods. The freeze\thaw procedure was accelerated by reducing the time of freezing from 24 hours/cycle to 12 hours/cycle. The wet\dry procedure was accelerated by decreasing the drying period from 42 hours to 19 hours and the time of submergence from 5 hours to 4 hours. Using these accelerated methods, testing was completed in time to incorporate the results in the final phase. Table 6-2 defines curing times and the cylinders required for each test.

FIGURE 6-1



LEGEND

* CENTER POINT CONCENTRATION

● CONCENTRATIONS ± %
AROUND CENTER POINT

TABLE 6-1

BATCHES FOR 207C STABILIZATION
LIME/CEMENT/FLYASH + HR-25 ADDITIVE

	Sludge Mixture	Cement	Flyash	HR-25
Batch 1	2000g	625g	2084g	20.00g
Batch 2	2000g	1041g	2084g	20.00g
Batch 3	2000g	625g	1250g	20.00g
Batch 4	2000g	1041g	1250g	20.00g
Batch 5	2000g	833g	1667g	30.00g
Batch 6	2000g	625g	2084g	40.00g
Batch 7	2000g	1041g	2084g	40.00g
Batch 8	2000g	625g	1250g	40.00g
Batch 9	2000g	1041g	1250g	40.00g

NOTE: Batches 8 and 9 were omitted due to an insufficient amount of the sludge mixture.

TABLE 6-2

SUMMARY OF TESTING SCHEDULE
207C - LIME/CEMENT/FLYASH + HR-25

Curing Time	UCS	TCLP (Metals)	Freeze/Thaw + UCS	Wet/Dry + UCS
48 hrs*	1	1	1	1
7-day	2	NA	NA	NA
14-day	1	NA	NA	NA
28-day	1	NA	NA	NA

* Accelerated Cure
NA - Not analyzed

6.3 RESULTS

Only Batches 1 and 2 hardened after the 48-hour accelerated cure. Table 6-3 summarizes TCLP data for these two batches. Both failed LDR standards for cadmium and nickel, which would be expected based on the low pH o the TCLP extract.

Table 6-4 summrizes available UCS data (28-day cure data not yet available). Only Batches 1 and 2 hardened after the accelerated cure. These batches represented the lowest HR-25 concentrations but the highest flyash concentrations. Under normal cure conditons, only Batches 2 and 5 reached the maximum level on the machine. Batch 2 corresponds to the highest flyash and cement concentratins, but the lowest HR-25 concentration. Batch 5 is the center point comparison of data on Tble 6-4 with data on Table 2-4 shows the retarding effect of the HR-25.

None of the cylinders have failed through 11 cycles of the accelerated durability tests. Final weight loss and UCS data are not yet available.

TABLE 6-3

48 hr ACCELERATED CURE TCLP RESULTS (mg/L)
207C - LIME/CEMENT/FLYASH + HR-25

ANALYTE	BATCH #1	BATCH #2	TOXICITY CHARACTERISTIC STANDARD	NONWASTEWATER LDR STANDARD
Arsenic, Leachable (As)	<0.6	<0.6	5.0	---
Barium, Leachable (Ba)	2.65	2.00	100.0	---
Cadmium, Leachable (Cd)	0.160	0.390	1.0	0.066
Chromium, Leachable (Cr)	1.79	2.24	5.0	5.2
Lead, Leachable (Pb)	<0.2	0.260	5.0	0.51
Mercury, Leachable (Hg)	0.0018	<0.0008	0.2	---
Selenium, Leachable (Se)	<0.8	<0.8	1.0	---
Silver, Leachable (Ag)	<0.03	<0.03	5.0	0.072
Nickel, Leachable (Ni)	1.26	1.30	---	0.32
pH after TCLP extraction	5.0	5.2	---	---

NOTE: Only Batches 1 and 2 hardened after the 48-hour accelerated cure.

TABLE 6-4

UCS RESULTS (psi)
207C -LIME/CEMENT/FLYASH + HR-25

Mix	48 Hr.*	7-Day	7-Day (Dup.)	14-Day	28-Day
Batch 1	287	261	285	441	
Batch 2	>637	630	>637	>637	
Batch 3	TSTT	17	14	19	
Batch 4	TSTT	224	217	281	
Batch 5	TSTT	(1)	(1)	>637	
Batch 6	TSTT	10	(1)	(1)	
Batch 7	TSTT	58	20	64	
Batch 8	ND	ND	ND	ND	ND
Batch 9	ND	ND	ND	ND	ND

(1) Sample broke in half when removed from mold

* Accelerated Cure
TSTT - Too Soft To Test
ND - No data; batch not mixed
Dup. - Duplicate

7.0 STABILIZATION OF POND 207C LIME/CEMENT/FLYASH + HR-4

7.1 PURPOSE

The purpose of this series of tests is to analyze the effect of adding HR-4 to the previously established mixtures of lime/cement/flyash, further utilizing factorial experimentation (3x2). This experiment is conceptually illustrated in Figure 7-1. HALLIBURTON SERVICE'S HR-4 is an additive for the control of efflorescence in salt solutions. HR-4 is also a cement retarder. The effect on strength, durability and TCLP leachability of previously tested mixes was monitored.

7.2 PROCEDURE

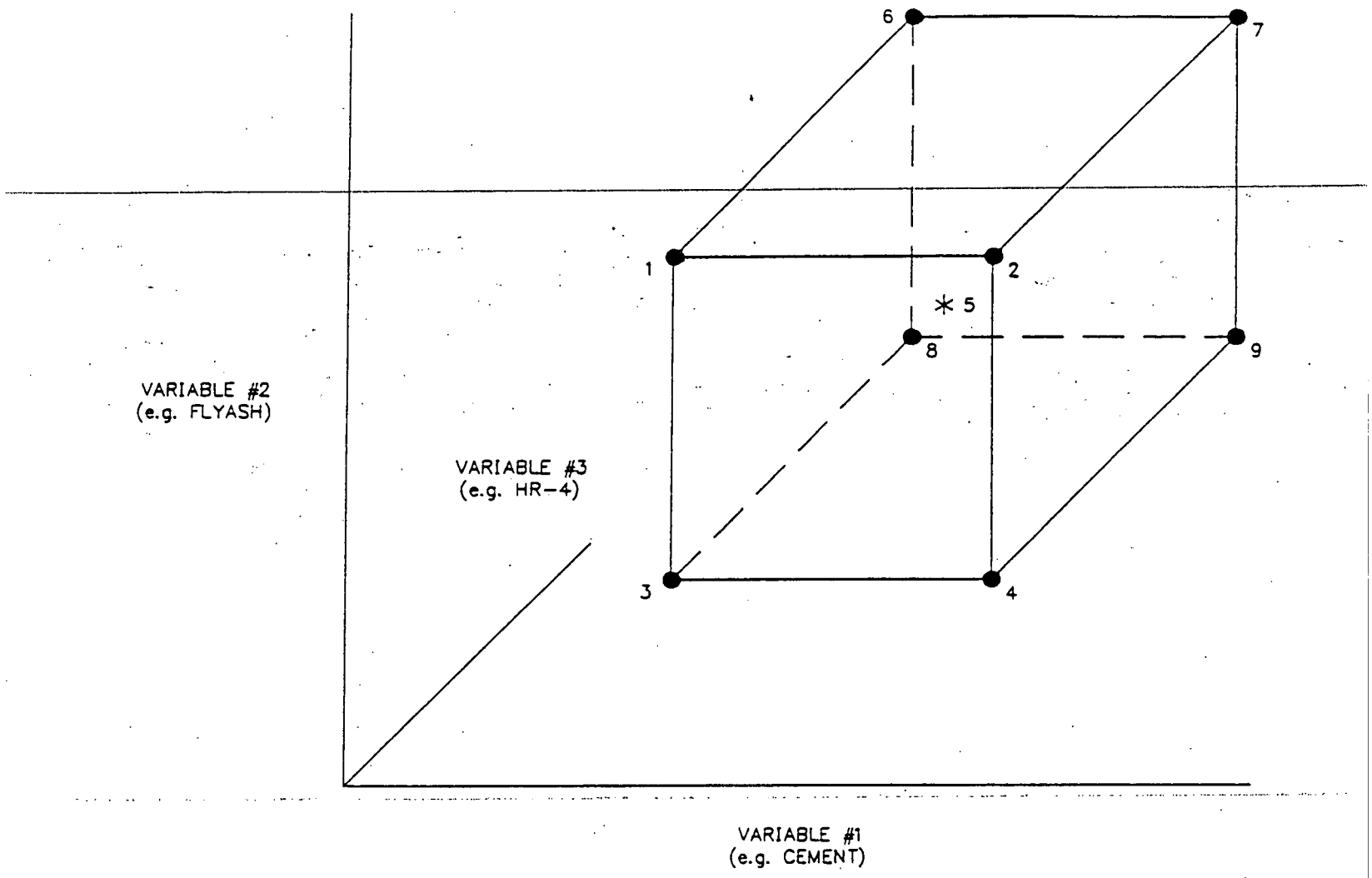
Initially, a sludge mixture was made using 5 parts pond water, 1 part crystal, and 1 part underlying sludge (by volume). This ratio of the "sludge mixture" was held constant for all 9 batches. The batches that were mixed are defined in Table 7-1 with batch #5 being the previously defined center point.

Hydrated lime was used to achieve a pH of 11.5 to 12 in the sludge mixture. After the pH adjustment, the HR-4, Type V cement, and Type C "comanche" flyash was added. The mixture was wet mixed for 5 minutes.

The mixtures incorporated the HR-4 at a range of 20.00g to 40.00g.

Eight cylinders were made for each batch. After curing, products were tested for UCS using ASTM Method C39-86. TCLP extraction and metals analysis were also conducted. The freeze/thaw and wet/dry durability test procedures were modified to enable some of the testing to be completed prior to the start of the final phase. The control cylinder (i.e., volume and moisture loss specimen) was omitted, thus only one cylinder was submitted for each test. The dimension measurements and the weighing of the cylinders were omitted. Brushing of the cylinders was done as specified in the methods. The freeze/thaw procedure was accelerated by reducing the time of freezing from 24 hours/cycle to 12 hours/cycle. The wet/dry procedure was accelerated by decreasing the drying period from 42 hours to 19 hours and the time of submergence from 5 hours to 4 hours. Using these accelerated methods, testing was completed in time to incorporate the results in the final phase. Table 7-2 defines curing times and the cylinders required for each test.

FIGURE 7-1



LEGEND

* CENTER POINT CONCENTRATION

● CONCENTRATIONS ± %
AROUND CENTER POINT

TABLE 7-1

BATCHES FOR 207C STABILIZATION
LIME/CEMENT/FLYASH + HR-25 ADDITIVE

	Sludge Mixture	Cement	Flyash	HR-4
Batch 1	2000g	625g	2084g	20.00g
Batch 2	2000g	1041g	2084g	20.00g
Batch 3	2000g	625g	1250g	20.00g
Batch 4	2000g	1041g	1250g	20.00g
Batch 5	2000g	833g	1667g	30.00g
Batch 6	2000g	625g	2084g	40.00g
Batch 7	2000g	1041g	2084g	40.00g
Batch 8	2000g	625g	1250g	40.00g
Batch 9	2000g	1041g	1250g	40.00g

NOTE: Batches 1 and 9 were omitted due to an insufficient amount of the sludge mixture.

TABLE 7-2

SUMMARY OF TESTING SCHEDULE
207C - LIME/CEMENT/FLYASH + HR-4

Curing Time	UCS	TCLP (Metals)	Freeze/Thaw + UCS	Wet/Dry + UCS
48 hrs*	1	1	1	1
7-day	2	NA	NA	NA
14-day	1	NA	NA	NA
28-day	1	NA	NA	NA

* Accelerated Cure
NA - Not Analyzed

7.3 RESULTS

Only Batches 2, 3, and 4 solidified after accelerated curing. Table 7-3 summarizes the TCLP results for these three accelerated cure cylinders. As with the HR-25, thee samples failed the LDR standards for cadmium and nickel. Again, the pH of the TCLP leachate was low.

Table 7-4 summarizes available UCS data (28-day regular cure day cure are not yet available). The dta clearly show the retrding effect of the HR-4 additive. Only Batches 2, 4, 5, and 7 achieved the maximum UCS reading after 14-day regular curing. Batches 2, 4, and 7 correspond to the maximum cement dosages, while Batch 5 is the center point.

Final durability test results are not yet available for the three accelerated cure batches. All of the cylinders are sill intact through 11 cycles. It was noted during mixing that the HR-4 resisted complete mixing with the sludge.

TABLE 7-3

48 hr ACCELERATED CURE TCLP RESULTS (mg/L)
207C - LIME/CEMENT/FLYASH + HR-4

ANALYTE	BATCH #2	BATCH #3	BATCH #4	TOXICITY CHARACTERISTIC STANDARD	NONWASTEWATER LDR STANDARD
Arsenic, Leachable (As)	<0.6	0.0870	0.138	5.0	---
Barium, Leachable (Ba)	6.06	1.76	2.02	100.0	---
Cadmium, Leachable (Cd)	0.190	0.0690	0.179	1.0	0.066
Chromium, Leachable (Cr)	1.63	1.58	1.53	5.0	5.2
Lead, Leachable (Pb)	0.360	0.142	0.158	5.0	0.51
Mercury, Leachable (Hg)	<0.0008	<0.0008	<0.0008	0.2	---
Selenium, Leachable (Se)	<0.8	0.109	<0.08	1.0	---
Silver, Leachable (Ag)	<0.03	<0.003	<0.003	5.0	0.072
Nickel, Leachable (Ni)	1.23	0.926	0.838	---	0.32
pH after TCLP extraction	5.2	5.0	5.1	---	---

NOTE: Only Batches 2, 3, and 4 hardened after the 48-hour accelerated cure.

TABLE 7-4

UCS RESULTS (psi)
207C - LIME/CEMENT/FLYASH + HR-4

Mix	48 Hr.*	7-Day	7-Day (Dup.)	14-Day	28-Day
Batch 1	ND	ND	ND	ND	ND
Batch 2	>637	>637	>637	>637	
Batch 3	>637	395	476	105	
Batch 4	424	>637	625	>637	
Batch 5	TSTT	270	248	>637	
Batch 6	TSTT	TSTT	TSTT	527	
Batch 7	TSTT	>637	>637	>637	
Batch 8	TSTT	TSTT	TSTT	(1)	
Batch 9	ND	ND	ND	ND	ND

(1) Sample broke in half when removed from mold.

* Accelerated Cure
TSTT - Too Soft To Test
ND - No data; batch not mixed
Dup. - Duplicate

8.0 CONCLUSIONS AND RECOMMENDATIONS

Following is a summary of the major conclusions as a result of the 207C treatability testing to date:

- The results of TCLP testing clearly verify the sensitivity of leaching to the pH of the leach solution. A pH of 9 or greater in the leach solution must be maintained to assure compliance with LDR standards.

- No other additives, such as ferrous sulfate, appear to be necessary to achieve desired TCLP results.

- Mixes of lime/cement/flyash appear capable of meeting all stabilization objectives.

- The addition of plastic fibers did not show any benefits as far as strength or durability.

The addition of sodium silicate did not show any benefits as far as strength or durability.

Results of the Latex 2000 system are not conclusive and will require further discussion.

additives HR-4 and HR-25 retarded the solidification of the
s. There appear to be no advantages to the inclusion of these
ves (this assumes that efflorescence, which has not been
i to date, will not be a long-term problem). Both additives
reduced the pH of the TCLP leachate, resulting in failure to
standards. Obviously, more lime is needed to neutralize
ty contributed by the additives.

:ation of some of the cylinders, which often took a donut
ends of the cylinders, cannot be explained. It is not
this is of any long-term significance or is indicative
or chemical process that should be of concern (see
. ppendix B).

s for the final regulatory confirmation phase:

the previously-established center point, with

the factorial adjusted to increase the UCS in Batch 3.

- Lime/cement/flyash + entrained air as a further protection against freeze/thaw damage.

- Lime/cement/flyash + Latex 2000 (at 1%, 3%, and 5%). Further discussion of these concentrations is needed.

- Titration tests will be performed to quantify the amount of lime needed with each additive to assure that the pH of the TCLP extract stays above 9.

APPENDIX A

JANUARY 8, 1992 MEMORANDUM SUMMARIZING PRELIMINARY 207C TREATABILITY STUDY RESULTS

HALLIBURTON NUS
Environmental Corporation

INTERNAL CORRESPONDENCE

C-49-01-92-57

DATE: JANUARY 8, 1991

TO: TED BITTNER

COPY: RICH NINESTEEL
DONALD BRENNEMAN
SHAJ MATHEW
JOHN ZAK
JERRY CHILDS
FILE 2K68

FROM: TOM SNARE

SUBJECT: OBSERVATIONS FROM PRELIMINARY 207C TREATABILITY STUDY - EG&G ROCKY FLATS STABILIZATION PROJECT REVISION NO. 1

1.0 Purpose

The goal of this testing was to initiate an early study for the solidification of the 207C pond sludge, crystals and water (i.e., slurry). This slurry was solidified using lime, cement and flyash, with the second mix adding HALLIBURTON Services Latex 2000 System. The intent is to observe mixing characteristics, establish long term disability of the mixes, and analyze for TCLP constituents for an initial starting point for subsequent testing.

2.0 Procedure

The slurry of 207C pond sludge, crystals and water was solidified using two different mixtures. The first mixture consisted of slurry, lime (to pH 11), Type C flyash and portland type I-II cement. The second mixture was essentially the same except for the addition of the LATEX 2000 System. The LATEX 2000 system included D-AIR 3, stabilizer 434C and LATEX 2000. Solidification mixture ratios are described in Table 2-1. Nine cylinders were filled for both mixtures. The mixing was completed on November 25, 1991.

3.0 Results

BATCH #1 - The crystal part of the sludge was ground to a -10 mesh size. The crystals were then combined with the water and sludge to form the slurry. While in this slurry, the crystals visually reformed to a size of +10 mesh. Upon the addition of cement and flyash the crystals dissipated based on the feel of the mix during hand mixing.

After the blending with the HOBART mixer the consistency of the mixture was described as "very runny, but started to set up by the time the last cylinder was poured."

BATCH #2 - After the blending with the HOBART mixer, the consistency of the mixture was described as "thicker than Batch #1 and started to set up during molding." The mixture had to be spooned into the molds. air Pockets in molds?

A visual observation was performed after 5 days of NORMAL curing; both batches were described as being hard. After 24 days of curing, samples from both batches were submitted for UCS, TCLP (metals) and durability tests. The following results were reported:

UCS	Result
Batch #1	>600 psi
Batch #2	>600 psi

TCLP Preliminary Data

As shown in Table 3-1.

Durability Tests

1. Freeze/Thaw

   The samples submitted from Batch #1 continue to be cycled with small hair-line cracks appearing. Samples submitted from Batch #2 developed cracks and crumbled, and were deemed a failure after 3 cycles on December 31, 1991.

2. Wet/Dry

   The samples submitted from Batch #1 cracked and crumbled thus failing on January 6, 1992 after 8 cycles. Samples from Batch #2 continue to be cycled.

4.0 Conclusions

1. Both batches were within regulatory standards (toxicity characteristic and LDR standards) based on the TCLP results.

2. The addition of the Latex 2000 System enhanced resistance to wet/dry cycling but decreased resistance to freeze/thaw cycling.

3. No efflorescence has been observed to date.

TLS/pam

TABLE 2-1

SOLIDIFICATION MIXTURE RATIOS

	Batch #1		Batch #2	
	Grams Added	% (by wt.)	Grams Added	% (by wt.)
Pond Water	1430g	35.7	1430g	33.7
Pond Sludge	286g	7.1	286g	6.7
Pond Crystals	286g	7.1	286g	6.7
Lime	to pH 11	---	to pH 12	---
Cement Type I-II	667g	16.7	667g	15.7
Flyash Type C	1334g	33.3	1334g	31.4
Latex 2000	NA	---	200g	4.7
Stabilizer 43B	NA	---	32g	0.75
D-Air-3	NA	---	9g	0.21

NA: Not Added

TABLE 3-1

TCLP PRELIMINARY DATA (mg/L)

Analyte	Batch #1	Batch #2	Toxicity Characteristic Standard	Nonwastewater LDR Standard
TCLP Leaching Procedure	DONE	DONE	5.0	---
Arsenic, Leachable (As)	0.42	0.46	100.0	---
Barium, Leachable (Ba)	0.50	0.51	1.0	0.066
Cadmium, Leachable (Cd)	<0.005	<0.005	5.0	5.2
Chromium, Leachable (Cr)	0.22	0.20E	5.0	0.51
Lead, Leachable (Pb)	<0.02	<0.02	0.2	---
Mercury, Leachable (Hg)	<0.00008	<0.00008	1.0	---
Selenium, Leachable (Se)	<0.08	<0.08	5.0	0.072
Silver, Leachable (Ag)	<0.003	<0.003	---	0.32
Nickel, Leachable (Ni)	<0.03	0.03	---	---
Iron, Leachable (Fe)	0.014	0.022	---	---
Aluminum, Leachable (Al)	3.6	4.0	---	---
Calcium, Leachable (Ca)	640	590E	---	---
Magnesium, Leachable (Mg)	0.07	0.07	---	---

NOTE: Batch #1 - Final pH of TCLP is 11.7.
Batch #2 - Final pH of TCLP is 11.7. E-Serial dilution result did not agree with the original results within 10%. Matrix interference should be suspected.

APPENDIX B

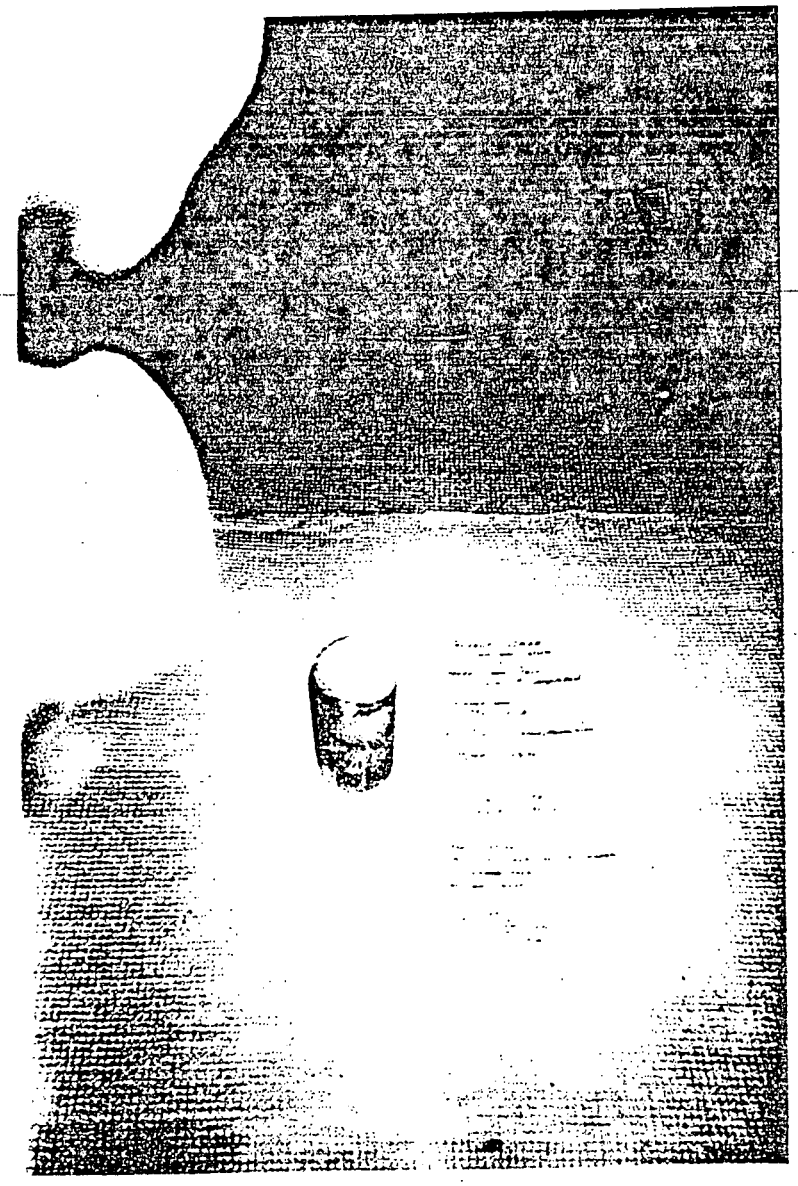
PHOTOGRAPHS OF CYLINDERS AFTER DURABILITY TESTING

THE ORIGINALS OF THESE PHOTOS WERE DISTRIBUTED TO D. BRENNEMAN, J. CHILDS, AND THE PITTSBURGH HALLIBURTON NUS FILE (2K68).

LIME/CEMENT/FLYASH

FREEZE/THAW

5 CYLINDERS



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

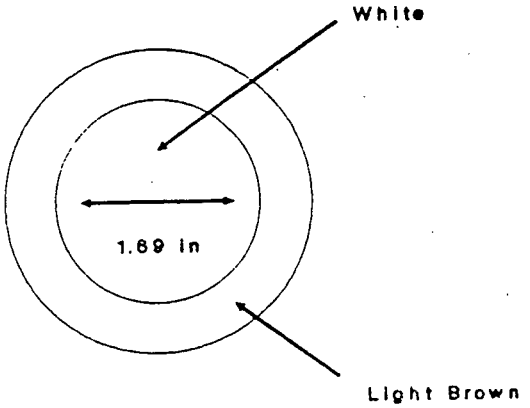
FREEZE/THAW TEST (Accelerated)
~~In cycle:~~ ~~#Completed~~ 5 cycles completed

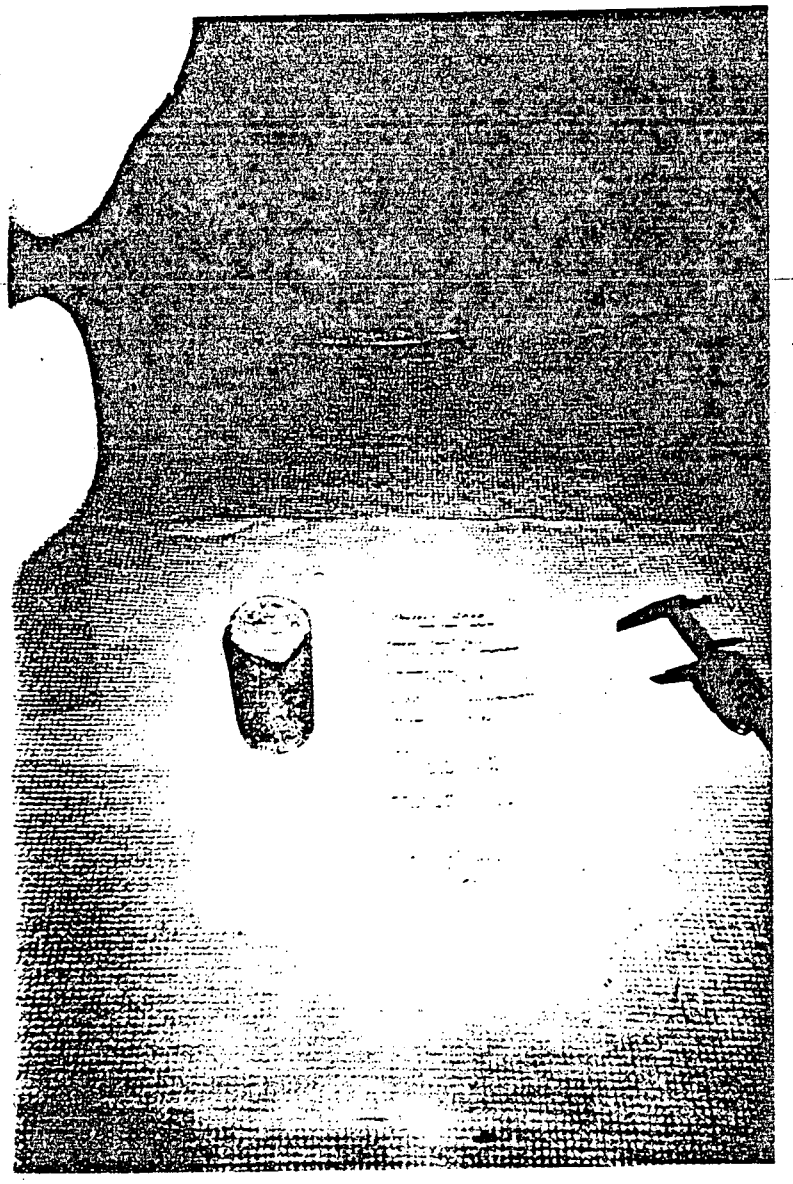
CYLINDER NAME:
M1 1.3

207C CEMENT/FLYASH/LIME
Mix 1
Mixed 1/17/92

OBSERVATIONS:
Dia: 1.98 in.
Height: 3.91 in.

Deep scratches
Hairline crack with a ~~complete~~ complex
longitudinal face





ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

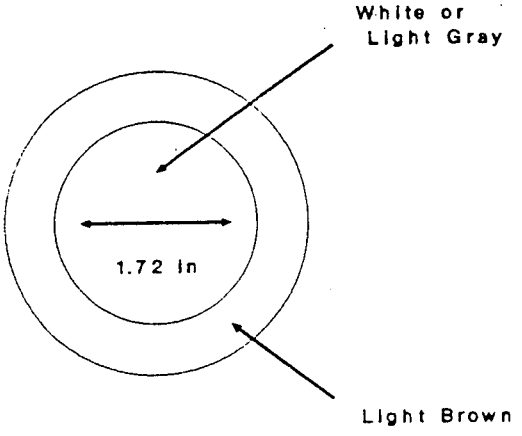
FREEZE/THAW TEST (Accelerated)
~~In cycle: #Completed~~ 5 cycles completed

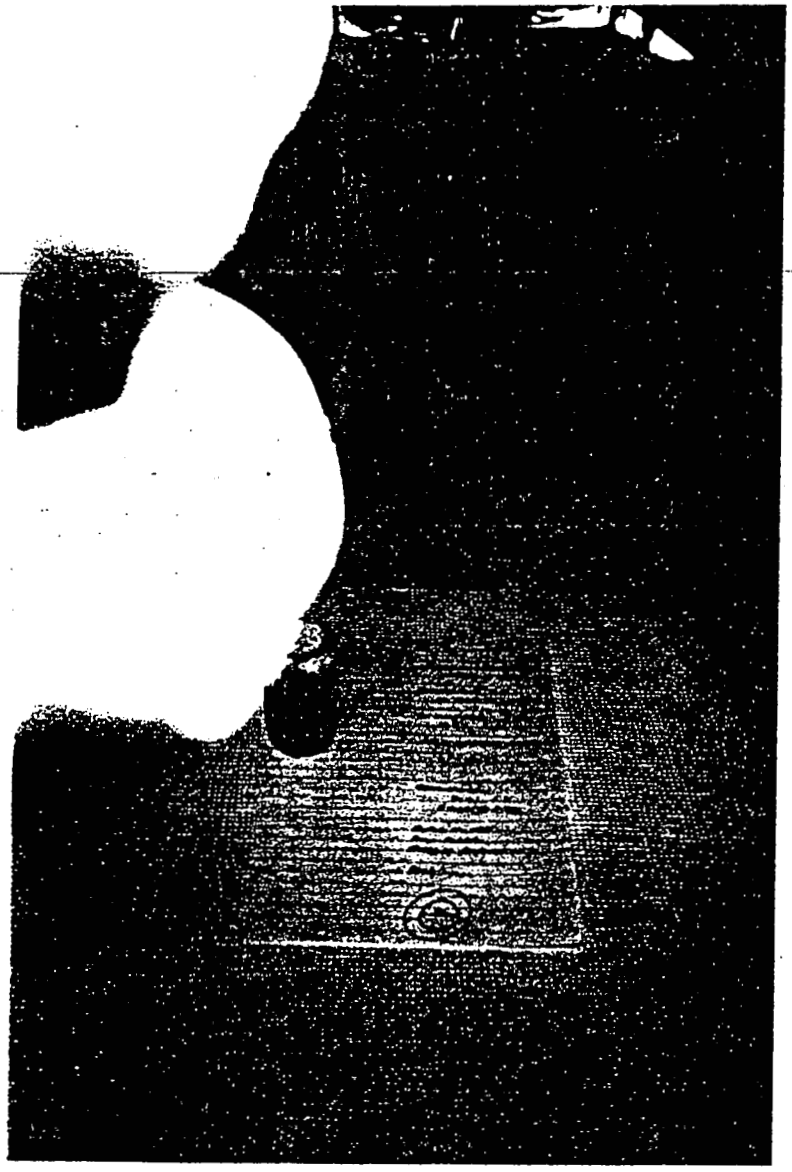
CYLINDER NAME:
M2 2.3

207C CEMENT/FLYASH/LIME
Mix 2
Mixed 1/17/92

OBSERVATIONS:
Dia: 2.00 in.
Height: 3.94 in.

Good cylinder
Slight hairline cracks





ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

FREEZE/THAW TEST (Accelerated)
~~In cycle: #Completed~~ 5 cycles completed

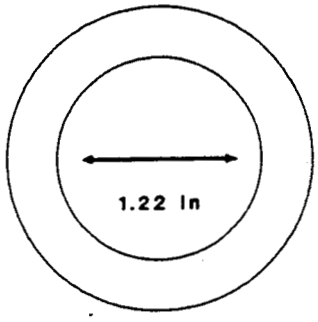
CYLINDER NAME:
M3 3.3

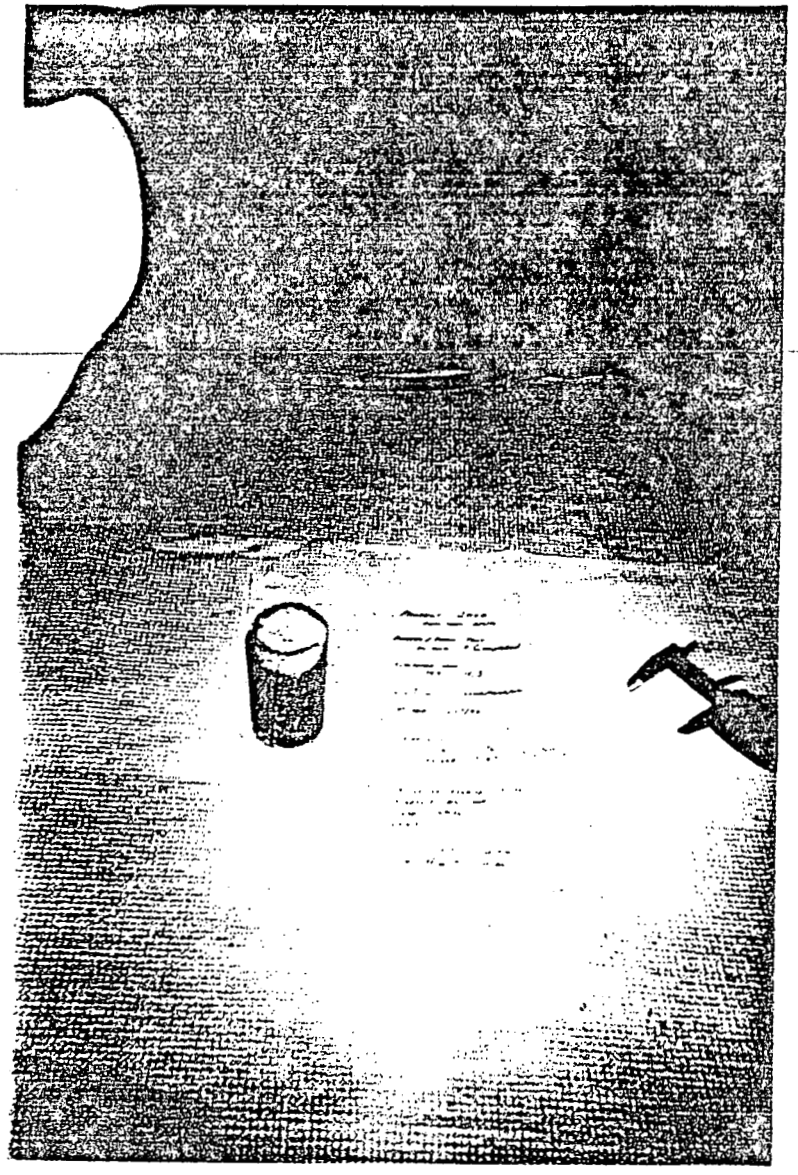
207C CEMENT-FLYASH-Lime

Mixed 1/17/92

OBSERVATIONS:
Dia: 1.91 in.
Height: 3.70 in.

Elephant like skin
Deep scratches
Flaking or powdering
Donut





ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

FREEZE/THAW TEST (Accelerated)
~~In cycle: #Completed~~ 5 cycles completed

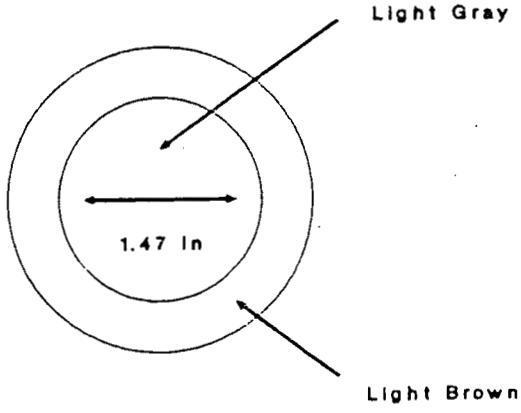
CYLINDER NAME:
M4 4.3

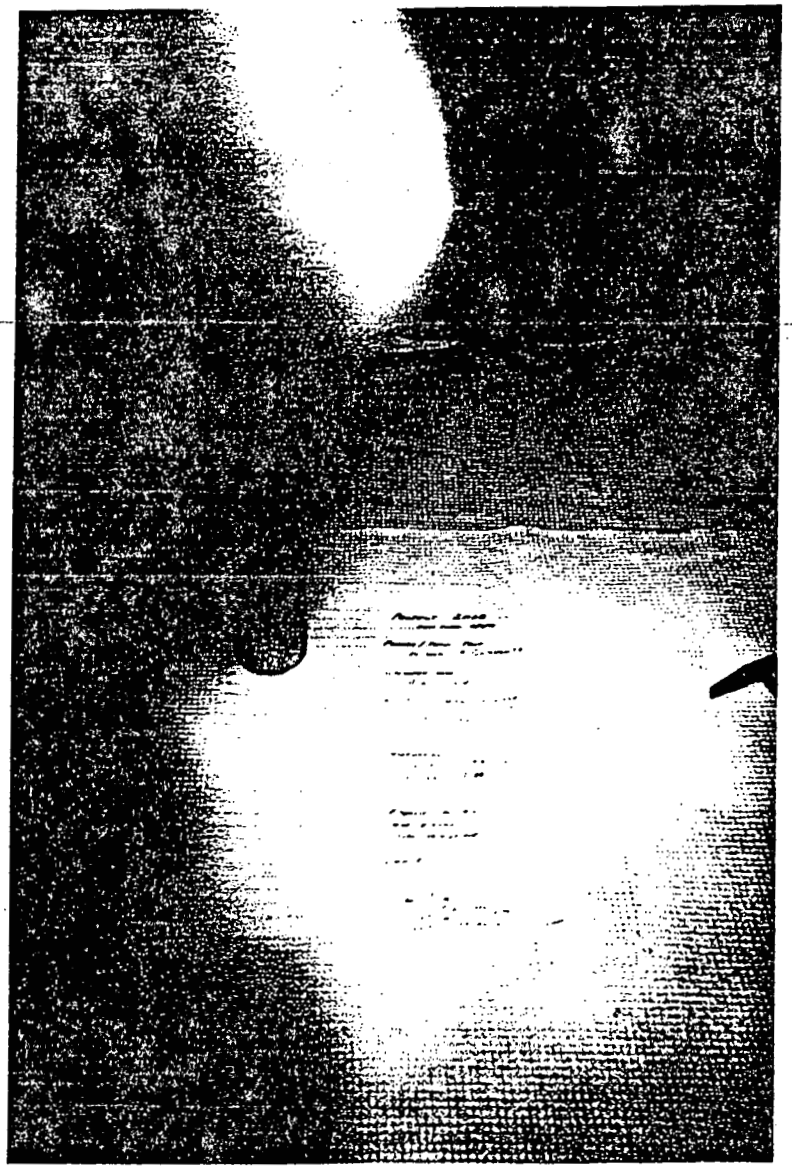
207C CEMENT/FLYASH/LIME

Mixed 1/17/92

OBSERVATIONS:
Dia: 1.96 in.
Height: 3.87 in.

A lot of flaking
Elephant skin look
Deep scratches
Donut





ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

FREEZE/THAW TEST (Accelerated)
~~In cycle. #Completed~~ 5 cycles completed

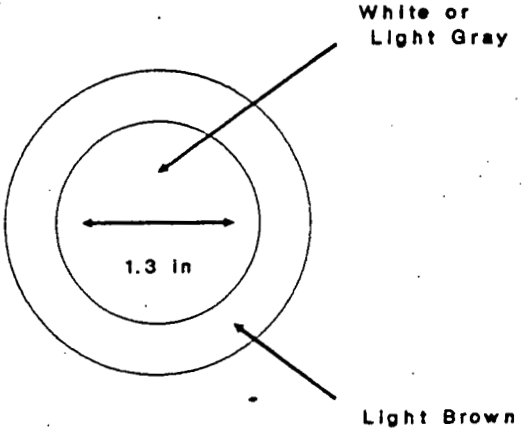
CYLINDER NAME:
M5 5.3

207C CEMENT-FLYASH-Lime

Mixed 1/17/92

OBSERVATIONS:
Dia: 1.99 in.
Height: 3.88 in.

Elephant like skin
Deep grooves
Cracks throughout
Donut

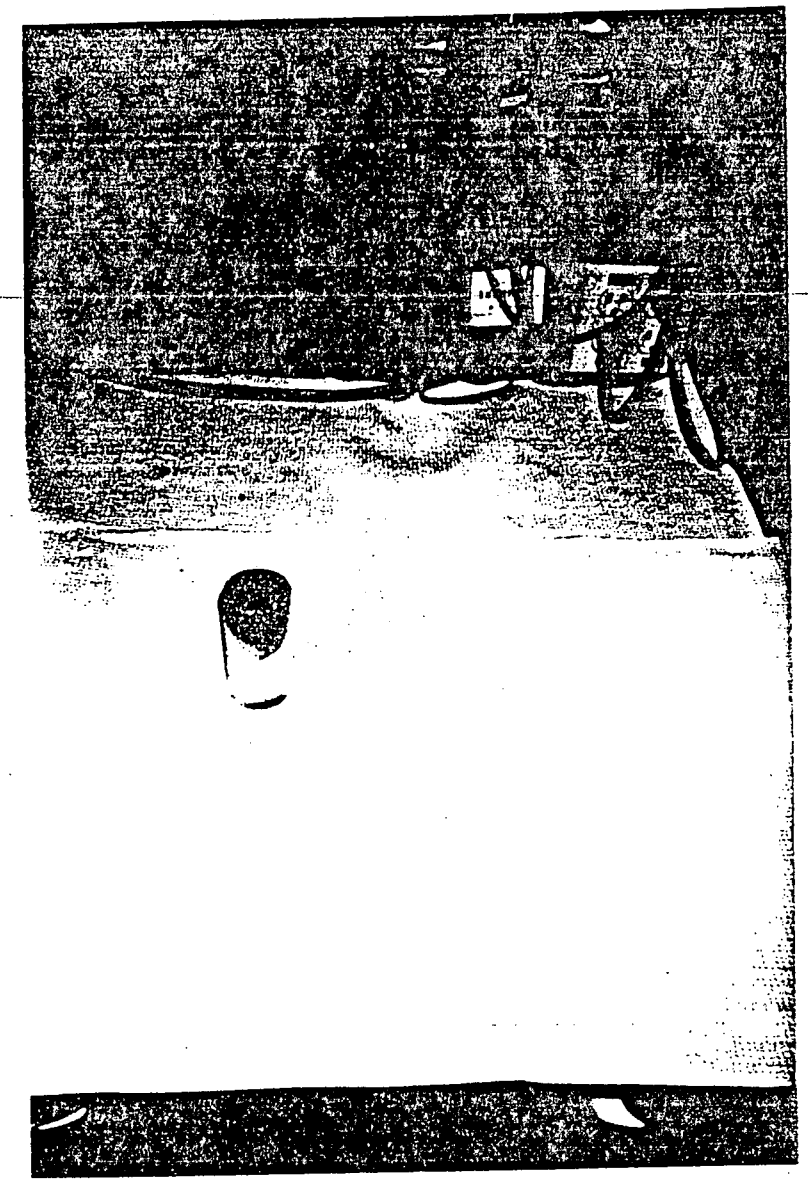


M5 5.3

LIME/CEMENT/FLYASH

WET/DRY

5 CYLINDERS



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

WET/DRY TEST
~~In cycle: #Completed~~ 5 cycles completed

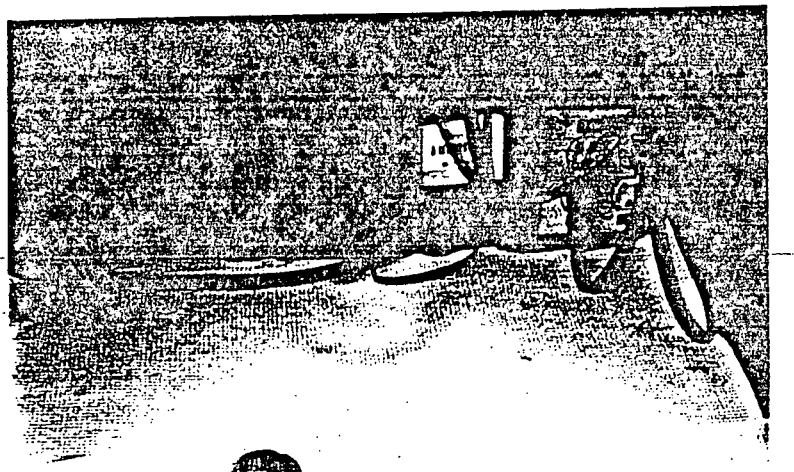
CYLINDER NAME:
M1 1.2

207C CEMENT/FLYASH/LIME

Mixed 1/17/92

OBSERVATIONS:
Dia: 1.99 in.
Height: 3.93 in.

Hairline cracks
Resembles elephant skin
Cylinder looked good



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

WET/DRY TEST
~~In cycle: #Completed~~ 5 cycles completed

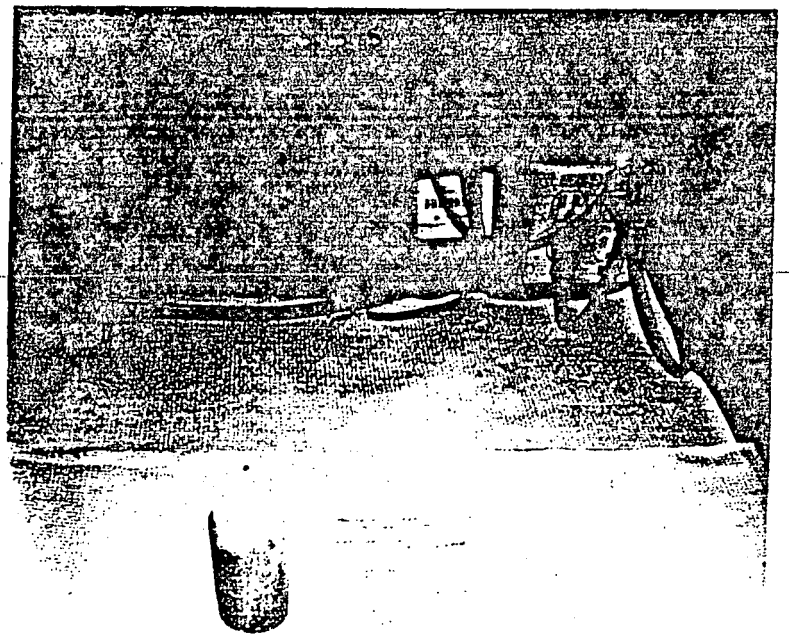
CYLINDER NAME:
M2 2.2

207C CEMENT/FLYASH/LIME

Mixed 1/17/92

OBSERVATIONS:
Dia: 2.01 in.
Height: 3.94 in.

Hairline cracks
Resembles elephant skin
Good cyliner



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

WET/DRY TEST
~~In cycle: #Completed~~ 5 cycles completed

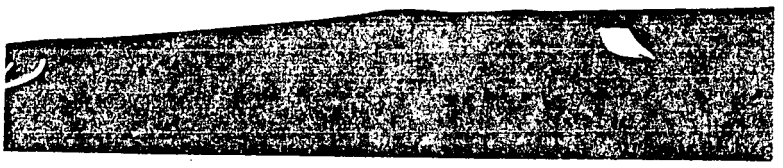
CYLINDER NAME:
M3 3.2

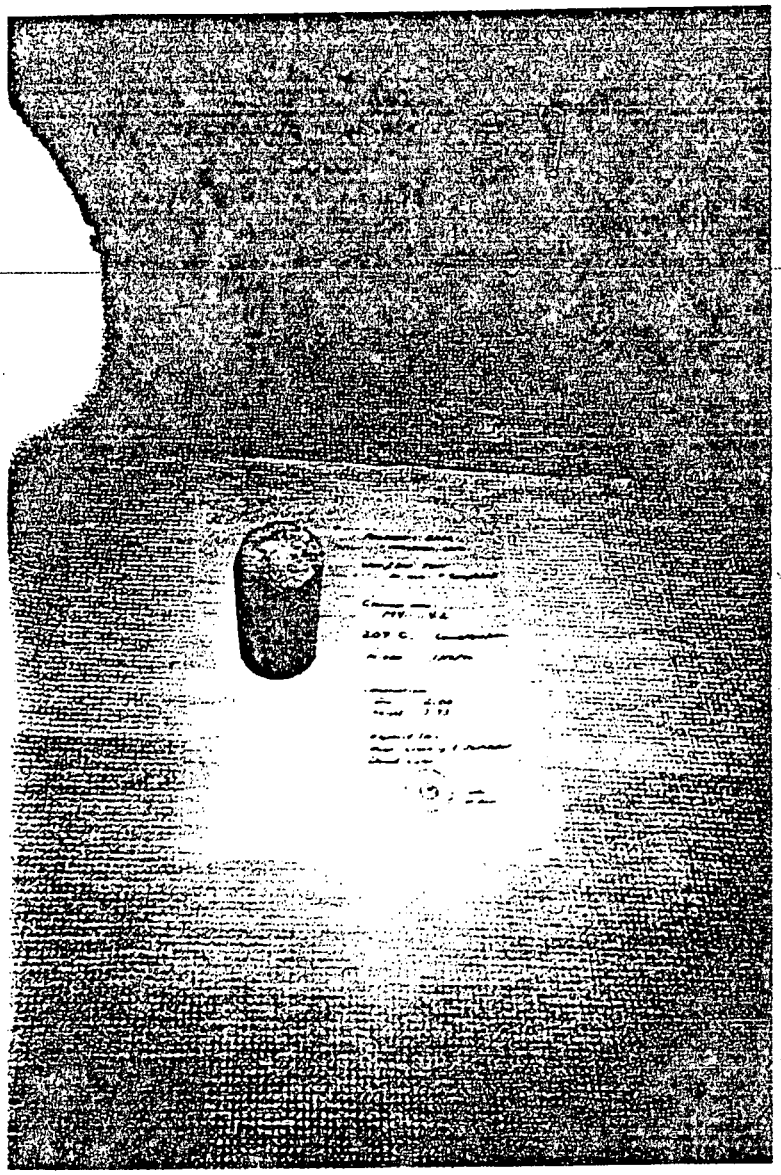
207C CEMENT/FLYASH/LIME

Mixed 1/17/92

OBSERVATIONS:
Dia: 1.99 in.
Height: 3.71 in.

Elephant skin/hairline cracks
Deep scratches
Ends flaked off





ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

WET/DRY TEST
~~In cycle: # Completed~~ 5 cycles completed

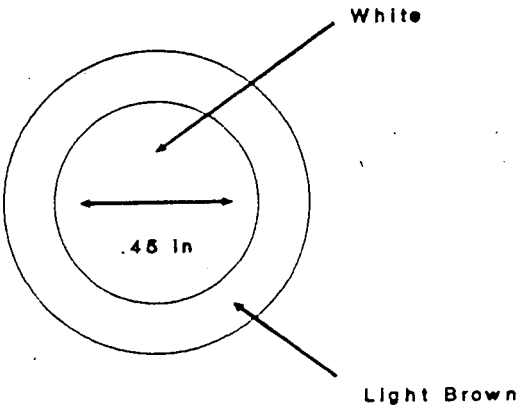
CYLINDER NAME:
M4 4.2

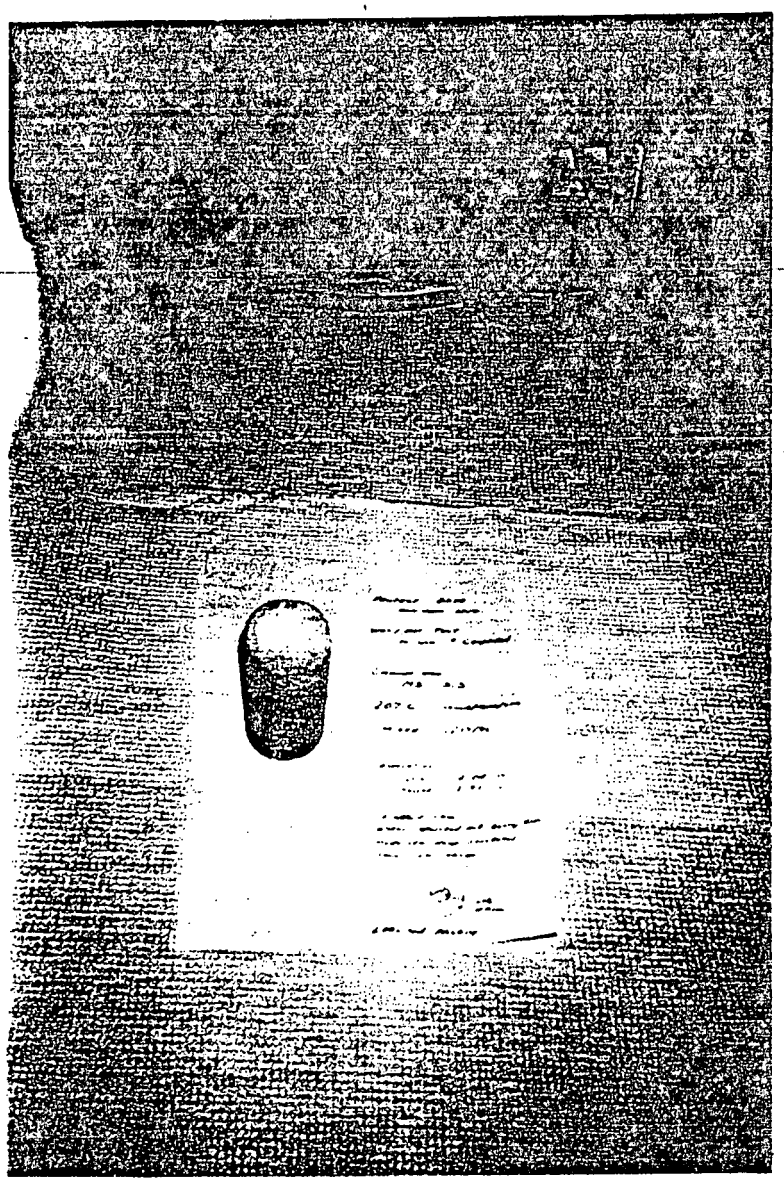
207C CEMENT/FLYASH/LIME

Mixed 1/17/92

OBSERVATIONS:
Dia: 2.00 in.
Height: 3.93 in.

Elephant skin
Deep cracking and scratches
Donut color





ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

WET/DRY TEST
~~In cycle: #Completed~~ 5 cycles Completed

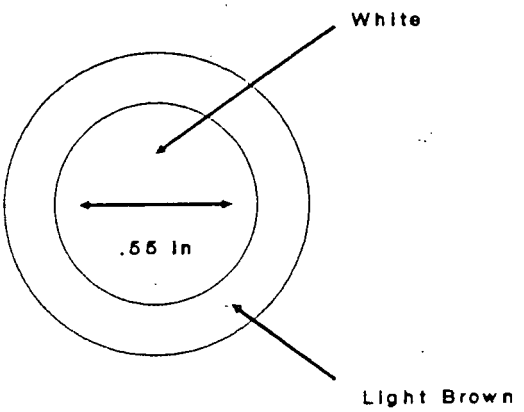
CYLINDER NAME:
M5 5.5

207C CEMENT/FLYASH/LIME

Mixed 1/17/92

OBSERVATIONS:
Dia: 2.00 in.
Height: 3.91 in.

Elephant skin
Water separated out during cure
Moderately deep scratches
Some color change
Little end flaking

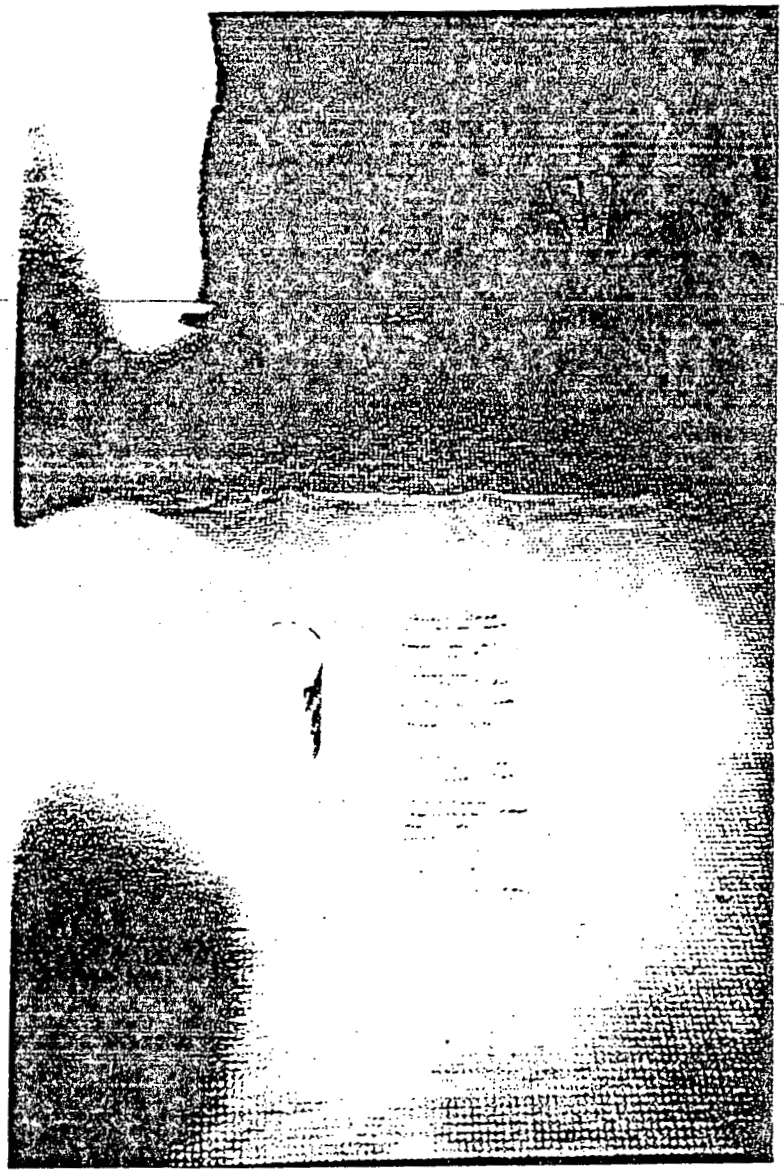


M5 5.5

LIME/CEMENT/FLYASH AND SODIUM SILICATE

FREEZE/THAW

9 CYLINDERS



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

FREEZE/THAW TEST
~~In cycle: #Completed~~ 5 cycles completed

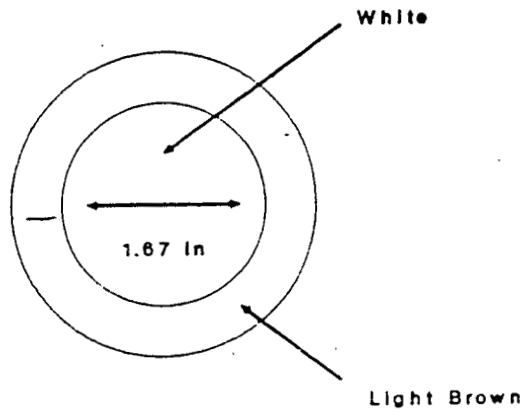
CYLINDER NAME:
M1 M1.3S

207C w/ SILICATE

Mixed 1/17/92

OBSERVATIONS:
Dia: 1.99 in.
Height: 3.84 in.

A lot of flaking
Deep scratching and pitted
Bad cylinder
Donut



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

FREEZE/THAW TEST
~~In cycle: #Completed~~ 5 cycles completed

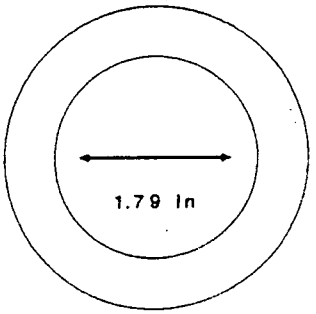
CYLINDER NAME:
M2 2.3S

207C w/ SILICATE

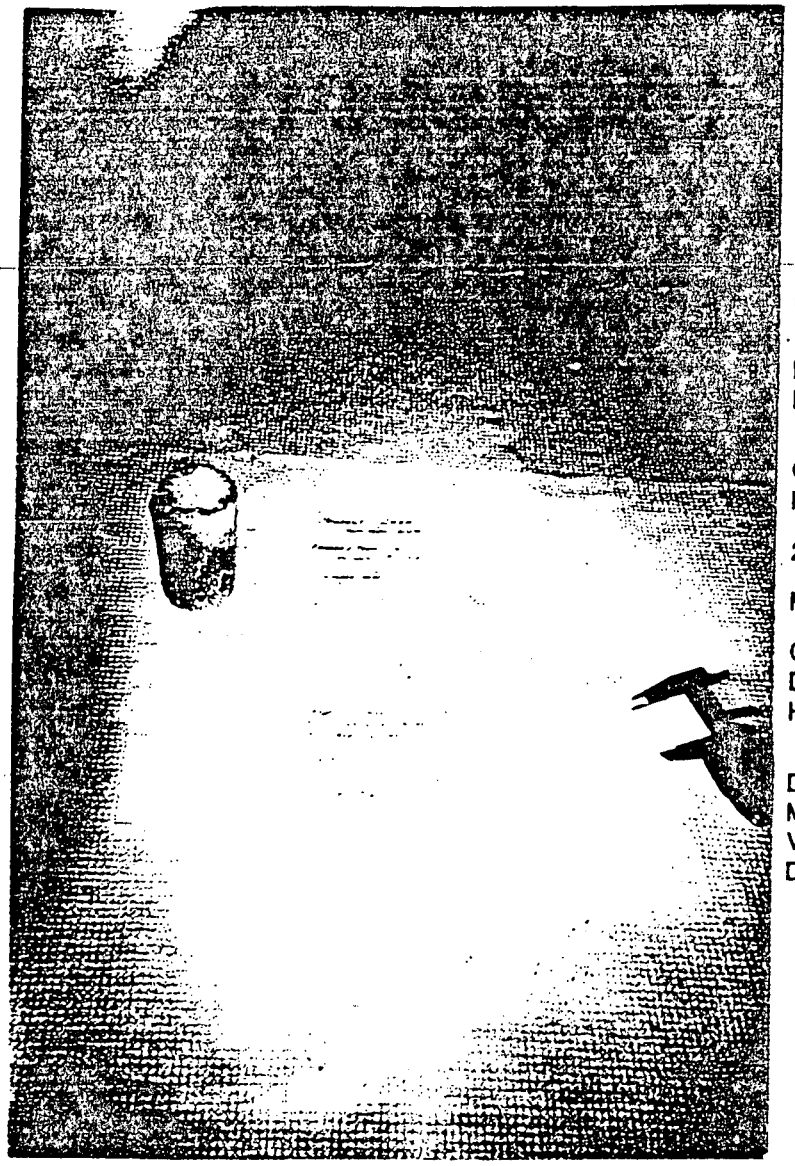
Mixed 1/17/92

OBSERVATIONS:
Dia: 1.98 in.
Height: 3.99 in.

Minimum flaking
Minimum grooves
Cracking on diameter and longitude



M2 2.3S



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

FREEZE/THAW TEST
~~In cycle. #Completed~~ 5 cycles completed

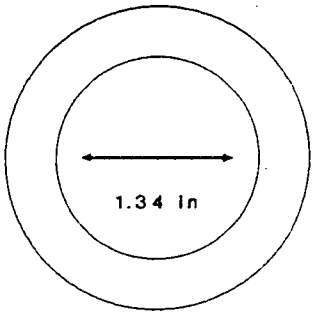
CYLINDER NAME:
M3 3.3S

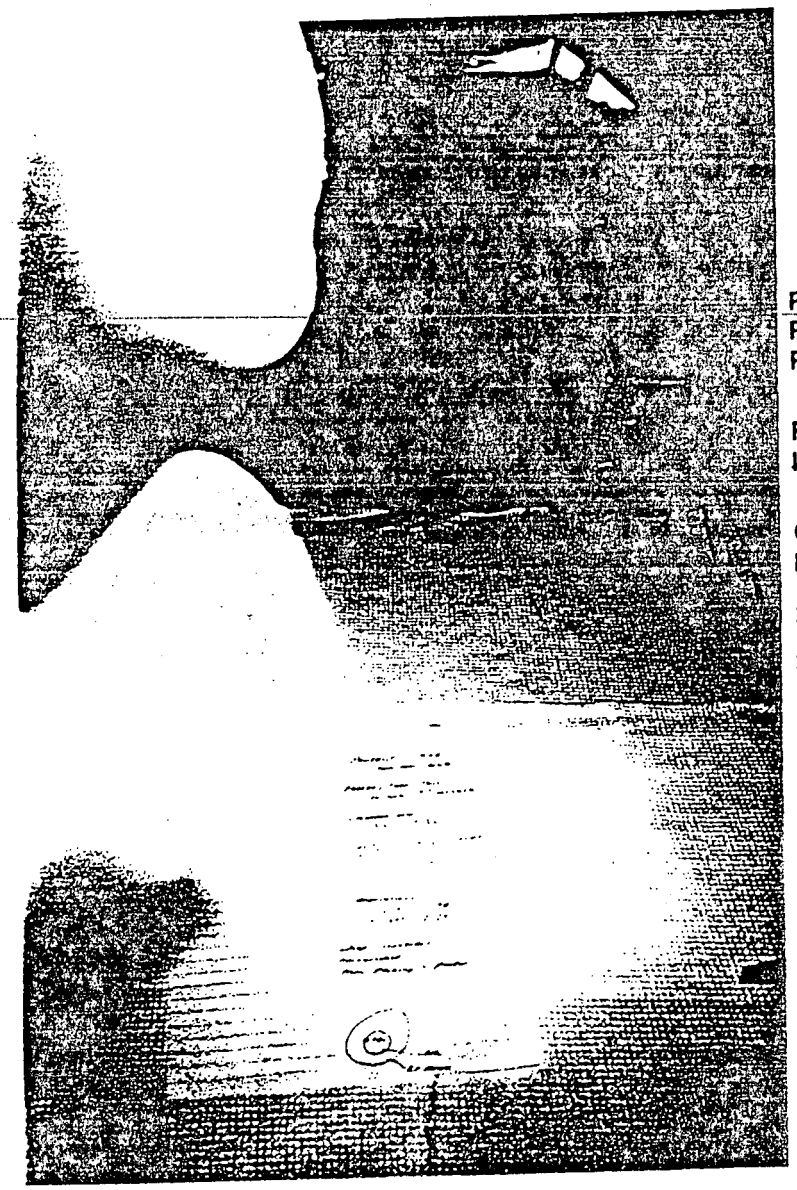
207C w/ SILICATE

Mixed 1/17/92

OBSERVATIONS:
Dia: 1.94 in.
Height: 3.68 in.

Deep scratches
Minimum flaking, but powdering
Very bad cylinder
Donut





ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

FREEZE/THAW TEST
~~In cycle. #Completed~~ 5 cycles completed

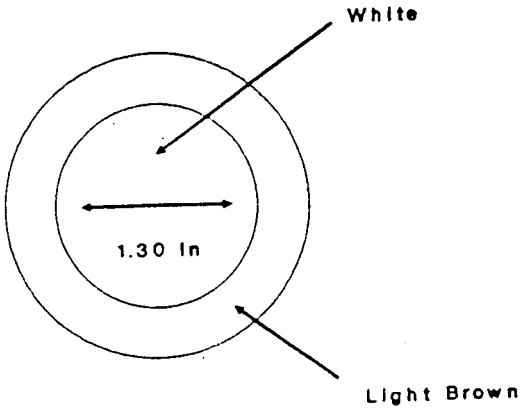
CYLINDER NAME:
M4 4.3S

207C w/ SILICATE

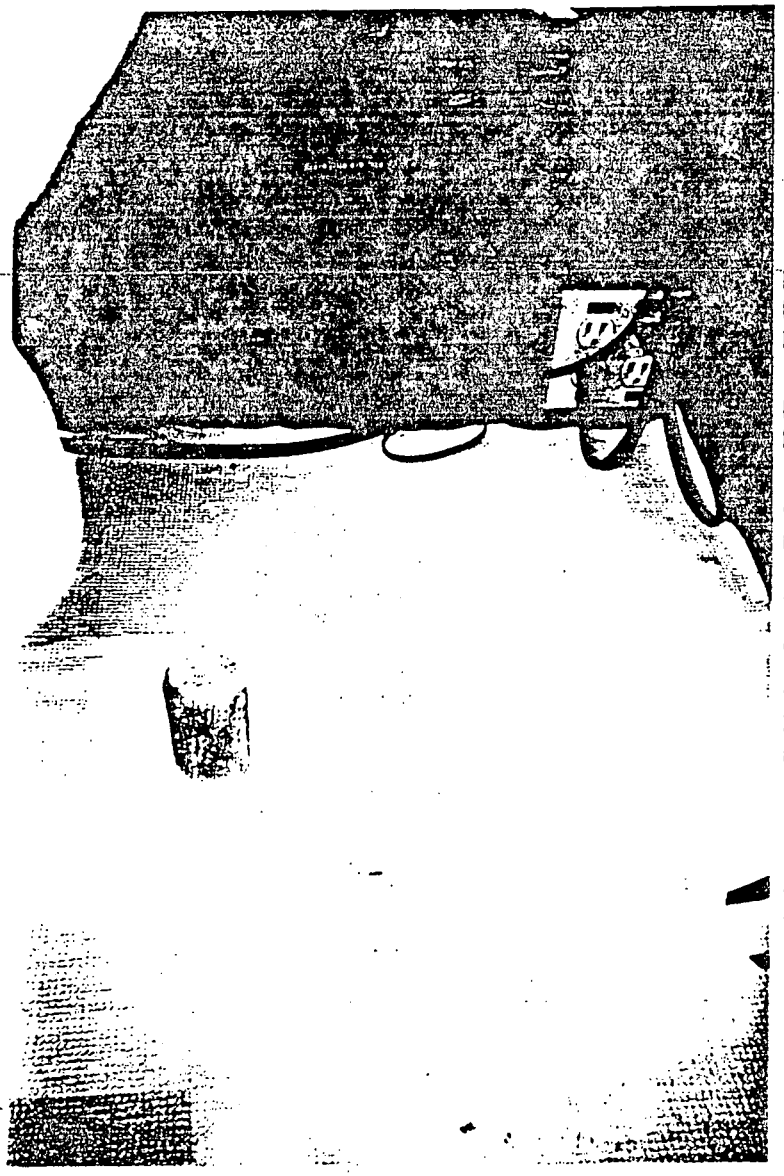
Mixed 1/17/92

OBSERVATIONS:
Dia: 1.98 in.
Height: 3.74 in.

Deep scratches
Non-cracked
Minimum flaking/powder



M4 4.3S



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

FREEZE/THAW TEST
~~In cycle> #Completed~~ 5 cycles completed

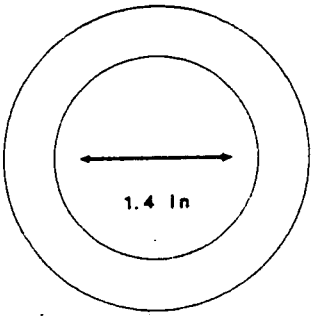
CYLINDER NAME:
M5 5.3S

207C w/ SILICATE

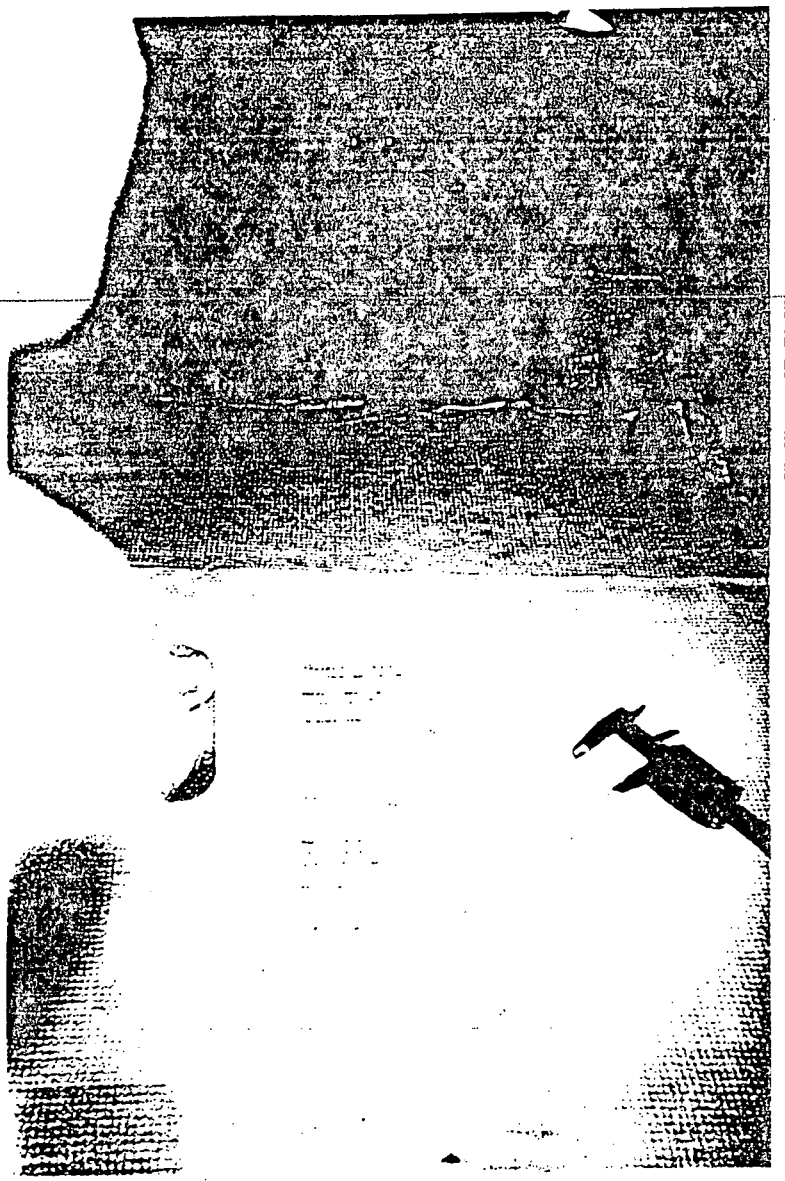
Mixed 1/17/92

OBSERVATIONS:
Dia: 1.98 in.
Height: 3.87 in.

Deep scratches
Minimum flaking
Minimum cracking
Poor cylinder
Donut



M5 5.3S



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

FREEZE/THAW TEST
~~In cycle. #Completed~~ 5 cycles completed

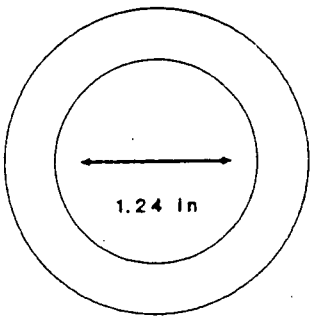
CYLINDER NAME:
M6 6.3S

207C w/ SILICATE

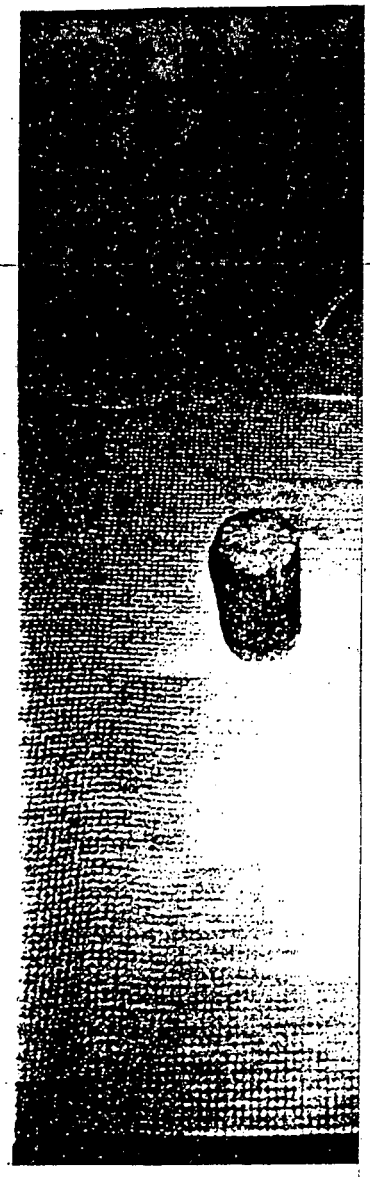
Mixed 1/17/92

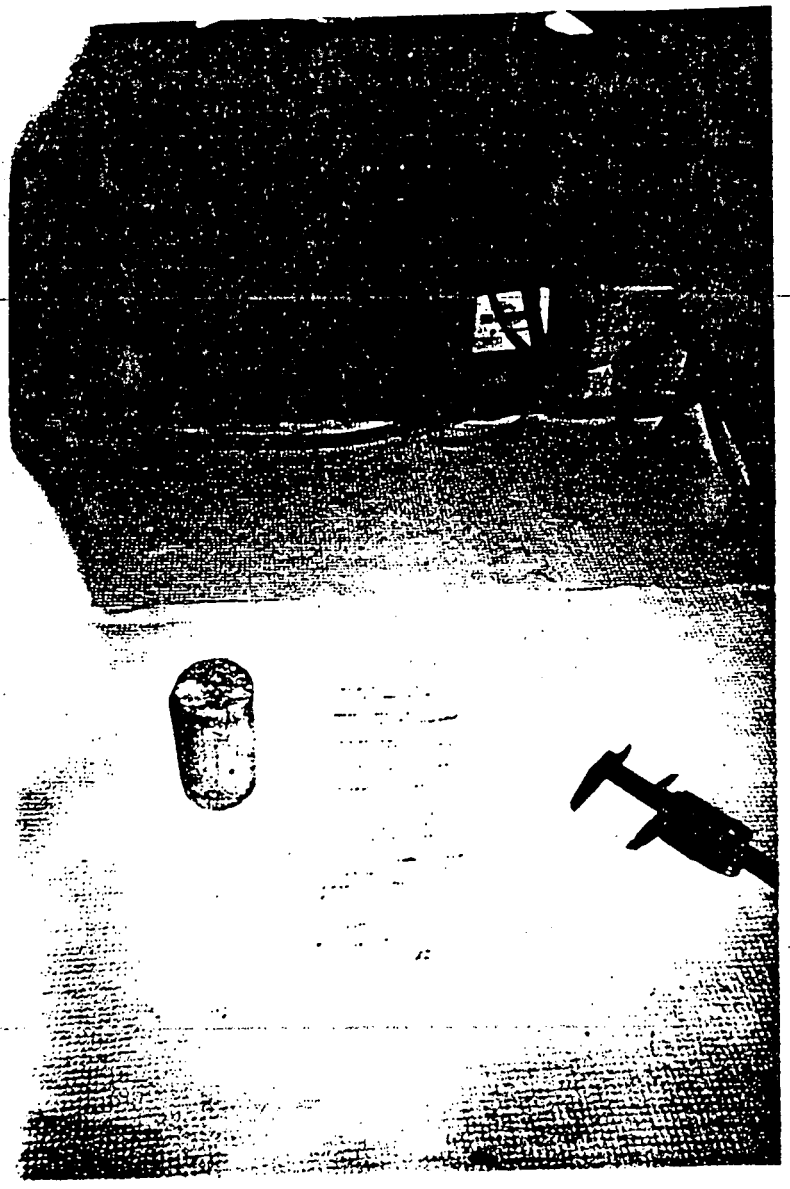
OBSERVATIONS:
Dia: 1.98 in.
Height: 3.81 in.

Deep scratches
Minimum flaking
Cracks like elephant skin
Donut color change



M6 6.3S





ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/9

FREEZE/THAW TES
~~In cycle: # Complet~~

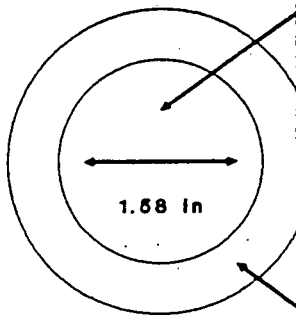
CYLINDER NAME:
M7 7.4S

207C w/ SILICATE

Mixed 1/17/92

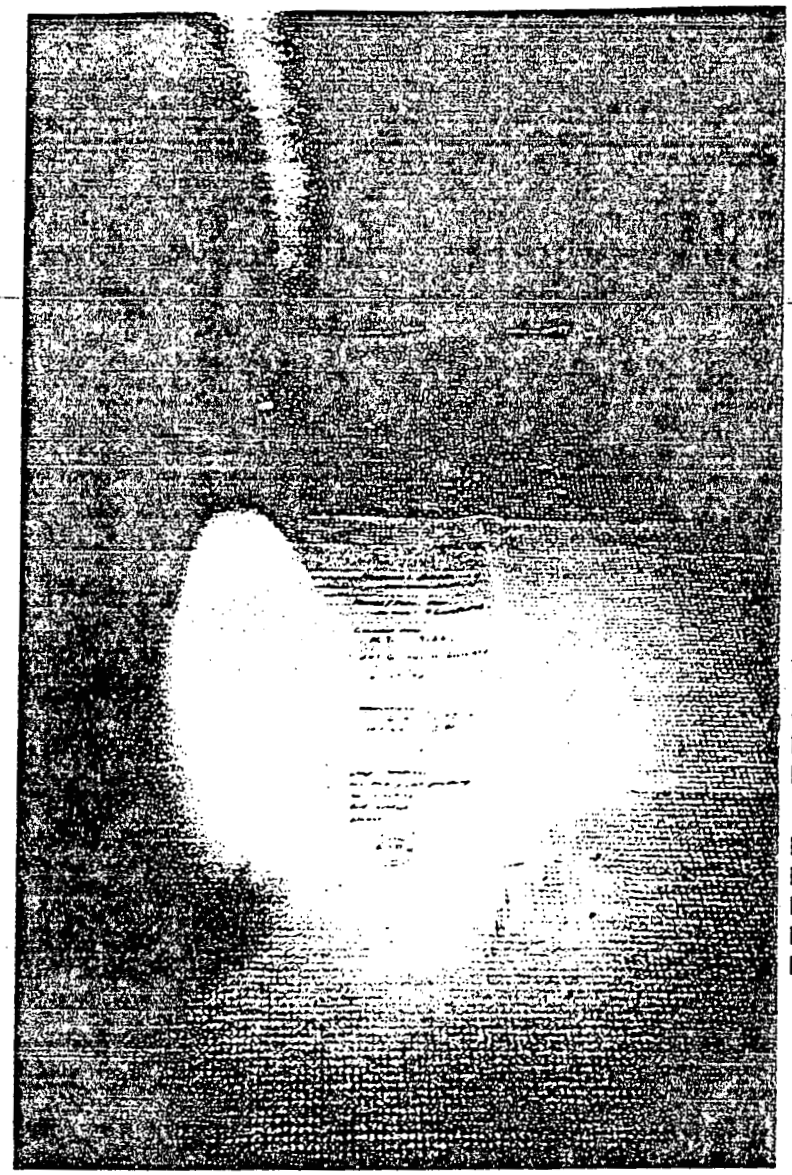
OBSERVATIONS:
Dia: 1.98 in.
Height: 3.88 in.

A lot of flaking and
Deep scratches
Donut



M8 8.3B

M7 7.4B



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

FREEZE/THAW TEST
~~In cycle. # Completed~~ 5 cycles completed

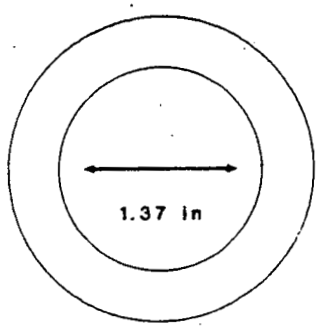
CYLINDER NAME:
M9 9.3S

207C w/ SILICATE

Mixed 1/17/92

OBSERVATIONS:
Dia: 1.97 in.
Height: 3.81 in.

Deep scratches
Minimum flaking, but powdering
No cracking
End eroded
Donut

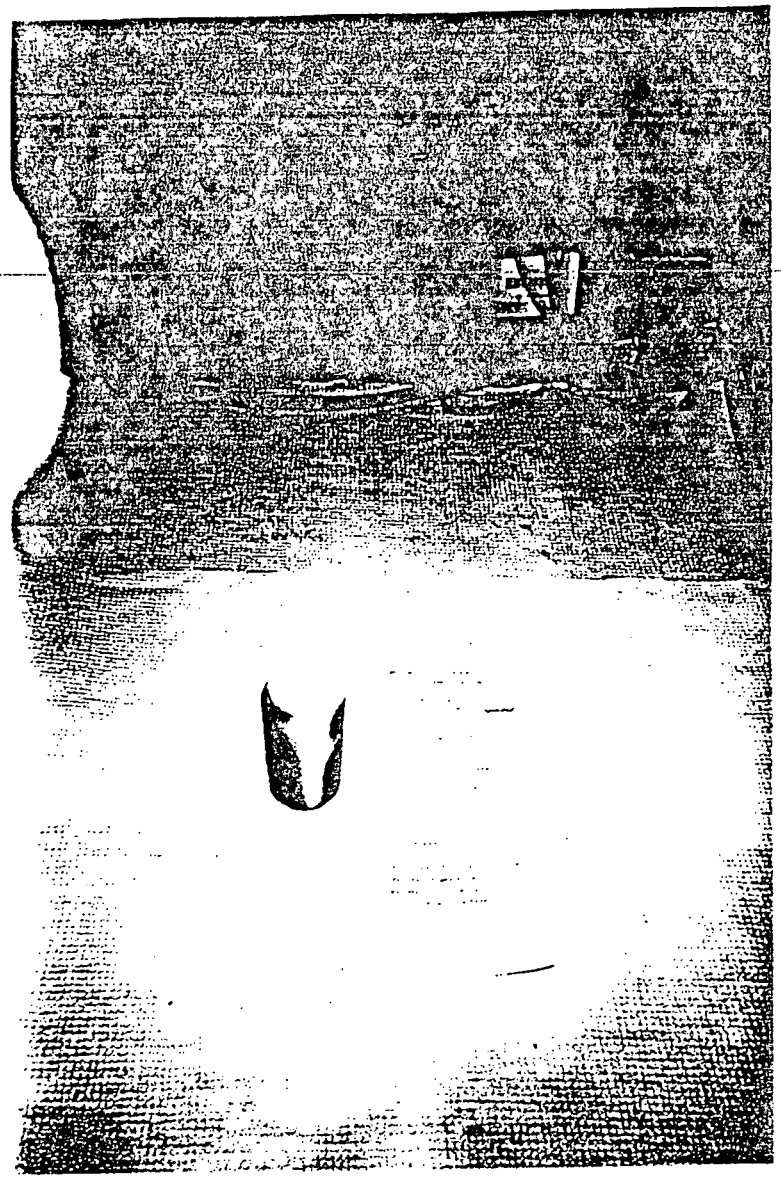


M9 9.3S

LIME/CEMENT/FLYASH AND SODIUM SILICATE

WET/DRY

8 CYLINDERS



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

WET/DRY TEST
~~In cycle: #Completed~~ 5 cycles completed

CYLINDER NAME:
M1 1.2S

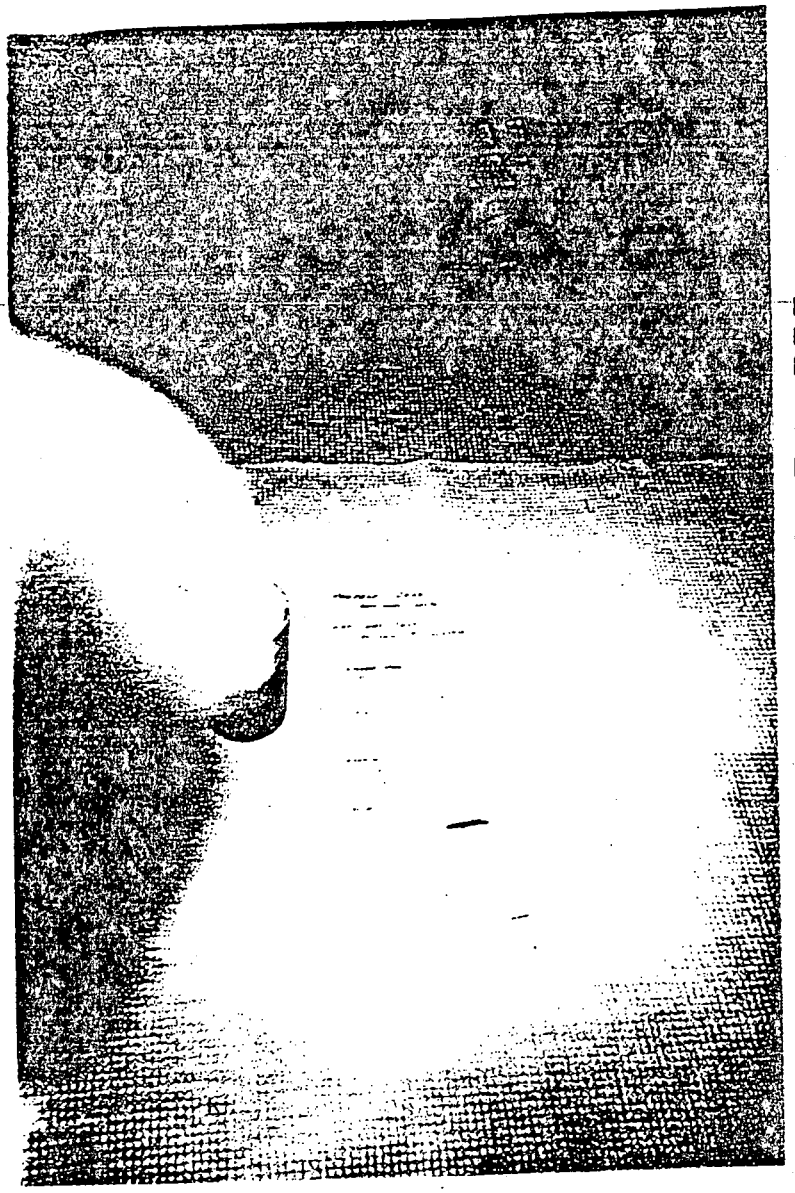
207C w/SILICATE

Mixed 1/17/92

OBSERVATIONS:
Dia: 2.00 in.
Height: 3.90 in.

Water separation during cure
Moderate elephant skin
Moderate scratching
Corner or end flaking

M1 1.2S



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

WET/DRY TEST
~~In cycle. #Completed~~ 5 cycles completed

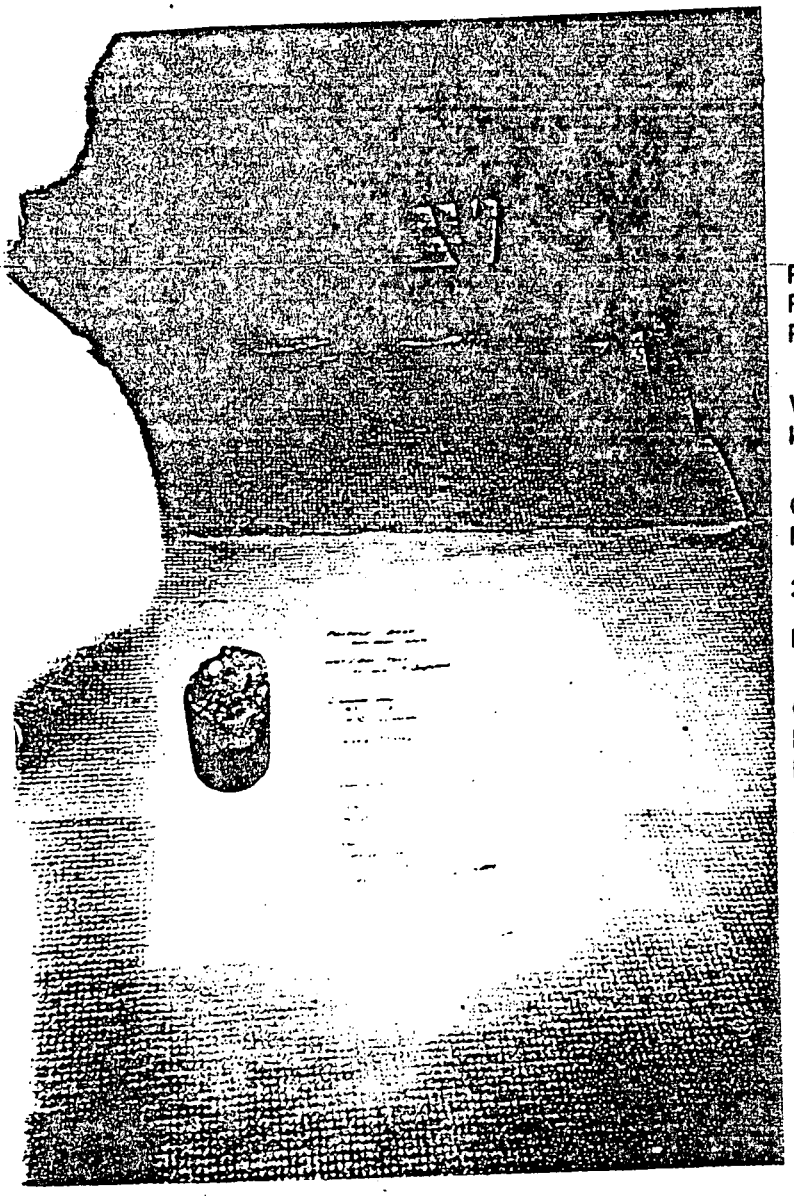
CYLINDER NAME:
M2 2.2S

207C CEMENT/FLYASH/LIME/SILICATE

Mixed 1/17/92

OBSERVATIONS:
Dia: 2.00 in.
Height: 4.01 in.

Moderate elephant skin/cracking
Very little scratching
Small amount end flaking



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

WET/DRY TEST
~~In cycle. #Completed~~ 5 cycles completed

CYLINDER NAME:
M3 3.2S

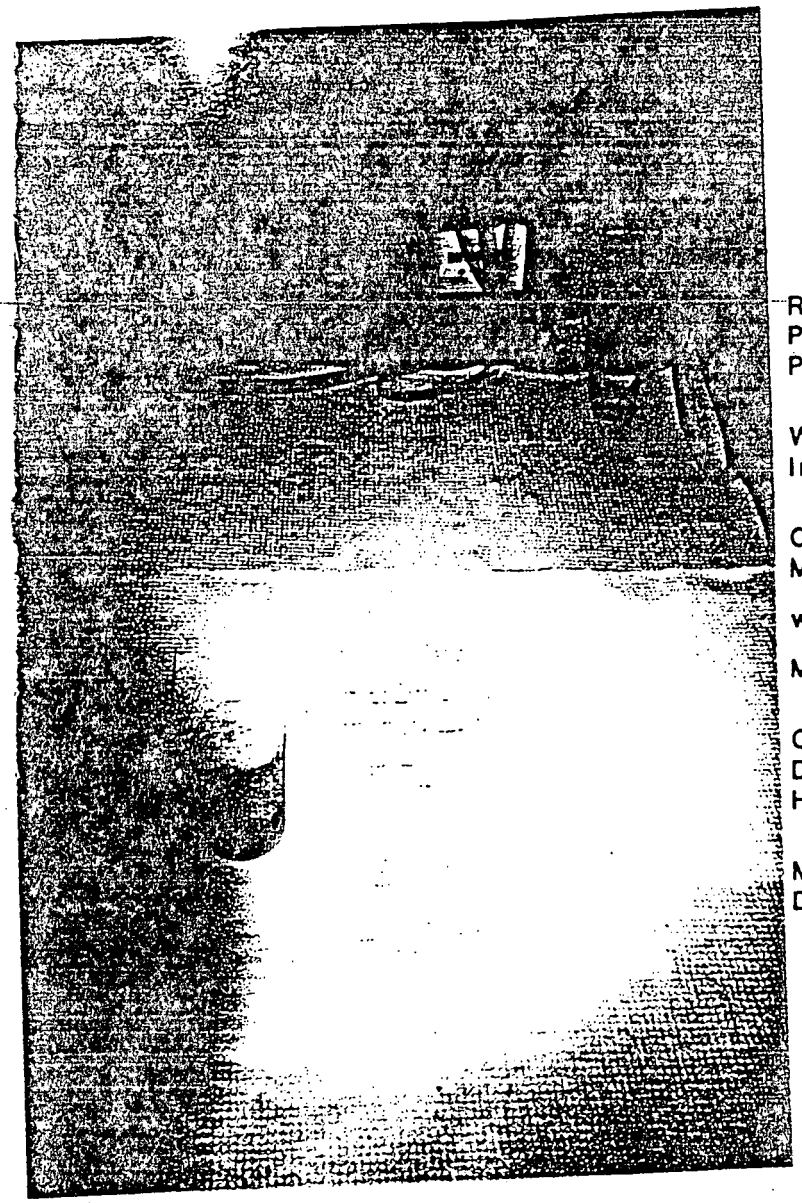
207C w/ SILICATE

Mixed 1/17/92

OBSERVATIONS:
Dia: 1.99 in.
Height: 3.68 in.

Bad cylinder
Moderate hairline cracks
and scratching
Large amount of end flaking

M3 3.2S



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

WET/DRY TEST
In cycle: #Completed

CYLINDER NAME:
M4 4.2S

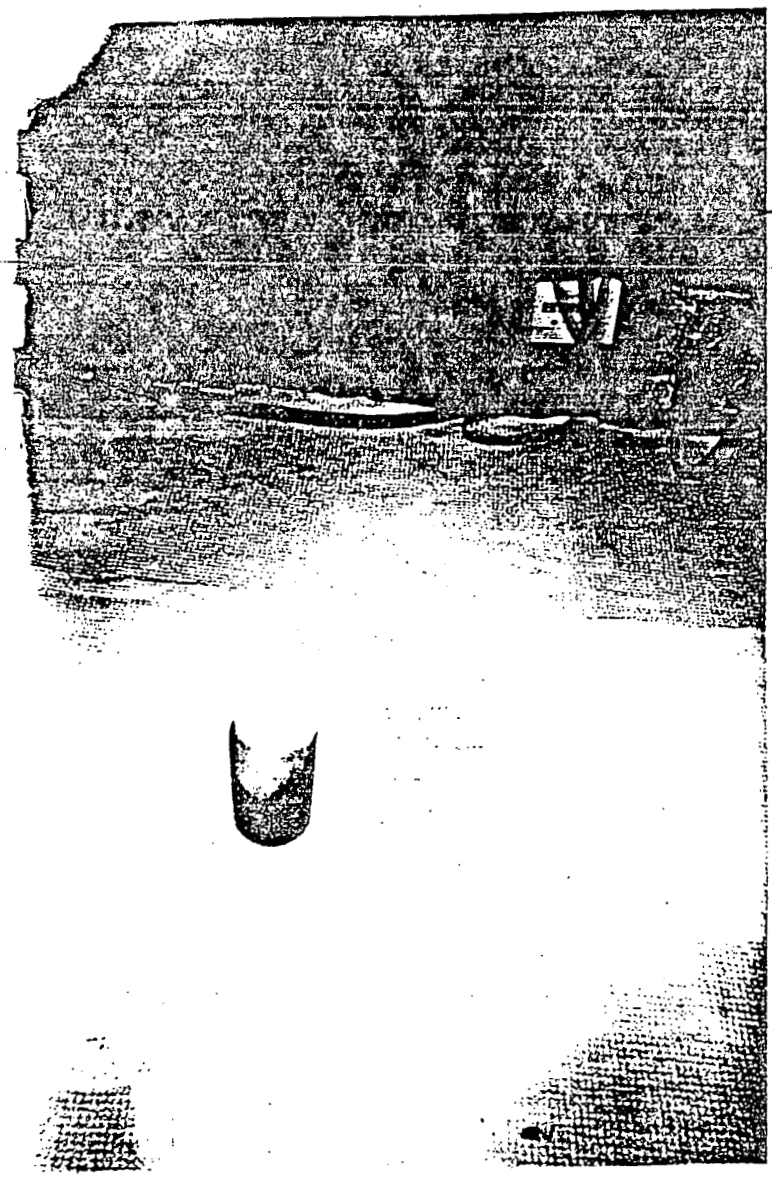
w/ SILICATE – 207C

Mixed 1/17/92

OBSERVATIONS:
Dia: 1.99 in.
Height: 3.81 in.

Moderate elephant skin
Deep scratch with end flaking

M4 4.2S



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

WET/DRY TEST
~~In cycle: #Completed~~ 5 cycles completed

CYLINDER NAME:
M5 5.2S

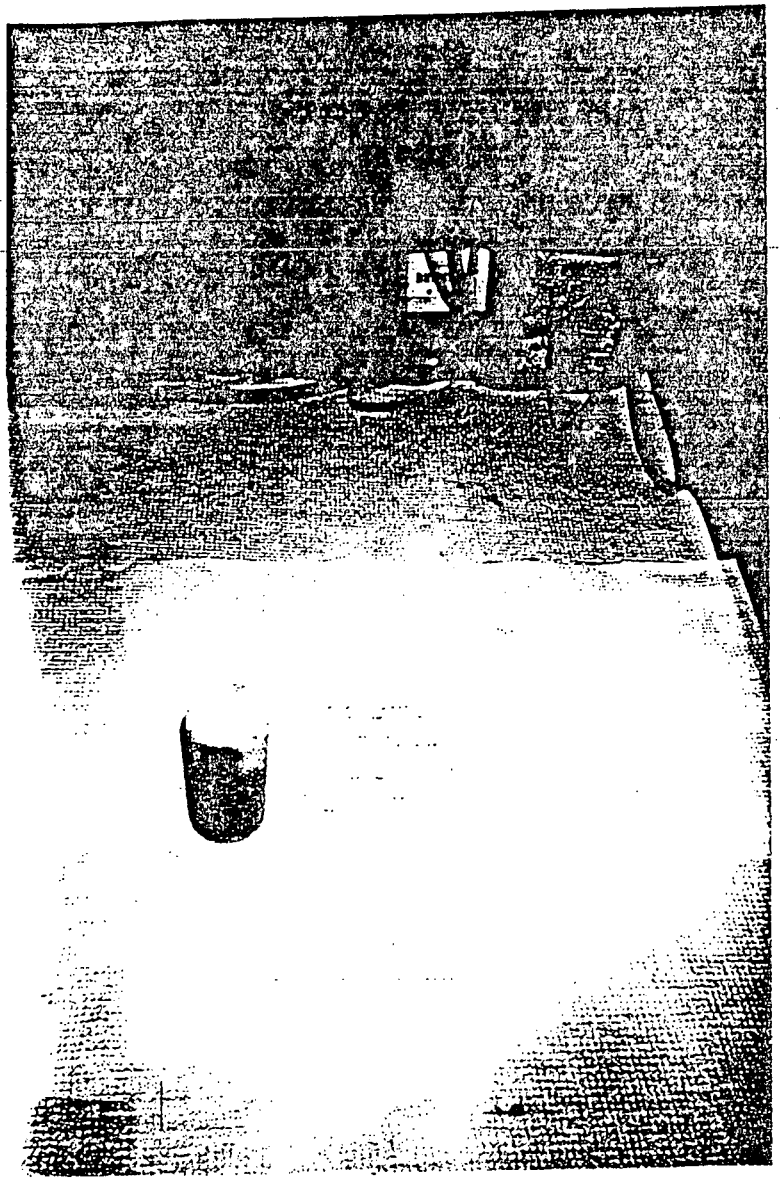
207C w/ SILICATE

Mixed 1/17/92

OBSERVATIONS:
Dia: 1.99 in.
Height: 3.90 in.

Moderate scratching and
hairline cracks

M5 5.2S



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

WET/DRY TEST
~~In cycle: #Completed~~ 5 cycles completed

CYLINDER NAME:
M6 6.2S

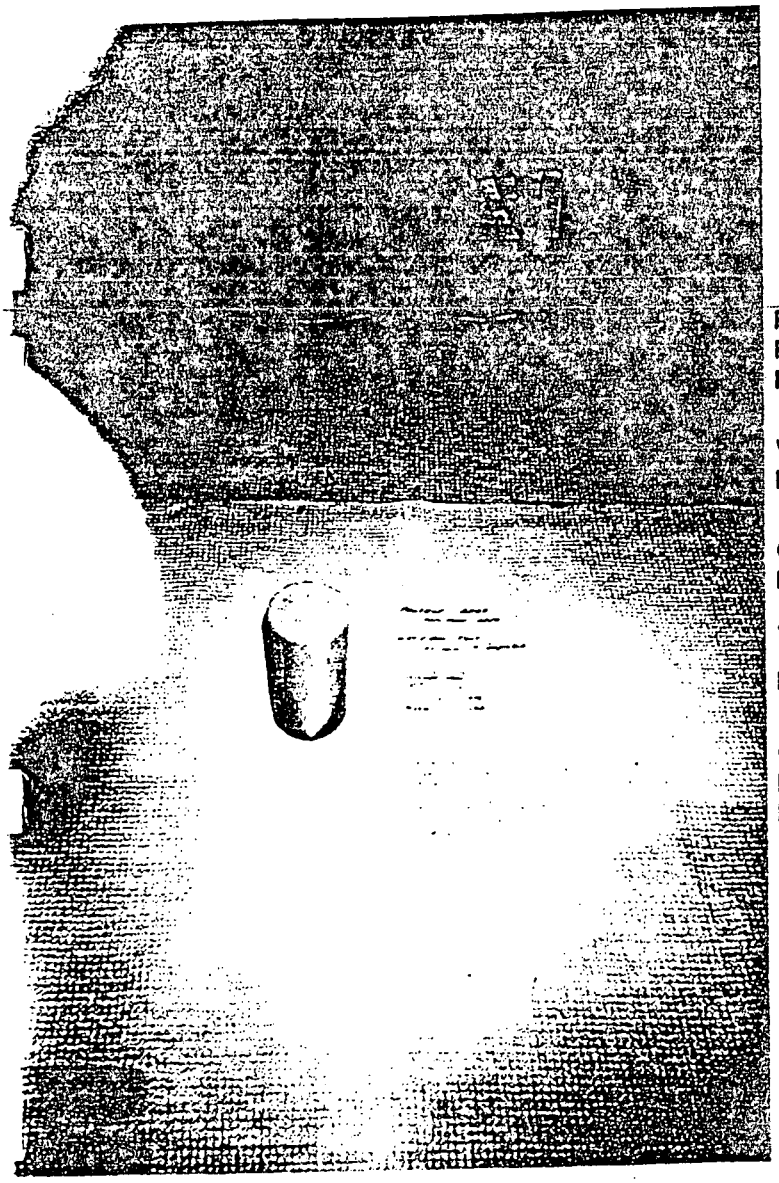
w/ SILICATE – 207C

Mixed 1/17/92

OBSERVATIONS:
Dia: 1.99 in.
Height: 3.91 in.

Moderate scratching
Corner or end flaking
Top showed water separation

M6 6.2S



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

WET/DRY TEST
~~In cycle: #Completed~~ 5 cycles completed

CYLINDER NAME:
M7 7.2S

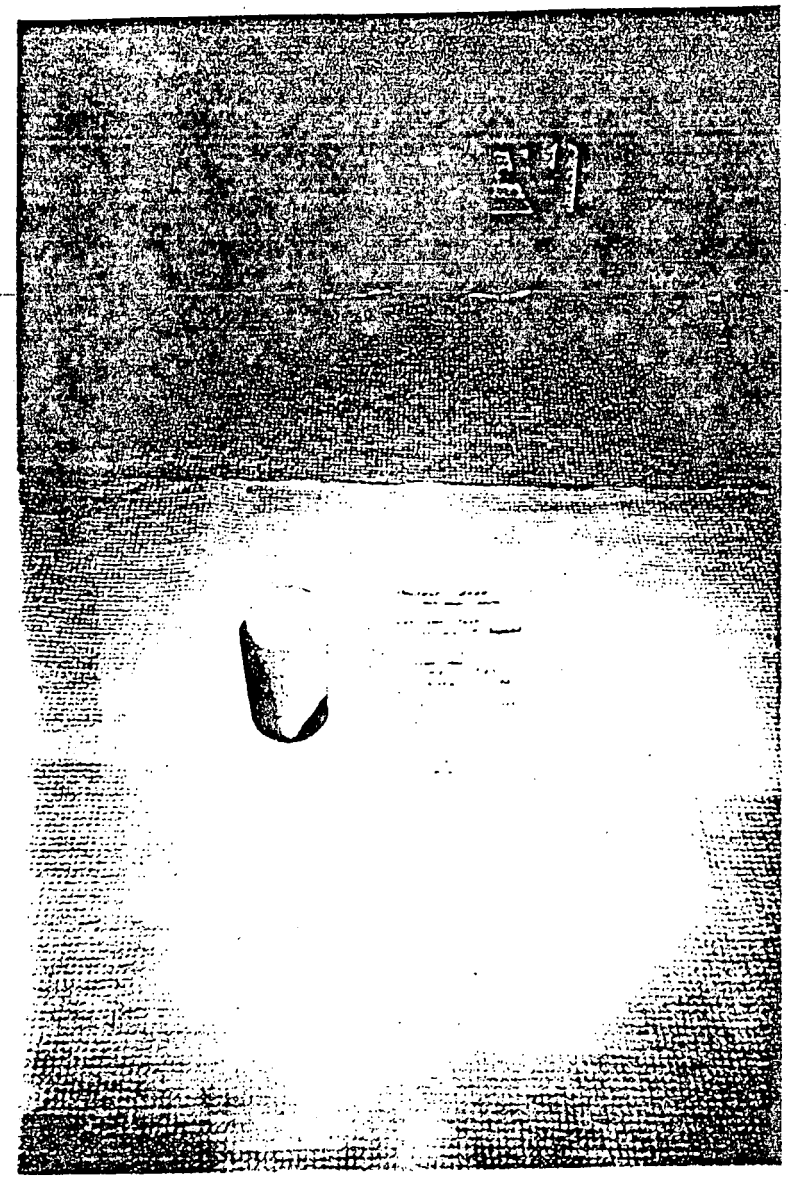
w/ SILICATE - 207C

Mixed 1/17/92

OBSERVATIONS:
Dia: 1.98 in.
Height: 3.95 in.

Moderate scratching
and hairline cracking
and end flaking

M7 7.2S



ROCKY FLATS
PROJECT NO. 2K68
Photo Taken: 2/1/92

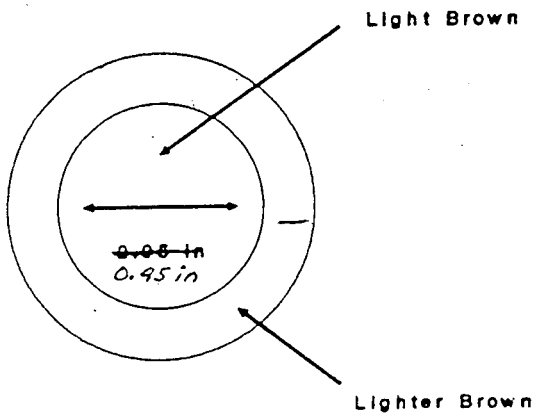
WET/DRY TEST
~~In cycle: #Completed~~ 5 cycles completed

CYLINDER NAME:
M9 9.2S
Mixed 1/17/92

207C w/ SILICATE

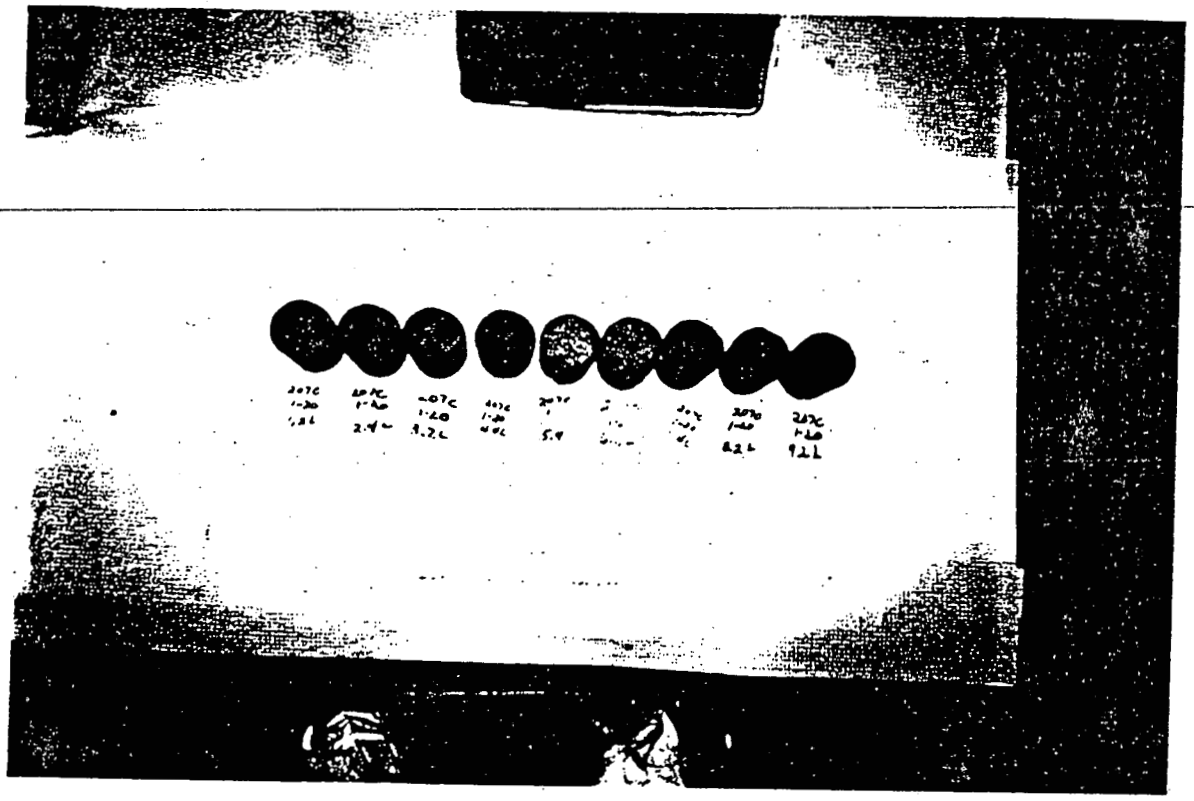
OBSERVATIONS:
Dia: 1.98 in.
Height: 3.82 in.

Moderate hairline cracks
Deep scratches
Moderate end flaking



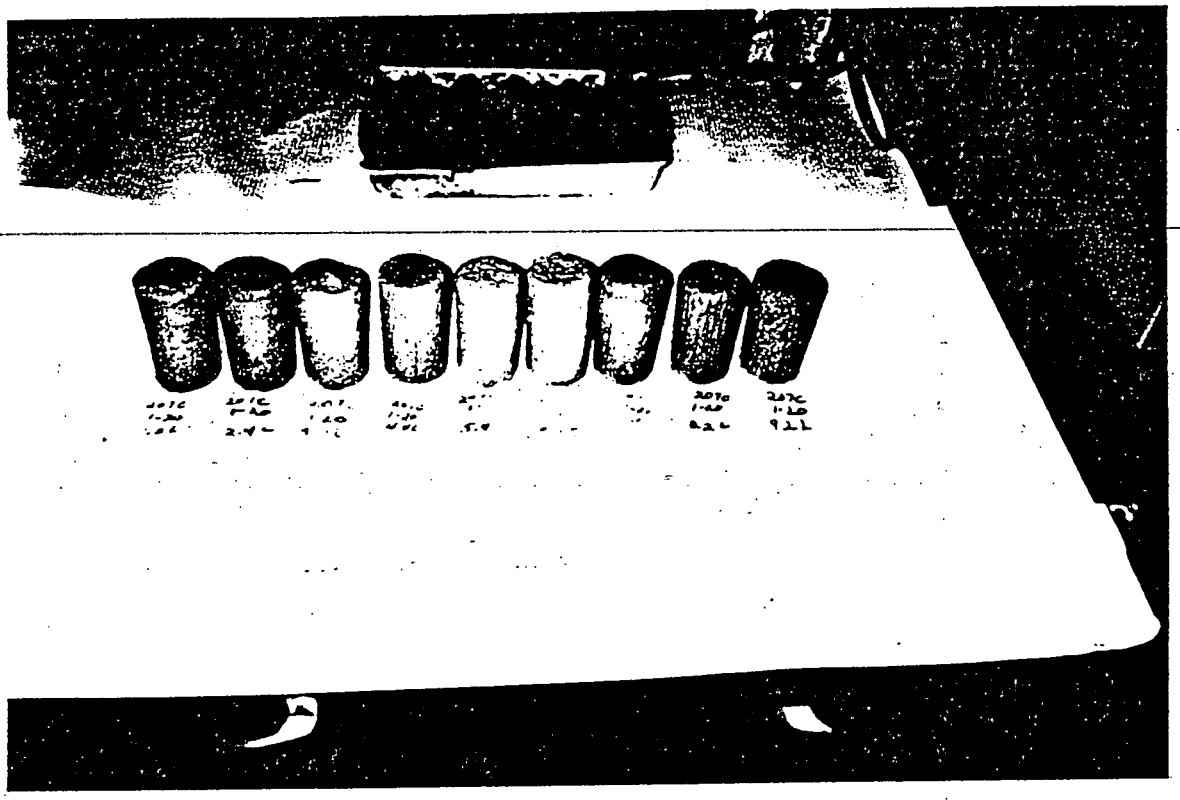
M9 9.2S

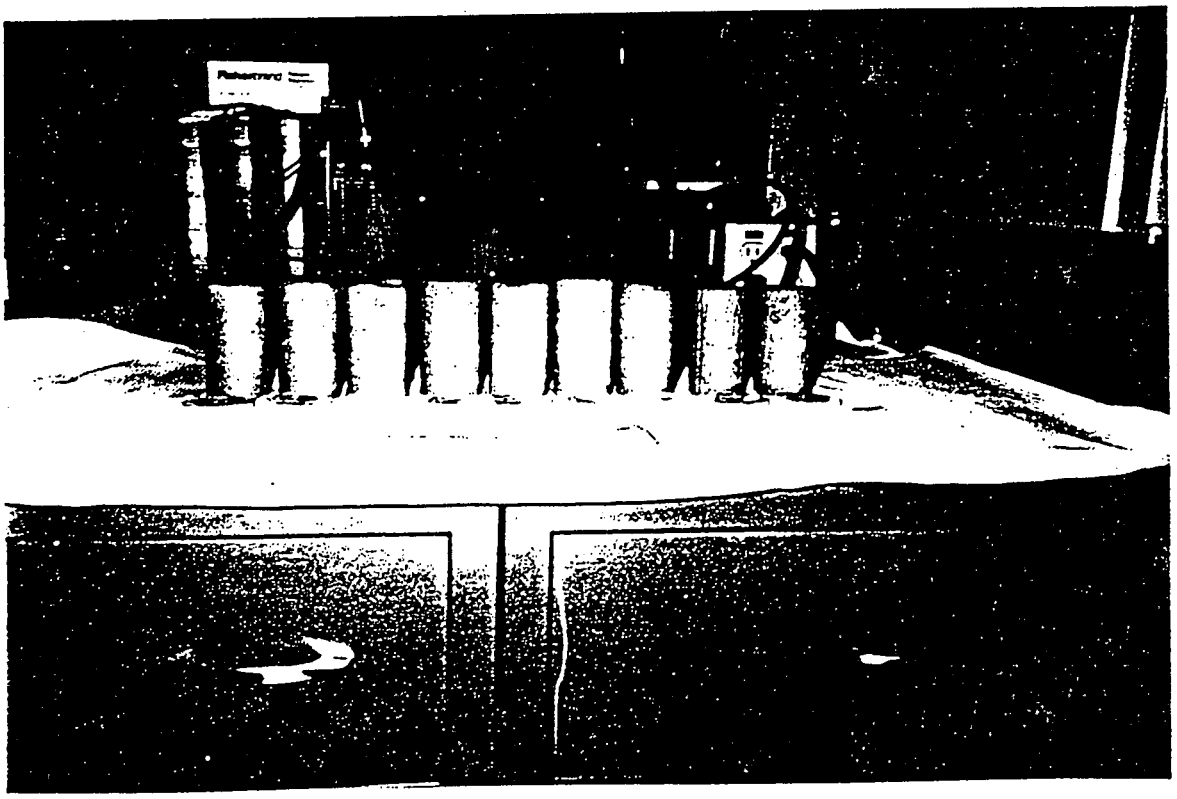
207C WITH LIME/CEMENT/FLYASH + LATEX
FREEZE/THAW CYCLE 10



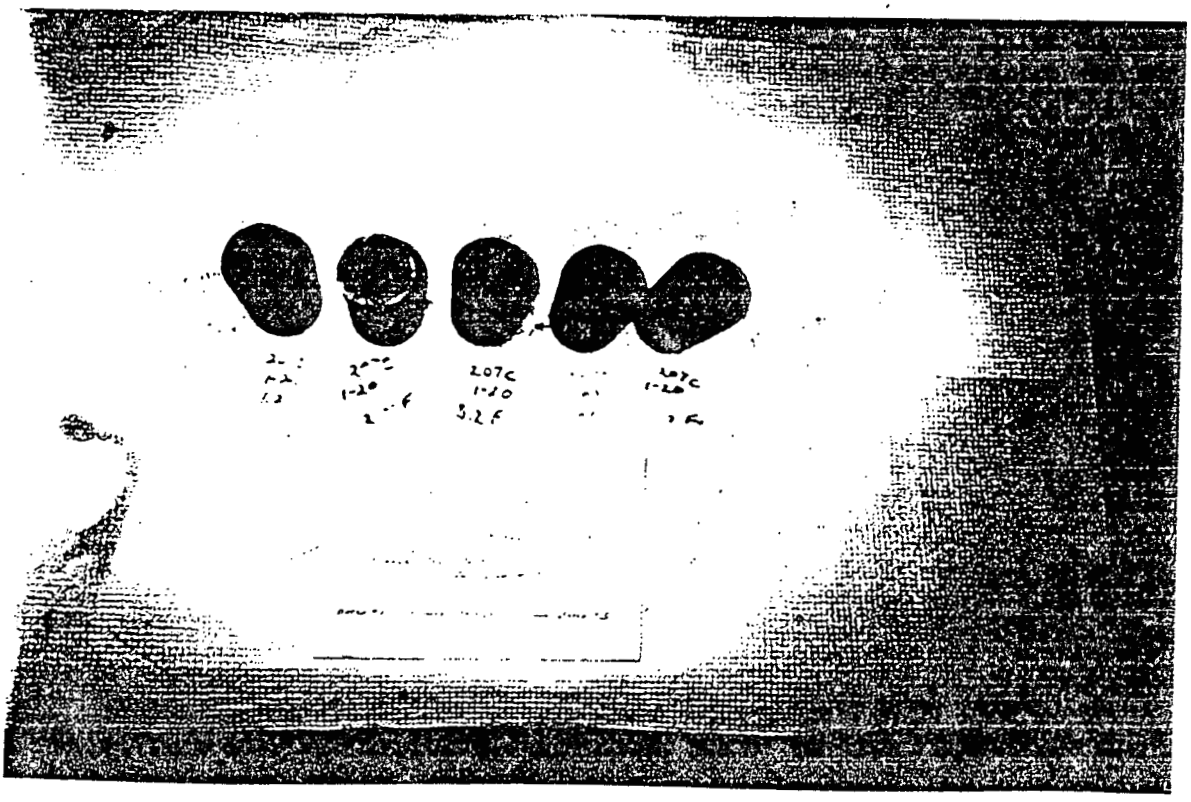
207C WITH LIME/CEMENT/FLYASH + LATEX
WET/DRY CYCLE 10

207C WITH LIME/CEMENT/FLYASH + LATEX
FREEZE/THAW CYCLE 10

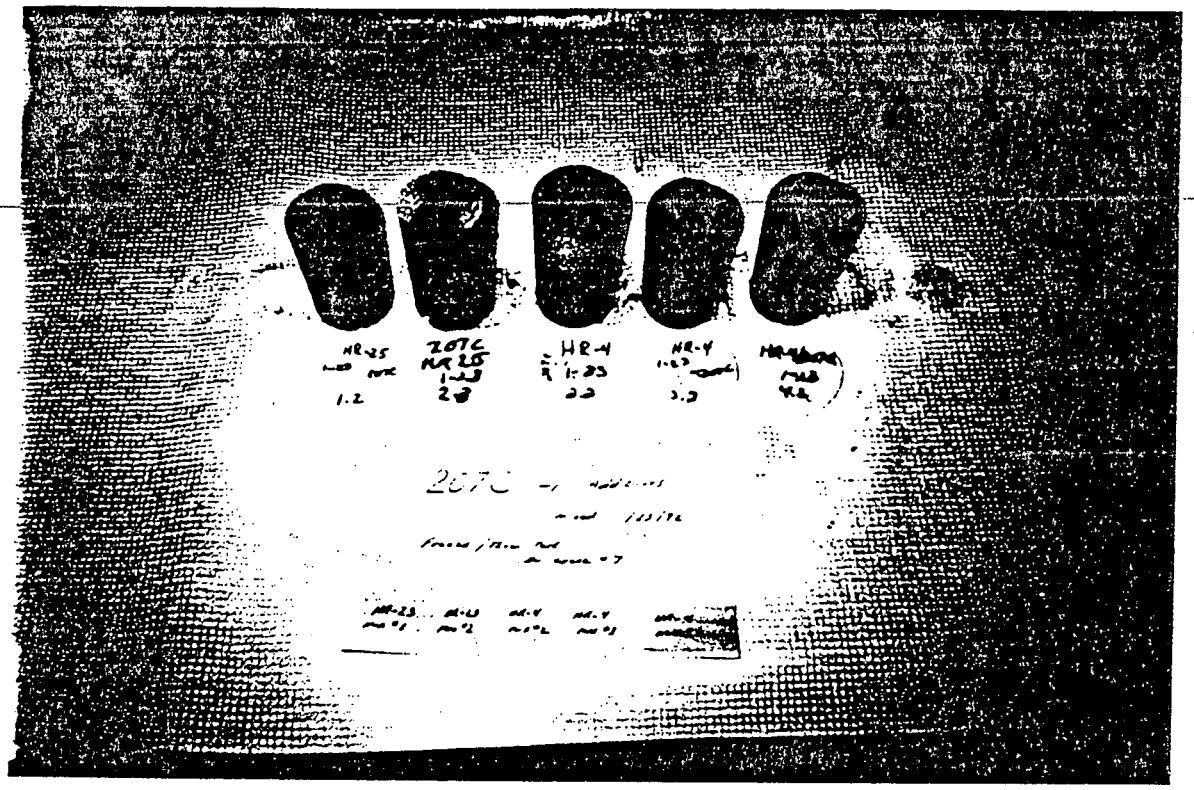


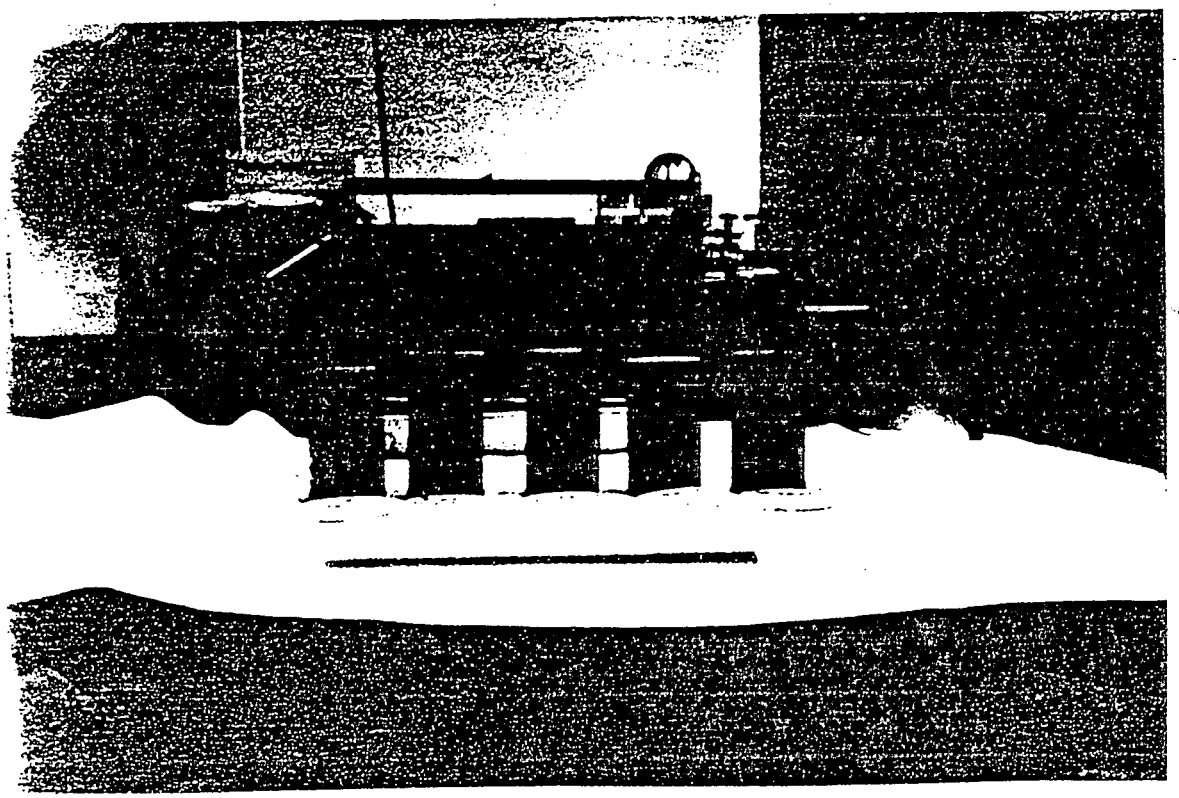


207C WITH LIME/CEMENT/FLYASH + PLASTIC FIBER
FREEZE/THAW CYCLE 10

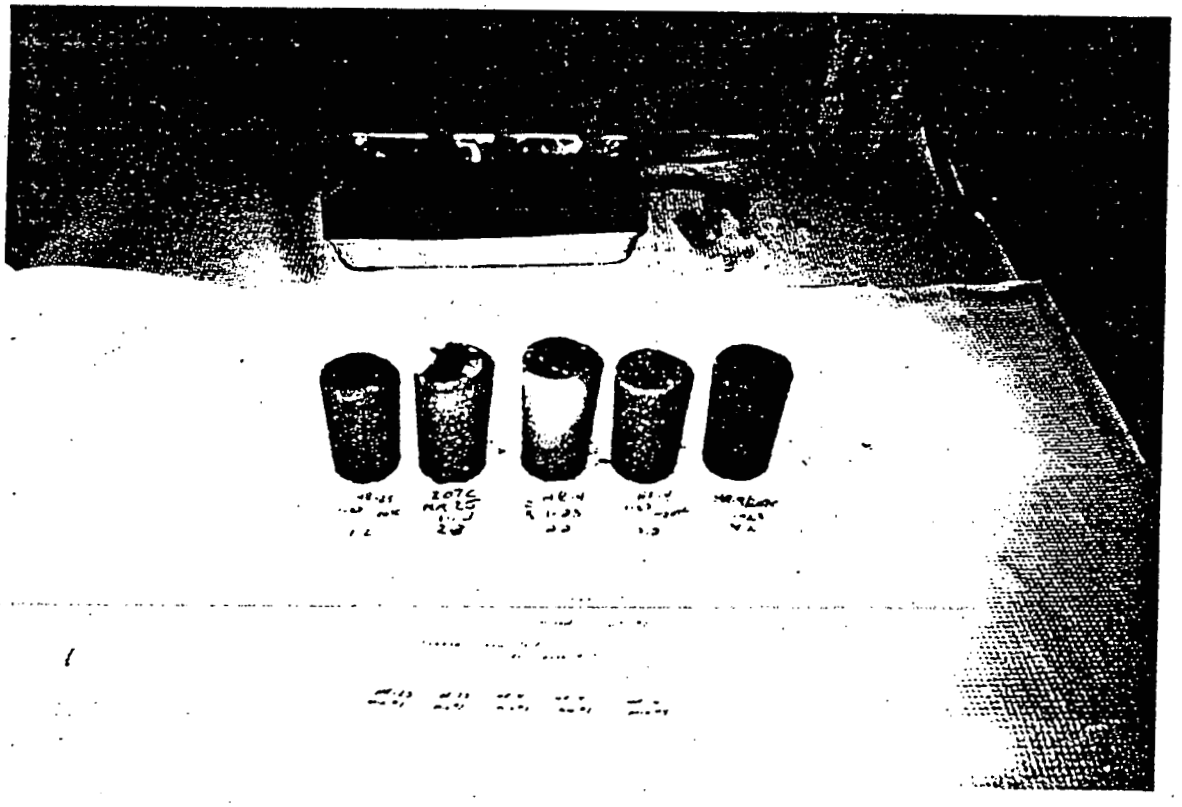


207C WITH LIME/CEMENT/FLYASH + HR4 AND HR25
FREEZE/THAW CYCLE 7

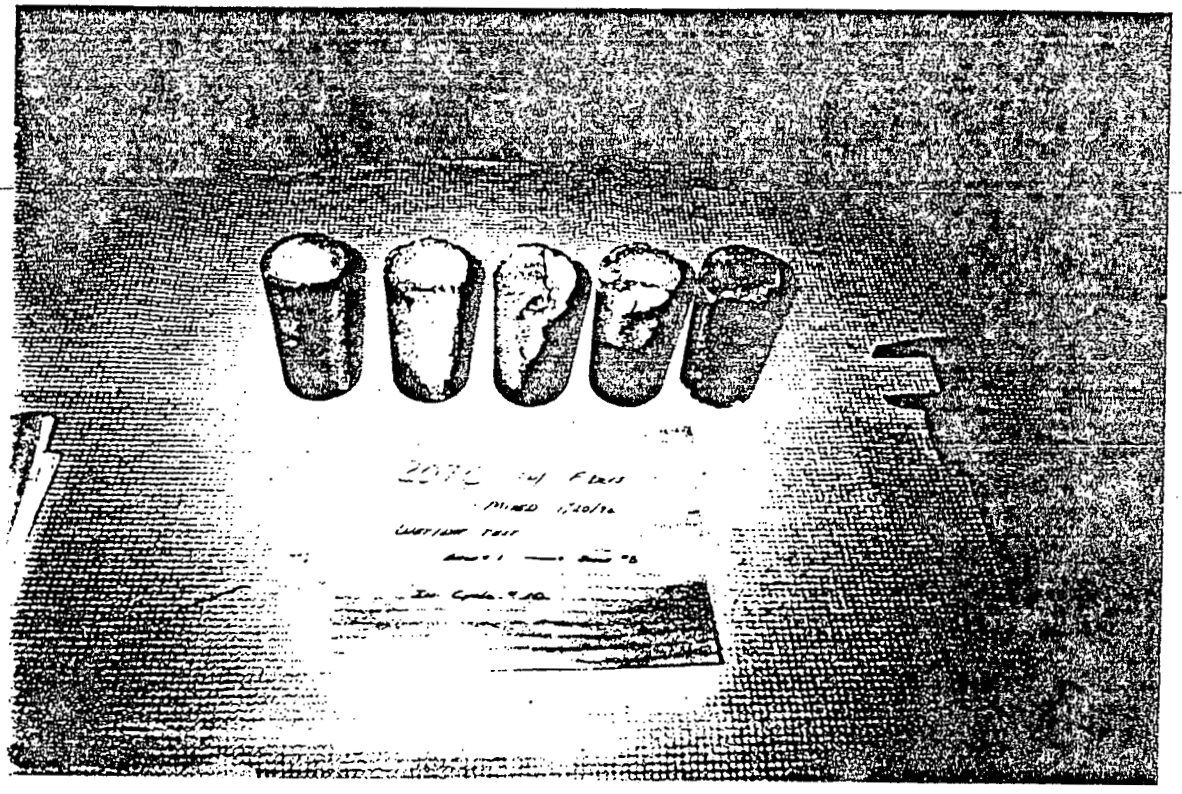




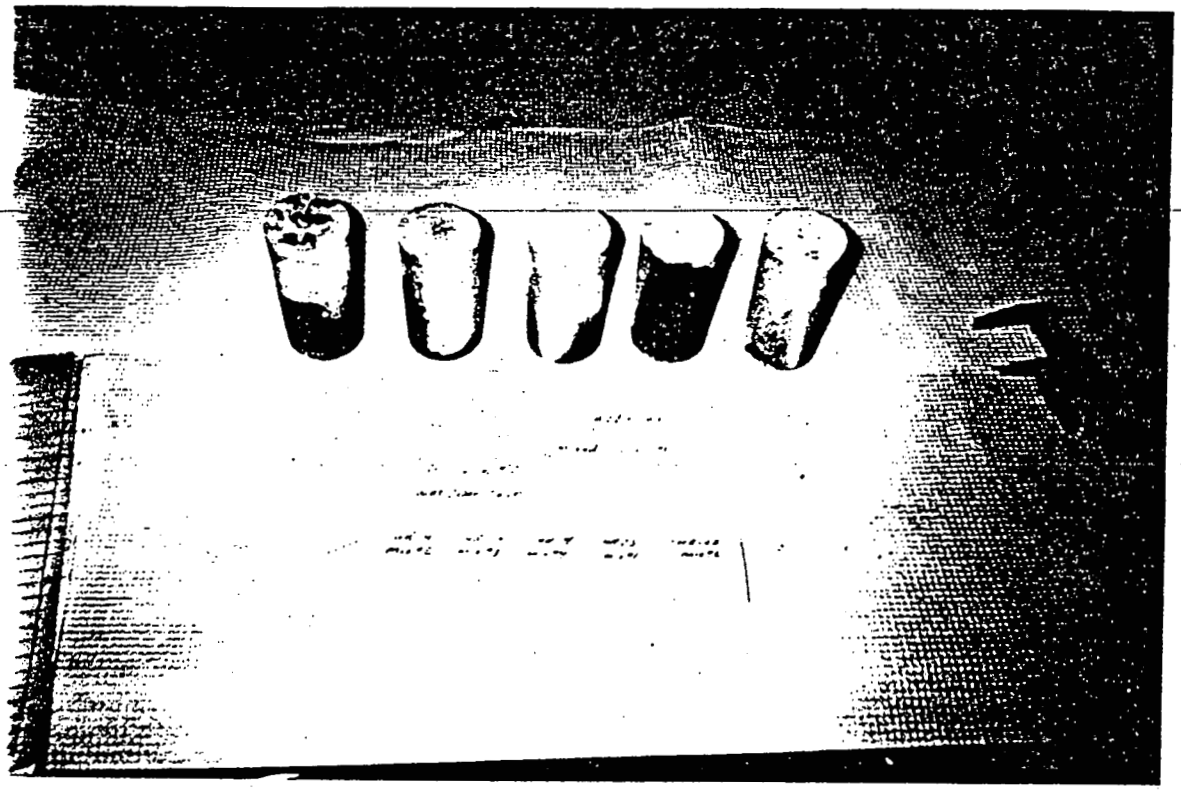
207C WITH LIME/CEMENT/FLYASH + HR4 AND HR25
FREEZE/THAW CYCLE 7



207C WITH LIME/CEMENT/FLYASH + PLASTIC FIBERS
WET/DRY CYCLE 10



207C WITH LIME/CEMENT/FLYASH + HR4 AND HR25
WET/DRY CYLCE 7



APPENDIX C

FLYASH SPEC SHEETS

REPORT OF FLY ASH ANALYSIS

RESOURCE MATERIALS TESTING, INC.

"Specialists in Fly Ash Testing"

REPORT TO: Western Ash Company
4380 S. Syracuse Street
Suite 305
Denver, CO 80237
Attn: Mr. Harry Roof

PROJECT NO.: RMT-021
SAMPLE NO.: 2381
DATE REC.: 4-5-90
DATE REP.: 5-8-90

PROJECT NAME: Pawnee Plant Fly Ash Q.A. Program

SAMPLE ID: Class C Fly Ash QAP #137 March '91

PARAMETER	RESULTS	ASTM C618 SPEC. F/C
CHEMICAL ANALYSES		
Silicon Dioxide, SiO_2, %	34.1	---
Aluminum Oxide, Al_2O_3, %	20.5	---
Iron Oxide, Fe_2O_3, %	7.2	---
Sum of SiO_2, Al_2O_3, Fe_2O_3, %	61.8	70/50 min
Calcium Oxide, CaO, %	26.1	---
Magnesium Oxide, MgO, %	6.1	---
Sodium Oxide, Na_2O, %	---	---
Potassium Oxide, K_2O, %	---	---
Sulfur Trioxide, SO_3, %	2.7	5.0 max
Moisture Content, %	0.02	3.0 max
Loss on Ignition, %	0.27	6.0 max
Available Alkalies as Na_2O, %*	1.20	1.5 max
PHYSICAL ANALYSES		
Amount Retained on No. 325 Sieve, %	14.1	34 max
Pozzolanic Activity Index		
Portland Cement at 7 days, % of Control	105	75 min
Portland Cement at 28 days, % of Control	109	75 min
Lime at 7 days, psi	---	800/NA min
Water Requirement, % of Control	91	105 max
Autoclave Expansion, %	+0.05	0.8 max
Specific Gravity	2.74	---
Increase of Drying Shrinkage, %*	---	0.03 max
Reactivity with Cement Alkalies, %*		
Reduction of Mortar Expansion, %	---	---
Mortar Expansion, %	---	0.020 max

*Optional requirements applicable only when requested by the purchaser.

By Robert L. Smith

Robert L. Smith, Ph.D.

532 Myrtle Street, S.W. • Gainesville, Georgia 30501 • (404) 287-7907 • FAX (404) 287-7920

REPORT OF FLY ASH ANALYSIS

RESOURCE MATERIALS TESTING, INC.

"Specialists in Fly Ash Testing"

REPORT TO: Western Ash Company
4380 S. Syracuse Street
Suite 305
Denver, CO 80237
Attn: Mr. Harry Roof
Comanche #1

PROJECT NO.: RMT-018
SAMPLE NO.: 2379
DATE REC.: 4-5-90
DATE REP.: 5-8-90

PROJECT NAME: Comanche Plant Fly Ash Q.A. Program

SAMPLE ID: Class C Fly Ash QAP #119 March '91

PARAMETER	RESULTS	ASTM C618 SPEC. F/C
CHEMICAL ANALYSES		
Silicon Dioxide,SiO2,%	29.5	---
Aluminum Oxide,Al2O3,%	22.8	---
Iron Oxide,Fe2O3,%	5.1	---
Sum of SiO2,Al2O3,Fe2O3,%	57.4	70/50 min
Calcium Oxide,CaO,%	28.9	---
Magnesium Oxide,MgO,%	5.1	---
Sodium Oxide,Na2O,%	---	---
Potassium Oxide,K2O,%	---	---
Sulfur Trioxide,SO3,%	3.7	5.0 max
Moisture Content,%	0.01	3.0 max
Loss on Ignition,%	1.13	6.0 max
Available Alkalies as Na2O,%*	3.52	1.5 max
PHYSICAL ANALYSES		
Amount Retained on No. 325 Sieve,%	13.7	34 max
Pozzolanic Activity Index		
Portland Cement at 7 days, % of Control	92	75 min
Portland Cement at 28 days,% of Control	94	75 min
Lime at 7 days, psi	---	800/NA min
Water Requirement, % of Control	93	105 max
Autoclave Expansion, %	+0.05	0.8 max
Specific Gravity	2.66	---
Increase of Drying Shrinkage,%*	---	0.03 max
Reactivity with Cement Alkalies,%*		
Reduction of Mortar Expansion,%	---	---
Mortar Expansion,%	---	0.020 max

*Optional requirements applicable only when requested by the purchaser.

By Robert L Smith

Robert L. Smith, Ph.D.

532 Myrtle Street, S.W. • Gainesville, Georgia 30501 • (404) 287-7907 • FAX (404) 287-7920

WAL, Inc.

6385 W 52nd Ave., #5 (303) 420-7700 Arvada, CO 80002

June 6, 1991

Mr. Matt Lahrs
Western Ash Company
4380 S. Syracuse St. Suite 305
Englewood, CO 80155

WAL # 91177-1
Sample ID: COMMANCHE #2

CHEMICAL ANALYSIS
WT%, DRY BASIS

Silicon Dioxide, SiO2	34.86	
Aluminum Oxide, Al2O3	17.96	
Iron Oxide, Fe2O3	5.75	
Total (SiO2 + Al2O3 + Fe2O3)		58.57
Calcium Oxide, CaO	27.93	
Magnesium Oxide, MgO	4.60	
Sodium Oxide, Na2O	1.55	
Potassium Oxide, K2O	0.22	
Titanium Dioxide, TiO2	1.58	
Manganese Dioxide, MnO2	0.16	
Phosphorus Pentoxide, P2O5	1.22	
Strontium Oxide, SrO	0.51	
Barium Oxide, BaO	0.60	
Sulfur Trioxide, SO3	2.59	
Loss on Ignition	0.50	
Moisture, as Received	0.13	

Laboratory Manager

HALLIBURTON NUS
Environmental Laboratories

5350 Campbells Run Road
Pittsburgh, PA 15205
800-228-6870

6751-L Engle Road
Cleveland, OH 44
216-891-4700

CLIENT DUPLICATE

September 26, 199
Report No.: 00002813
Section A Page 1

LABORATORY ANALYSIS REPORT

CLIENT NAME: HALLIBURTON NUS ENVIRONMENTAL
ADDRESS: 5950 N. COURSE DR/P.O BOX 721110
HOUSTON, TX 77272-
ATTENTION: MR. DON BRENNEMAN

NUS CLIENT NO: 0165 00
WORK ORDER NO: 2x66
VENDOR NO:

Carbon Copy:

SAMPLE ID: WESTERN ASH / COMANCHE FLYASH #1
NUS SAMPLE NO: P0165726
P.O. NO.:

DATE SAMPLED: UnAvail
DATE RECEIVED: 17-JUN-9
APPROVED BY: J Simari

LN	TEST CODE	DETERMINATION	RESULT	UN
1	R035	Gross Alpha and Beta Screen		
		Gross Alpha Screen	33 +/- 10	pCi/g
		Gross Beta Screen	23 +/- 8	pCi/g
2	TIS	Available Calcium Oxide	4.9	%

COMMENTS:

CLIENT DUPLICATE

HALLIBURTON NUS
Environmental Laboratories

5350 Campbells Run Road
Pittsburgh, PA 15205
800-228 6870

6751-L Engle Road
Cleveland, OH 44130
216-891-4700

September 25, 1991
Report No.: 00002513
Section A Page 2

LABORATORY ANALYSIS REPORT

CLIENT NAME: HALLIBURTON NUS ENVIRONMENTAL
ADDRESS: 5950 N. COURSE DR/P.O BOX 721110
HOUSTON, TX 77272-
ATTENTION: MR. DON BRENNEMAN

NUS CLIENT NO: 0165 0075
WORK ORDER NO: 2K6E
VENDOR NO:

Carbon Copy:

SAMPLE ID: WESTERN ASH / COMANCHE FLYASH #2
NUS SAMPLE NO: P0165727
P.O. NO.:

DATE SAMPLED: Unavail
DATE RECEIVED: 17-JUN-91
APPROVED BY: J Simanic

LN	TEST CODE	DETERMINATION	RESULT	UNITS
1	R03S	Gross Alpha and Beta Screen		
		Gross Alpha Screen	42 +/- 10	pCi/g
		Gross Beta Screen	29 +/- 8	pCi/g
2	T15	Available Calcium Oxide	4.0	%

COMMENTS:

HALLIBURTON NUS
Environmental Laboratories

5350 Campbells Run Road
Pittsburgh, PA 15205
800-228-6870

6751-L Engle Road
Cleveland, OH 44130
216-891-4700

September 25, 1991
Report No.: 00002761
Section A Page 1

LABORATORY ANALYSIS REPORT

CLIENT NAME: HALLIBURTON NUS ENVIRONMENTAL
ADDRESS: 5950 N. COURSE DR/P.O BOX 721110
HOUSTON, TX 77272-
ATTENTION: MR. DON BRENNEMAN

NUS CLIENT NO: 0165 0075
WORK ORDER NO: 2K68
VENDOR NO:

Carbon Copy:

SAMPLE ID: WESTERN ASH CO. - PAWNEE FLYASH
NUS SAMPLE NO: P0165665
P.O. NO.:

DATE SAMPLED: UnAvail
DATE RECEIVED: 14-JUN-91
APPROVED BY: J Simanic

LN	TEST CODE	DETERMINATION	RESULT	UNIT
1	R03S	Gross Alpha and Beta Screen		
		Gross Alpha Screen	31 +/- 9	pCi/g
		Gross Beta Screen	19 +/- 7	pCi/g
2	T15	Available Calcium Oxide	4.6	%

COMMENTS: