Title 40 CFR Part 191
Compliance Certification
Application
for the
Waste Isolation Pilot Plant

MASS Attachment 16-1

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WPO 38579

Westinghouse Electric Corporation
Government and Environmental Services Company

WS:96:03106
DA:96:11019
Waste Isolation Division
Box 2078
Carlsbad New Mexico 88221

April 4, 1996

INFORMATION ONLY

Mr. Mel Marietta, Manager
WIPP Project Compliance Department
Sandia National Laboratories
115 N. Main Street
Carlsbad, NM 88220

Subject: BOREHOLE PLUGGING IN THE DELAWARE BASIN

Dear Mr. Marietta:

Per our verbal discussion, please find attached summary results of regulatory analyses and records research used to determine plugging and abandonment practices in the Delaware Basin. The results summarized in the attachment are based on actual drilling and plugging records from the Bureau of Land Management and the Oil Conservation Division offices, that are most current and complete sources available.

The plug arrangements, material thicknesses, casing and cement specifications, and associated patterns are summarized by type so as to facilitate developing a conceptual model and probability distribution for time dependent plug performance in the Performance Assessment (PA).

This information will be the basis upon which Mr. B. Thompson of CTAC will provide the PA distribution. The case file for the CTAC work should be added to the detailed records package that supports the summary level conclusions attached here. The detailed records for the attached summary will be provided to you in a few days.

Should you have any questions, please contact Mr. Ross Kirkes of my staff at (505) 234-8145, or myself at 234-8380.

Sincerely,

B. A. Howard, Manager
Long-Term Regulatory Compliance

hmp

Attachments

cc: D. R. Anderson, SNL-AL
G. T. Basabilvazo, CAO
J. E. Bean, SNL-AL
M. S. Y. Chu, SNL-AL
J. H. Maes, CAO
J. A. Mewhinney, CAO
B. Thompson, CTAC

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BOREHOLE PLUGGING IN THE DELAWARE BASIN

EXPLANATION OF ASSUMPTIONS

The purpose of the Delaware Basin Drilling and Plugging Study was two-fold: 1) to determine the fraction of boreholes currently plugged in the basin; and 2) to provide a basis for the development of a conceptual model for long-term performance of plugged boreholes. This study has not attempted to predict the effectiveness of plugs, but only identify the location and physical characteristics of plugs which might be important to performance assessment.

Guidance in 40 CFR 194 states that "Performance assessments should assume that the permeability of sealed boreholes will be affected by natural processes, and should assume that the fraction of boreholes that will be sealed by man equals the fraction of boreholes which are currently sealed in the Delaware Basin." The rule also states that "...drilling practices will remain as those of today."

Using the guidance above, the following assumptions were used in the study:

1) In determining the fraction of plugged holes, all New Mexico wells in the Delaware Basin which are subject to plugging and abandonment (under the most recent plugging regulations [1988]) were analyzed. This analysis is consistent with the future state assumption provided in the guidance and includes boreholes on both state and federal land. Boreholes in the Texas portion of the Delaware Basin have been excluded by the future states interpretation taken from 40 CFR 194. That is, boreholes in Texas are currently plugged according to Texas state plugging regulations. These regulations are not currently applicable to the WIPP, and therefore will not be applicable in the future. These criteria result in a sample size of 194.

2) Initially, to find an appropriate plugging analogue for the WIPP, the study considered only boreholes on federal land, in the potash enclave, in a barren area that have been drilled and were subject to plugging under the most recent regulations (since 1988). The exclusion of state land from this sample was supported by the argument that WIPP currently resides on land under federal ownership, and therefore falls under plugging and abandonment regulations imposed by the Bureau of Land Management (BLM). In addition, the WIPP is within the potash enclave, but is in a barren area, where potash grades and quantities are not of economic value. This set of bounding conditions appeared to be the most accurate description of an analogue for a borehole which might occur at the WIPP.

Unfortunately, these selection criteria resulted in only one plugged borehole. This situation is due to the fact that drilling in potash areas is not generally allowed by regulators. Interestingly, the single borehole identified was not plugged per the applicable R-111-P requirements; waivers from this requirement are granted due to the fact that in barren areas, there is no potash ore to protect. Clearly, a sample size of one is not adequate to determine plugging practice in the area of interest.

Based on this finding, these criteria were modified to include all boreholes in the New Mexico portion of the Delaware Basin subject to plugging since 1988 under BLM regulations, without regard to potash. After examining the data from these boreholes, it became apparent that there is little variability in plugging procedures for wells on federal land. That is, boreholes on federal land are plugged in a consistent manner regardless of whether or not the borehole is within the potash enclave. Interestingly, one borehole has been identified which does meet the R-111-P requirements, however, it is not within the R-111-P area. Use of these criteria resulted in a sample size of 115.

For completeness, wells plugged on state land since 1988 were added to the sample to help determine any significant differences in plugging practices between state and federal procedures. There have been 73 wells on state land plugged and abandoned since 1988, raising the total sample to 188.

3) For the purposes of this study, only boreholes with depths greater than 2,150 ft were considered. Pressurized brine is assumed to be at depths from 2700 - 3000.

CONCLUSIONS

Frequency

As mentioned, the fraction of plugged boreholes in the Delaware Basin must be known and used for input in performance assessment. Using the sample size of 194, the records reveal 188 plugged and abandoned boreholes, and 6 unplugged boreholes. Of these 6 unplugged boreholes, each have proposals to plug and abandon filed with the appropriate regulatory agency. Westinghouse personnel have field verified and/or verbally communicated with regulatory personnel regarding each of these wells and have noted that 5 of these boreholes have in fact been plugged and abandoned. The records, however, have not been brought up to date. The remaining 1 borehole is merely in the interim period between the proposal to plug and the actual plugging activities. The important point here is that these boreholes have not been forgotten or neglected; they are somewhere along the prescribed regulatory sequence. Once these boreholes are plugged, a final record stating the exact procedure used, composition, location, and length of all plugs emplaced will be filed with the regulatory agency. The study suggests that plugging and abandonment regulations are followed consistently, and that no wells in the basin have been left unplugged since the implementation of the most current regulation. Therefore, it is recommended that performance assessment

assume a 100% plugging frequency. An alternative to this would be to use 99% to ensure that wells that are not captured by the records management system do not invalidate the performance assessment calculations using a 100% frequency.

Configuration

Type I 50,

To determine the typical configuration and composition of a borehole plug, the study considered both current drilling and plugging practices. Records of the plugged boreholes have revealed that the surface casing rarely extends beyond 800', and there is almost always a plug at this transition in casing size. It is therefore reasonable to assume by applying current practice to a borehole occurring at WIPP, that there will typically be a surface casing shoe plug below the Culebra (at approximately 800').

Current practice also shows consistent use of the intermediate casing shoe plug. Conversations with drillers have indicated that drilling proceeds relatively quickly through the salt, until the Lamar Limestone is encountered. This formation is a thin unit that lies directly below the Castile formation. When this unit is reached, drilling ceases and the intermediate casing string is installed. It is at this transition in casing size that another plug will be installed upon plugging and abandonment. Drillers have confirmed that this is done without consideration to any pressurized brine that may or may not have been encountered in overlying strata. Therefore, it is reasonable to assume that a borehole at WIPP would typically have an intermediate casing shoe plug near the base of the Castile (at approximately 4000 ft). The location of these two plugs represent the Type I plug.

Type II and III

Other plugging configurations exist in the Delaware Basin. For example, in cases where the production casing is removed upon abandonment, a plug is required at this interval. The depth at which this casing is cut and removed is a function of practicality and economics. If the casing is in sufficient condition to salvage upon abandonment, that portion may be removed. This depth may vary from approximately 4000' to approximately 1200'. Typically, this would occur somewhere within the intermediate casing string. For the purposes of this study, we have called this plug the "stub" or "intermediate plug of significance." Plugs of this type may occur at depths greater than 4000', but have no importance or protective capability with regard to the repository or the hypothetical brine pocket.

The placement of this intermediate plug is of particular interest in generating a conceptual model for the borehole plug. If this plug exists between the repository and the hypothetical brine pocket (2150' - 2700'), some protection may be provided from the infiltration of brine. Plugging configurations such as this are represented by the Type II plug.

15

If this intermediate plug is above 2150', it may have the negative effect of directing flow into the repository from the underlying brine pocket. This situation is represented by the Type III plug. Both the Type II and Type III plugging configurations include the upper and lower plugs evident in the Type I plug.

Type IV

In some cases, intermediate plugs in addition to those of Type II have been emplaced. These are represented here as Type IV plugs.

Type V

In very few cases, only a surface plug and a bottom or lower plug is evident. Such configurations meet the minimum regulatory requirements, provided that the borehole did not encounter any water bearing zones. While this would not be the case at the WIPP, they have occurred within the Delaware Basin, and are included here for completeness. This configuration represents the Type V plug.

Type VI

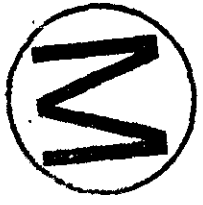
The Type VI plug is a solid cement plug through a significant portion of the salt section. This plug, like the others, may have additional plugs above and below the salt-section plug.

These types are displayed in Figure 1.

(50)

Type I Plugs (BLM)					
	API #	Base of Top Plug	Length	Base of Bottom Plug	Length
1	30-025-30599	670	670	5100	130
2	30-025-31403	837	100	4340	150
3	30-015-25317	436	436	3665	35
4	30-015-26278	1265	200	4050	50
5	30-015-27998	800	154	4490	140
6	30-025-30062	698	100	6165	100
7	30-015-26152	820	75	7250	500
8	30-025-31394	850	104	3870	157
9	30-025-31193	940	142	3410	240
10	30-025-32233	1450	150	5130	430
11	30-025-32871	733	100	5156	200
12	30-015-27972	820	100	4525	345
13	30-015-27760	713	263	4300	300
14	30-015-27959	720	200	4198	300
15	30-025-32231	575	100	5020	120
16	30-015-27225	915	155	2853	137

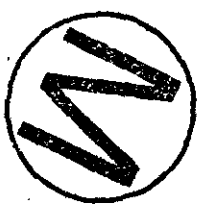
17	30-015-27522	815	173	2842	100
18	30-015-27523	450	100	3050	221
19	30-015-27966	551	123	3775	221
20	30-015-26446	450	100	2850	100
21	30-025-29302	433	290	3000	220
22	30-025-29540	1100	262	4357	152
23	30-015-26799	408	50	3800	225
24	30-015-21916	946	574	4127	147
25	30-015-05874	847	50	4100	270
26	30-015-21187	770	220	3340	100
27	30-015-24799	1573	183	3814	100
28	30-015-21530	500	100	5763	414
29	30-015-04757	540	240	3260	187
30	30-025-21093	671	81	3131	141
31	30-025-08219	775	361	4650	361
32	30-025-31650	410	100	4365	100
33	30-025-26234	770	191	3429	100
34	30-025-27267	720	100	5358	178



35	30-025-27752	1555	100	5221	220
36	30-015-25405	1108	600	4260	195
37	30-015-20475	715	715	3715	175
38	30-015-20603	800	80	3800	100
39	30-015-23832	850	100	3798	100
40	30-015-25169	425	425	3565	35
41	30-015-25150	450	450	3600	35
42	30-025-28682	659	127	3059	133
43	30-025-31518	925	206	3625	526
44	30-015-23356	525	50	3415	205
45	30-025-29962	710	100	3200	184
46	----------[1]	1000	1000	4765	100
47	30-025-27154	849	100	3600	227
48	---------- [1]	390	213	4500	360
49	---------- [1]	1029	1029	4500	50
50	---------- [1]	1000	1000	4765	100

[1]Records for this well do not include API number, only township, range, and section.

Type I Plugs (State)					
	API #	Base of Top Plug	Length	Base of Bottom Plug	Length
1	30-025-31986	465	115	4250	164
2	30-015-27144	2000	2000	4700	35
3	30-025-30458	608	100	3250	200
4	30-025-31821	778	197	4300	160
5	30-015-26531	666	100	2882	150
6	30-025-27466	1100	100	4900	201
7	30-025-21081	1210	200	4780	100
8	30-025-29127	1000	325	5250	103
9	30-025-29917	1125	125	5300	100
10	30-015-22971	525	225	3375	225
11	30-015-24207	620	254	3103	40



Type II Plugs (BLM)							
	API #	Base of Top Plug	Length	Base of Intermediate Plug	Length	Base of Bottom Plug	Length
1	30-015-26519	450	162	2367	123	3544	100
2	30-015-26631	452	154	2165	173	3650	100
3	30-015-28020	530	200	2500	200	4050	250
4	30-015-27782	650	200	2800	150	3850	250
5	30-015-21035	808	248	2499	75	3350	35
6	30-015-24341	100	50	[1]	[1]	4582	2082
7	30-015-24033	500	100	2200	100	3175	100
8	30-015-03703	470	292	2781	188	[2]	[2]
9	30-025-27280	520	119	2511	99	5317	155
10	30-015-27322	450	100	2748	200	4775	125
11	30-015-24283	456	132	2571	132	6030	232

[1]Lower plug is of sufficient length to extend into this interval.

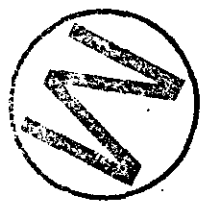
[2]This well has a total depth less than 3000', therefore the intermediate plug listed is actually the deepest plug in the borehole.

12	30-015-24902	425	60	2335	54	3625	75
13	30-015-25211	450	450	2300	50	4025	50
14	30-015-24903	425	60	2335	54	3625	100
15	----------[1]	380	380	2455	100	4525	315

[1]Records for this well do not include API number, only township, range, and section.

Type II Plugs (State)							
API #		Base of Top Plug	Length	Base of Intermediate Plug	Length	Base of Bottom Plug	Length
1	30-015-26456	602	135	2314	327	5810	110
2	30-015-26105	450	100	2340 1400	200 100	3343	100
3	30-015-27790	500	100	2183	383	4100	50
4	30-015-26707	650	275	2650	100	2830	100
5	30-015-25864	650	100	2410	100	4680	100
6	30-015-26812	550	90	2375	175	4650	662
7	30-015-26911	370	155	2785	545	3400	35
8	30-015-22330	450	100	2486	304	3342	54
9	30-015-25004	700	200	2300	85	3400	120
10	30-015-24352	570	100	2310	100	3344	50
11	30-015-10358	1260	875	2235	725	3750	120
12	30-015-22954	560	560	2690	300	3600	100
13	30-015-22441	463	218	2461	427	3286	276

14	30-015-22312	1500	950	2500	435	[1]	[1]
15	30-015-24836	369	369	2850	515	3460	364
16	30-015-23301	550	200	2500	200	3584	200
17	30-015-24810	500	402	2600	100	5550	168
18	30-025-28596	650	110	2704	109	4351	221
19	30-015-22352	238	100	2525	100	4300	75
20	30-015-23615	565	100	2814	86	3340	50
21	30-015-23586	800	150	2442	100	3673	100
22	30-015-24061	465	250	2400	40	[1]	[1]



[1]This is a shallow well with a total depth less than 3000'.

(41)

Type III Plugs (BLM)							
	API #	Base of Top Plug	Length	Base of intermediate plug	Length	Base of Bottom Plug	Length
1	31-015-27274	670	100	2050	50	4350	50
2	30-025-31885	682	102	1160	100	4911	175
3	30-025-30691	413	47	1300	162	4666	162
4	30-025-30388	1240	100	1643	100	5177	200
5	30-025-32482	623	50	1150	150	4690	150
6	30-025-30873	650	100	1200	100	4473	196
7	30-015-27044	456	116	2100	131	3960	131
8	30-015-27427	783	150	1814	150	3066	150
9	30-015-24201	545	100	1800 760	100 103	5510	50
10	30-015-26802	450	154	1995	152	3550	100
11	30-015-27678	710	200	1922	125	3280	405
12	30-015-27554	516	100	1150	100	3100	260
13	30-025-25685	685	252	1020	76	3224	184
14	30-025-27557	300	147	900	138	3492	292

15	30-025-31664	700	250	1175	50	4375	258
16	30-015-21126	515	250	1080	100	3950	182
17	30-015-05883	965	68	1465	170	4000	99
18	30-015-05882	928	152	1451	214	4050	99
19	30-015-05869	960	269	2000	100	4100	100
20	30-015-05886	950	118	2050	100	4075	100
21	30-015-25444	1020	55	2880	142	4163	27
22	30-015-25582	870	100	1500	200	3478	100
23	30-105-24978	985	140	2000	61	3360	119
24	30-015-21519	600	150	2000	100	3050	100
25	30-015-01159	690	100	2000	100	3450	100
26	30-025-27753	590	100	1109	100	4965	104
27	30-025-26867	465	100	1200	200	3570	200
28	30-025-08185	775	361	1172	244	4600	434
29	30-025-08214	804	312	1200	150	4403	362
30	30-025-08189	775	361	1170	170	4650	506
31	30-025-08702	747	747	1170	170	4450	436
32	30-025-08205	775	361	1185	100	4506	361

33	30-025-08207	775	325	973	144	4520	578
34	30-025-08215	450	450	1170	495	4385	361
35	30-025-08201	775	325	1195	157	4500	434
36	30-025-28654	300	100	1071	184	2983	145
37	30-015-25273	384	384	1849	209	3000	192
38	30-015-24701	1375	153	3080	253	4616	450
39	30-025-08127	350	98	1237	63	4875	25
40	30-025-08188	818	361	1206	106	4650	578
41	----------[1]	434	434	1610	645	3600	100

[1]Records for this well do not include API number, only township, range, and section.

Type III Plugs (State)							
	API #	Base of Top Plug	Length	Base of Intermediate Plug	Length	Base of Bottom plug	Length
1	30-025-30179	648	170	1200	170	5300	170
2	30-015-26924	310	90EST	2000 1200	525 119	5000	105
3	30-015-26084	608	117	3800	170	5750	351
4	30-015-25578	524	149	1772	100	3089	35
5	30-015-26531	525	125	1350	55	2850	100
6	30-025-08193	400	400	1090	180	4575	50
7	30-105-20759	383	116	2080	244	5200	121
8	30-015-20843	680	170	1982	132	5450	180
9	30-015-20831	280	160	1775	375	5345	550
10	30-015-24476	600	600	2110	110	5700	35
11	30-015-24961	563	150	1981	153	5453	156
12	30-015-21007	425	100	1845	100	3000	100
13	30-015-21551	400	400	2100	410	5533	100
14	30-015-20842	441	441	1949	175	5562	506