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subject: Recompletion of Cabin Baby-1

The following memorandum summarizes the history of Cabin Baby-1 and the recompletion activities recently performed in the well.

History of Cabin Baby-1

Well Cabin Baby Federal No. 1 (Cabin Baby-1) is located 2000 ft south of the southern WIPP site boundary in the northeast quarter of Section 5, Township 23 south, Range 31 east. Cabin Baby-1 was originally drilled in 1974 and 1975 as a wildcat well by the M.P. Grace Company under lease number 0545110. It was drilled to a total depth of 4150 ft below ground surface (bgs) in the Bell Canyon Formation and cased with 13.375-inch outside diameter (O.D.), 71 lb/ft casing from ground surface to a depth of approximately 650 ft bgs, which appears to be a few feet above the contact between the Rustler and Salado Formations. The well was temporarily abandoned by M.P. Grace in 1975 after it proved to be a dry hole.

In January 1978, the DOE requested that the Bureau of Land Management (BLM) transfer ownership of the well to the DOE "to acquire hydrologic data from geologic formations below the Castile." BLM approved the transfer on February 7, 1978. In August 1983, D'Appolonia Consulting Engineers (acting on behalf of the DOE) reentered Cabin Baby-1 and deepened it to a new total depth of 4290.6 ft bgs in the Bell Canyon Formation (Beauheim et al., 1983). Caliper logs run in 1983 prior to deepening Cabin Baby-1 showed that the original hole had washed out to an average diameter of approximately 14 inches through the Salado Formation, was drilled at 10.5 inches through the upper Anhydrite III and Halite II units of the Castile (to approximately 3365 ft bgs), and was drilled at a diameter of 8.5 inches through the remainder of the Castile and through the Bell Canyon Formation. The Castile anhydrite units had uniform diameters and the halite units were enlarged to varying degrees. As part of the deepening, the lower and new portions of the hole were reamed to a diameter of 9.875 inches.

D'Appolonia performed drillstem tests (DSTs) and/or slug tests of four intervals within the Bell Canyon to assess its permeability and hydraulic head. At the completion of testing in September 1983, they set a 7.375-inch production-injection packer (PIP) from 4028 to 4033 ft bgs in the lower anhydrite of the Castile Formation. The PIP was set on 2.375-inch tubing open to the Bell Canyon below. Approximately 4450 gallons of brine were swabbed from the tubing to remove drilling fluid and draw native Bell Canyon brine into the well. The final fluid swabbed had a specific gravity of 1.128.

Bell Canyon water levels were measured in the tubing for the next three years, and showed a stabilized level approximately 308 ft bgs (Saulnier et al., 1987).

In September 1986, Sandia removed the PIP and tubing from the well and set a 7.375-inch bridge plug in place of the PIP from 4027 to 4032 ft bgs to isolate the Bell Canyon from the rest of the well (Stensrud et al., 1987). A 10.5-inch bridge plug was set in the well casing from approximately 585 to 588 ft bgs and the casing was perforated across the Culebra interval from 503 to 529 ft bgs. This configuration allowed testing and monitoring of the Culebra with the rest of the well isolated.

Between March and April 1990, the bridge plug in the casing apparently failed, as indicated by anomalous Culebra water-level measurements. An attempt was made to retrieve the bridge plug in August 1994, but it had fallen into the hole below the casing and could not be reached with the equipment then available. On September 1, 1994, a replacement 10.375-inch bridge plug was set in the casing from approximately 605 to 609 ft bgs.

From August 17-20, 1999, Cabin Baby-1 was recompleted so that both Bell Canyon and Culebra water levels could be monitored. Davis Tool Company provided the reverse unit, mud pit, miscellaneous tools, and technical expertise for the recompletion. Tyler Well Service provided the pulling unit used, and Baker Oil Tools provided the packers. The recompletion activities are described below.

Cabin Baby-1 Recompletion

On August 17, 1999, the bridge plug set at 605 ft in the Cabin Baby-1 casing was deflated and removed from the well. As part of the deflation procedure, 2.375-inch tubing was attached to the bridge plug and opened to the interval below (the Salado and Castile). When this occurred, water was discharged from the tubing due to the high pressure from the Salado and Castile that had been contained below the bridge plug. (Note that this high pressure would not have been present had the Salado and Castile been in hydraulic communication with the Bell Canyon, which is much more permeable and has a much lower pressure.) A valve was quickly closed to stop the flow of water, and then the valve was opened slightly to allow the pressure to bleed off slowly. The bridge plug was then retrieved without incident.

We then went into the hole to find the bridge plug that had been set in the casing in 1986 and failed in 1990. We tagged something solid at 731 ft bgs, but it did not appear to be the bridge plug as we were unable to latch onto it. On August 18, 1999, we went into the hole with a bit to clean out any rock that might have sloughed onto the bridge plug. We drilled three feet before the bit stopped on something hard and we began to get metal shavings in the circulation fluid. Circulation was performed using saturated brine, a reverse unit, and a steel "pit." We tried again to retrieve the bridge plug, but were unable to latch onto it. We then went in with a washover shoe to clean out any rock that may have settled around the mandril and nipple above the bridge plug. We washed out a lot of halite chips and crystals, as well as brown and red clastic material that looked like it came from the unnamed lower member of the Rustler. We then went in again and successfully retrieved the bridge plug.

On August 19, 1999, we entered the hole with a 9.875-inch bit to clean the hole down to the lower bridge plug. We encountered salt bridges at approximately 1398 and 1508 ft bgs in the Salado, but drilled through them in a few feet. At approximately 4017 ft bgs, we began to circulate the hole, recovering a lot of salt chips and crystals. We hit the top of the seal nipple at 4037 ft bgs, approximately 10 ft deeper than expected. We then tripped out and switched over to the washover shoe. We washed down around the seal nipple until the washover shoe was grinding on the metal of the bridge-plug assembly. We made one attempt to retrieve the bridge plug that day, but were unsuccessful.

On August 20,1999, we tried again to retrieve the bridge plug and succeeded. We then tripped in with the 9.875-inch bit to clean the hole to its total depth of 4291 ft bgs. Cleaning the hole to its total depth was important because the 1983 DSTs had shown that the lowermost 120 ft was the most permeable portion of the Bell Canyon penetrated by the well (Beauheim et al., 1983). At 4171 ft, we hit dehydrated drilling mud which we had to "drill" through the rest of the way. ("Dehydrated" drilling mud is actually the clay, barium, and other additives put in drilling brine to increase its density and viscosity. During drilling, these substances stay in suspension because of the agitation and circulation of the drilling mud. When drilling mud simply stands in a hole, these substances settle out, forming "dehydrated" drilling mud.) The drilling mud probably got into the Bell Canyon section of the hole during the period in 1986 between the removal of the PIP isolating the Bell Canyon and its replacement with a bridge plug. The denser fluid in the Salado-Castile portion of the hole probably displaced the lighter Bell Canyon fluid during the three days (Stensrud et al., 1987) when the two intervals were connected. The dehydrated drilling mud was light gray in color and had the consistency of modeling clay. Cleaning the hole from 4171 to 4291 ft bgs took approximately three hours and 45 minutes because the dehydrated drilling mud tended to plug the bit.

After tripping the bit out of the hole, we ran in with a 7-inch PIP which was set with the center of the element at 4020.2 ft bgs in anhydrite near the base of the Castile where the caliper log showed the hole maintained a uniform diameter. We disengaged the 2.375-inch tubing from the PIP, pulled out 599 ft (19 joints), and placed a 10.375-inch PIP in the tubing string. We then went back down and latched onto the lower PIP and set the upper PIP in the casing with the center of its element at 603.8 ft bgs. Before latching onto the lower PIP, we threaded the top of the tubing string into a bonnet which was bolted onto the wellhead before the upper PIP was inflated. A one-inch hole in the bonnet provides access for a water-level probe to measure the Culebra water level in the annulus between the well casing and the tubing above the upper PIP. The Bell Canyon water level can be monitored in the tubing. The Salado and Castile are isolated between the two PIPs.

From August 21 through 25, 1999, we swabbed brine from the tubing to remove circulation/drilling fluid from below the lower PIP and draw native Bell Canyon brine into the well. Approximately 5800 gallons of brine were swabbed, representing five times the volume of the open hole through the Bell Canyon. Specific gravity of the fluid removed was monitored during swabbing (Figure 1). The final specific gravity measured was 1.126, very similar to that measured in 1983.

Water-level measurements were begun on August 26, 1999 to track the rise and stabilization of the Bell Canyon water level in Cabin Baby-1 (Figure 2). On August 30, 1999, a TROLL memory gage was installed in the tubing to provide a continuous record of Bell Canyon water levels. Westinghouse will measure Culebra and Bell Canyon water levels and download the TROLL on a monthly basis hereafter. Culebra water levels may be offset from their historical levels because the brine left in the casing is more dense than the natural Culebra brine.

The PIP isolating the Bell Canyon was set in the lower Castile Formation in anhydrite, which has always provided excellent packer seats during many years of testing at WIPP. The PIP cannot fail without our quickly becoming aware of it. If the PIP were to fail, the Bell Canyon would be connected to the Salado-Castile portion of the borehole, which has a much higher (100's of feet) head and much denser fluid. The TROLL would immediately register a pressure increase, which would also be reflected in subsequent monthly water-level measurements. Because the Bell Canyon is orders of magnitude more permeable than the Salado and Castile, the water level would eventually come back into equilibrium with the Bell Canyon pressure. However, the increase in the average density of the fluid would cause the new stabilized water level to be at a lower height than before. Thus, a failure of the PIP would be easily detected.

References:

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Figure 1. Cabin Baby-1 Bell Canyon Water Cleanup

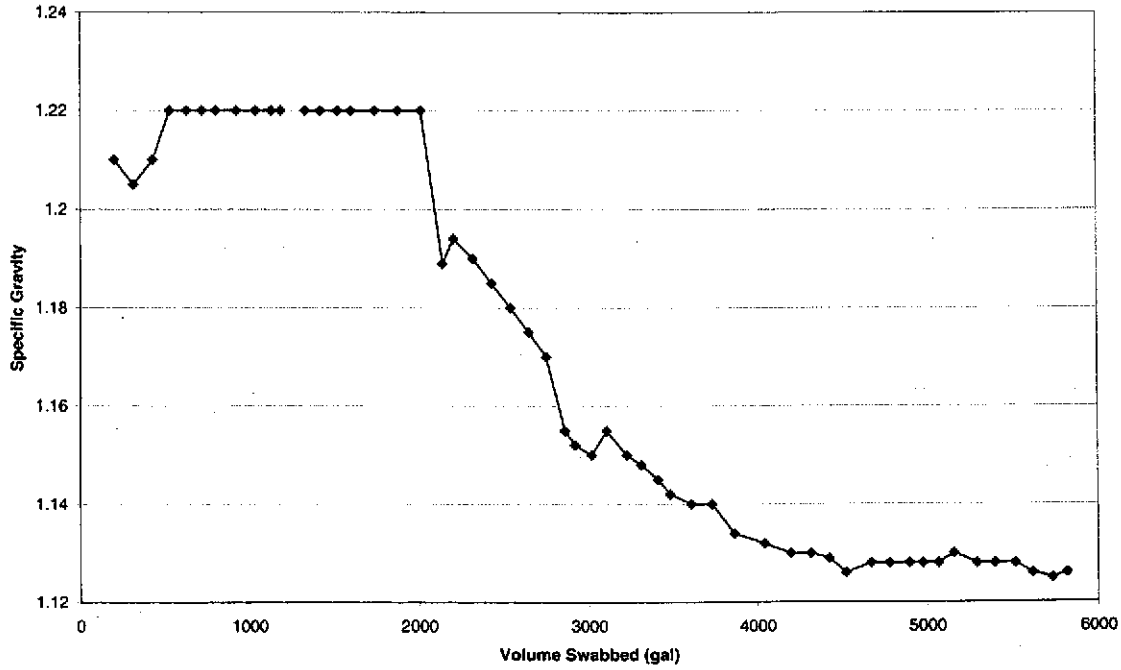

Figure 2. Cabin Baby-1 Bell Canyon Water Level