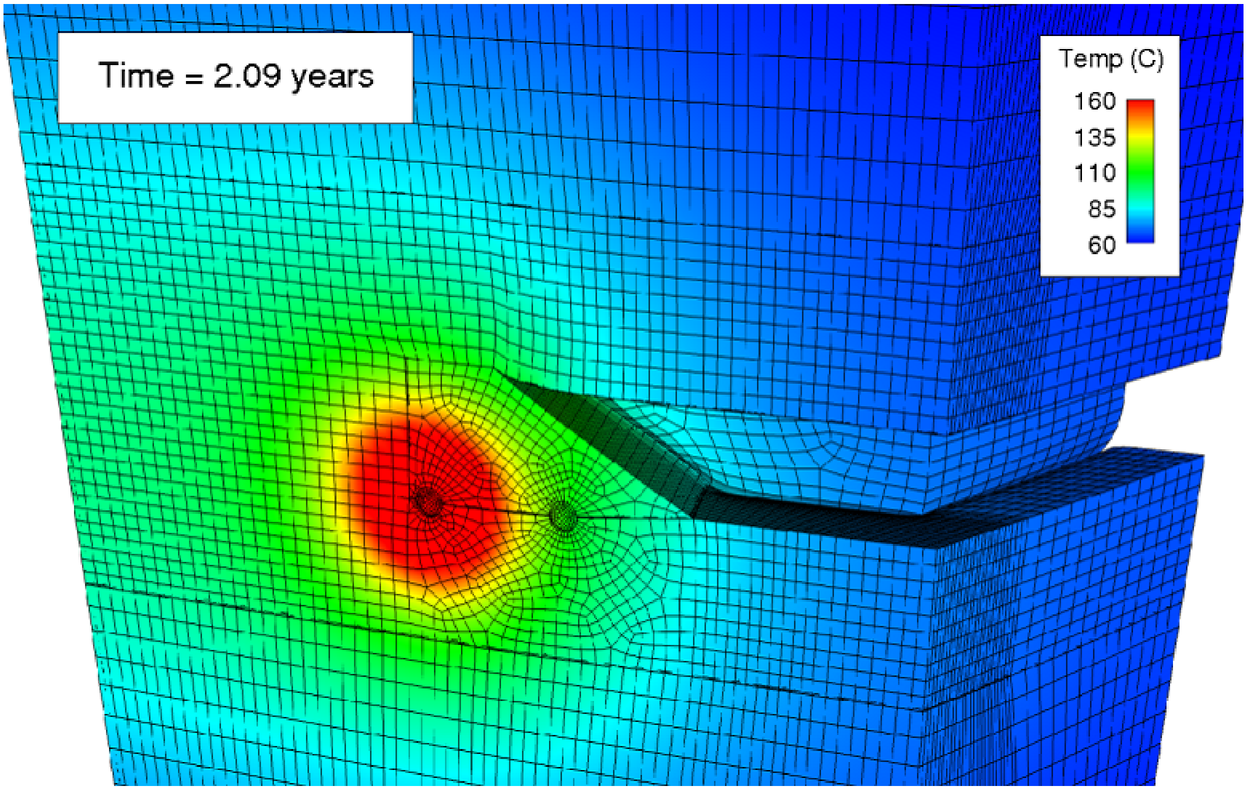
DOE Response to EPA Question SDI(HCR)-1 on the SDI Planned Change Notice

SDI(HCR)-1: Please provide information on the expected effects of convectively transported heat from the planned SDI heater tests on the lower portion of the WIPP exhaust shaft.

Background: Convectively transported heated air from the SDI tests could be conductively transferred to the halite along the perimeter of the exhaust shaft, potentially altering shaft geometry and disrupt or reduce the operational lives of the shaft. We would expect the area of greatest impact, if there were to be any, to be at the base of the exhaust shaft. Because the exhaust shaft is used by the SDI test as well as the rest of the underground facility, any impacts on the functionality of this shaft could impact waste disposal operations.

DOE Response:
Preliminary planning discussions for the SDI test have indicated the access drifts may be blocked off during the heating phase of the SDI test, preventing ventilation air from circulating through the test area. In this case, no heat from the SDI test will be added to the ventilation air and hence no heat from the SDI heater test will be transported by convection to the lower portion of the exhaust shaft. However, this response is not based on an assumption of zero convectively transported heat because the SDI test is still in its design phase, and because some convectively transported heat will occur after the heating phase when personnel reenter the test areas for experimental measurements on the crushed salt and intact halite.

Even if ventilation is not blocked during the heating phase, convectively transported heat from the SDI heater test will be minimal. Detailed thermal analyses were performed for a generic salt repository with hot waste canisters in alcoves that are partly filled with crushed salt. These thermal analyses are relevant to the SDI test because the physical configuration for the SDI test is patterned after the design of this generic salt repository. Figure 1 is a plot of the temperature distribution around a hot canister at 2 years after emplacement, which is the duration of the heating phase of the SDI test. This figure shows that the heat energy is concentrated in the intact halite and crushed salt surrounding the hot canister. The walls of the access drift, on the right-hand side of Figure 1, remain cool relative to the hotter salt surrounding the hot canister. In this situation, heat transfer from the walls of the access drift to any ventilation air flowing in the access drift will be minimal, and the convectively transported heat from the SDI heater test to the lower portion of the WIPP exhaust shaft will also be minimal.



Source: (DOE 2011), Figure 3-2

Figure 1. Preliminary Temperature Distribution for the Proof-of-Principle In Situ Field Test

Section 2.1.3 of the SDI Planned Change Notice (PCN) calculates an upper bound for the temperature change from the SDI heaters in the ventilation air stream in the exhaust shaft. This calculation is an upper bound because it assumes that all of the thermal power from the 5 SDI heaters, 42.5 kilowatts, is added to the ventilation air flow in the exhaust shaft. In other words, heat transfer from the SDI heaters to the ventilation air stream is 100% efficient, and no heat remains in the salt. This is obviously a very conservative upper bound because most of the heat from the SDI heaters remains in the intact halite and crushed salt, as shown in Figure 1 and discussed above.

The calculated upper bounds for the temperature change from the SDI heaters in the ventilation air stream in the exhaust shaft are 0.17°C and 0.28°C for the normal and alternate ventilation modes, respectively (SDI PCN, Section 2.1.3). Temperature changes that are less than 0.3°C will have minimal impact on the long-term response of the halite along the perimeter of the exhaust shaft. Most important, any change in the creep rate of the halite will be negligible for this small temperature change, so no measurable change in shaft geometry will occur.

The conclusion of minimal impact from a temperature change less than 0.3°C is confirmed by the stability of the exhaust shaft during the many years that the WIPP has been an operational facility. As shown next, the temperature of the returning ventilation air in the mine experiences natural variation between the winter and summer seasons in Carlsbad, and this natural variation is significantly greater than the upper bound on temperature change from the SDI test. This natural variation has occurred since the underground facility was opened without significant impact on the stability and geometry of the exhaust shaft.

The temperature of the returning ventilation air in the mine is continuously measured by Mine Weather Station (MWS) 8, which is located in the S-400 drift near the base of the exhaust shaft. During the month of February 2010, the minimum, mean, and maximum ventilation air temperatures measured by MWS 8 were 22.0°C, 22.8°C, and 23.6°C, respectively. MWS 8 records data minute-by-minute, but these values are based on daily measurements at 2 AM, 8 AM, 2 PM, and 8 PM. During part of the month of July 2009, the minimum, mean, and maximum ventilation air temperatures measured by MWS 8 were 28.2°C, 28.9°C, and 29.4°C, respectively. These values are based on daily measurements at 2 AM, 8 AM, 2 PM, and 8 PM on July 1 through July 19 (power was out at MWS 8 from July 20 through July 31). These measurements show that (1) the daily variability in ventilation air temperature at the base of the exhaust shaft is 1.6°C during February 2010 and 1.2°C during July 2009, and (2) the mean change in ventilation air temperature at the base of the exhaust shaft between winter and summer month is about 6°C.

The data from MWS 8 demonstrate that the conservative upper bound on temperature change in the ventilation air from the SDI test, 0.3°C, is less than the daily variability in ventilation air temperature, 1.2°C to 1.6°C, and much less than the seasonal variation in mean air temperature, 6°C. It follows that any convectively transported heat from the planned SDI heater tests cannot have a significant impact on the long-term response of the halite along the perimeter and base of the exhaust shaft because it is much less than the natural variability in ventilation air temperature at the base of the exhaust shaft from atmospheric conditions and because the natural variability in ventilation air temperature has not been observed to destabilize the exhaust shaft at WIPP.

In summary, this response demonstrates that the convectively transported heat from the SDI heater test to the lower portion of the WIPP exhaust shaft will be minimal. This response also demonstrates that the temperature change from convectively transported heat will be much less than the daily or seasonal changes in ventilation air temperature at the base of the exhaust shaft due to atmospheric conditions, leading to the conclusion that convectively transported heat from the SDI test will not have a significant impact on the stability of the exhaust shaft.

Reference

U.S. Department of Energy (DOE), 2011. *A Management Proposal for Salt Disposal Investigations with a Field Scale Heater Test at WIPP*. DOE/CBFO-11-3470, Revision 0. U.S. Department of Energy, Carlsbad Field Office, Carlsbad, New Mexico. June 2011.