DST As-Built TDIF XYZ Coordinates of the Sensors in the Drift Scale Test

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DST As-Built TDIF

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Introduction

The Drift Scale Test (DST) is one of the thermal tests being conducted in the Exploratory Studies Facility (ESF). One of the objectives of the DST is to study the coupled thermal-mechanical-hydrological-chemical (TMHC) processes in the ESF at the repository horizon of the potential high-level nuclear waste repository in Yucca Mountain, Nevada. The objectives, the test design, and the test layouts of the DST are included in the test design report by CRWMS M&O Contractor ^[1]. The configuration of the DST includes a declining Observation Drift driven mostly east and downward from main tunnel in the ESF, at about 2.827 km from the North portal. The downward slope of the Observation Drift (11.5 to 14.0 percent) ensures a minimum 10 m of middle nonlithophysal Topopah Spring Tuff as the overburden for the DST. The length of the Observation Drift is about 136 m. At the elevation of the DST crown (nominally 10 m below the upper extent of the middle nonlithophysal Topopah Spring Tuff) the Connecting Drift breaks out to the north from the Observation Drift, 136 m from the main tunnel of the ESF. The Connecting Drift extends approximately 40 m to the north from the Observation Drift. A Heater Drift breaks out westward from the Connecting Drift at about 30 m from the Observation Drift. The Heater Drift consists of an 11 m long entry, which includes a plate-loading niche, and a 47 m long heated drift. The nominal diameter of the drifts is 5 m. The detail configuration of the DST is included in the test design report by CRWMS M&O Contractor ^[1].

The installation of instruments in the DST includes installing instruments in boreholes drilled from the Heater Drift (HD), Connecting Drift (CD), and the Observation Drift (OD). The drift and borehole layouts in the DST are included in the report by CRWMS M&O Contractor ^[1], which also carries the borehole numbers and identifications. The instruments to be installed in the boreholes include resistance temperature devices (RTDs) in the temperature

holes, electrodes in the electrical resistivity tomography (ERT) holes, teflon liners in the neutron holes, gas sampling ports and water absorbing pads in the chemical holes, and Rapid Estimation of Thermal Conductivity (K) and Diffusivity (A) probes (REKA) in the thermal conductivity and diffusivity holes.

This report describes the xyz coordinates of some of the sensors in the DST. Also included in this report are the xyz coordinates of the ends of the bottom of the canister heaters in the Heater Drift. The xyz coordinates of the ERT collar and bottom electrodes in each hole are included in this report, but not that of all electrodes, because ERT presents measured results in two-dimensional or three-dimensional images, instead of data value at each electrode.

Calculation of the xyz Coordinates

The boreholes in the DST are numbered from 42 to 193. Among these holes, the following are the responsibility of Lawrence Livermore National Laboratory (LLNL): 45, 46, 62, 63, 135, 136, 145, 146, 166, 167, 176, and 177 are ERT holes; 47 to 51, 64 to 68, 79, and 80 are the neutron holes; 52 to 56 and 69 to 73 are the Chemistry-SEAMIST holes; 151 to 153 are the REKA holes; 79, 80, 133, 134, 137 to 144, 158 to 165, and 168 to 175 are the RTD holes. The as-built xyz coordinates of the collar and bottom of those holes are provided by the Test Coordinating Office (TCO) with a data tracking number (DTN) LANE834244AQ97.001. However 51 of those holes were only partially surveyed. The surveying line of sight in those holes did not reach the bottom of the holes. For those 51 holes the thermal test team, after consulting with the surveyor, determined an algorithm to project the xyz coordinates of the bottom of the holes. The projected xyz coordinates of the 51 partially surveyed holes are included in a TDIF with a DTN of MORW831213DQ98.001. The xyz coordinates of the collar and bottom of a hole are used to calculate the total depth of the hole by using

$$TD=[(xb-xc)^2+(yb-yc)^2+(zb-zc)^2]^{1/2} ,$$

where   TD is total depth,
              xb is the x coordinate of the bottom of a hole,
              xc is the x coordinate of the collar of a hole,

yb is the y coordinate of the bottom of a hole,
yc is the y coordinate of the collar of a hole,
zb is the z coordinate of the bottom of a hole,
zc is the z coordinate of the collar of a hole.

In these calculations the collar and bottom of the boreholes are assumed to be on a straight line. The uncertainties in the calculated xyz coordinates due to the straight line assumption are included in the TDIF with a DTN MORW831213DQ98.001.

The distance from the collar to each instrument in a hole is used to calculate the xyz coordinate of that instrument. The equations for that calculation are

$$\begin{aligned}x &= x_c + (d/TD)(x_b - x_c) \\ y &= y_c + (d/TD)(y_b - y_c) \\ z &= z_c + (d/TD)(z_b - z_c),\end{aligned}$$

where d is the distance from the collar to an instrument.

The xyz Coordinates of the RTDs

The xyz coordinates of the RTDs in the DST are calculated using the equations shown in the previous section. The distance d for each RTD is determined from the location of each RTD bundle in a hole and the spacing of the RTDs in a bundle. These data are in the scientific notebooks #00292 and #00312. The calculated xyz coordinates of the RTDs are included in the attached "[rtd.dat](#)".

The xyz Coordinates of Neutron Logging Locations

During neutron logging the instrument is moved along a borehole, and stopped at pre-determined locations according to the desired measurement spacing. A reading of the neutron count is obtained at each location. The measurement spacing in boreholes #79 and 80 is 30 cm; it is 10 cm in all other neutron holes. The xyz coordinates of the neutron logging locations of the first baseline measurement are calculated using the equations shown above. The calculated xyz coordinates are shown in the attached file "[neutron.dat](#)". The scientific notebook for the first baseline neutron logging is #00324. The xyz coordinates of the future neutron logging locations may be slightly, about 2 cm, different from that of the first baseline measurement, because it can not be expected that

the instrument will be put at the exact same location in each subsequent logging. However the location of the instrument in each logging will be documented in the scientific notebook used in that logging.

The xyz Coordinates of the Chemical Instruments

The xyz coordinates of the gas sampling ports and the water absorbing pads in the Chemistry-SEAMIST holes are calculated using the equations shown above and the distance of the ports and pads to the collar of each hole. Due to difficulties encountered during the installation of the SEAMIST liners, not all of the Chemistry-SEAMIST holes are covered with ports and pads. The locations of the ports and pads in each hole are included in scientific notebook #00342. The calculated xyz coordinates are shown in the attached file "**chemistry.dat**". These will be updated in the future when more ports and pads are installed.

The xyz Coordinates of the REKA Probes

There is one REKA probe in each one of the REKA holes. The xyz coordinates of the probe are calculated using the equations above. The calculated xyz coordinates are included in the attached file "**reka.dat**". The location of the REKA probe in each hole is included in scientific notebook #00328.

The xyz Coordinates of the ERT Holes

As mentioned above, the ERT images are two-dimensional and/or three-dimensional representations of electrical resistivity distributions. Therefore the xyz coordinates of each individual electrode are not required. Instead, the xyz coordinates of the collar and bottom electrodes in each ERT hole provide the boundary of each imaging plane. The xyz coordinates of these electrodes in the ERT boreholes are included in the table below. This table shows the coordinates for the deepest (bottom) and shallowest (collar) electrodes in each ERT borehole. The coordinates for other electrodes in each borehole are obtained by linear interpolation. The assumption that the boreholes are straight provides sufficiently accurate electrode locations for the purpose of ERT data processing. The origin of the coordinate system is located along the centerline of the Heated Drift by the hot side of the bulkhead, at the springline elevation.

ELECTRODE COORDINATES (m)

hole name	Hole #	total depth (m)	bottom elec. depth (m)	collar elec depth (m)	collar x	collar y	collar z	bottom x	bottom y	bottom z
AOD 1 top	45	39.84	39.116	11.116	-18.09	4.61	6.79	9.09	4.68	13.51
AOD 1 bott	46	39.80	39.014	11.014	-17.31	4.56	-2.86	8.37	4.53	-14.02
AOD 5 top	62	40.24	39.014	11.014	-18.39	24.74	8.22	9.18	24.84	13.07
AOD 5 bott.	63	39.93	39.014	11.014	-19.27	24.83	0.13	6.17	25.19	-11.55
HD 1 top	135	20.00	19.84	0.84	-0.77	2.71	3.24	-0.96	2.76	22.24
HD 1 bott.	136	16.33	15.774	1.774	-0.75	2.73	-3.39	-0.71	2.63	-17.39
HD 2 top	145	20.09	18.737	0.737	-0.77	11.89	3.32	-0.89	12.01	21.32
HD 2 bott.	146	16.46	15.797	1.797	-0.79	11.89	-3.41	-1.06	11.92	-17.40
HD 6 top	166	19.82	19.659	0.659	-0.73	22.86	3.23	-0.56	23.02	22.23
HD 6 bott.	167	15.88	15.748	1.748	-0.74	22.80	-3.39	-0.46	22.75	-17.38
HD 8 top	176	20.00	19.66	0.66	-0.75	39.29	3.12	-0.78	39.12	22.12
HD 8 bott.	176	16.20	15.748	1.748	-0.74	39.32	-3.37	-0.75	39.26	-17.37

The xyz Coordinates of the Canister Heaters

The xyz coordinates of the end of the bottom of the canister heaters on the floor of the Heater Drift are also included in this report. The attached file "**canister.dat**". carries the xyz coordinates of the canister heaters. The xyz coordinates are calculated using the as-built survey information of the lifting ears on the heaters and the dimensions of the heaters.

References

[1]. CRWMS M&O Contractor, 1996, Test Design, Plans and Layout Report, BAB000000-01717-4600-00025 REV 00, TRW Environmental Safety System Inc., 101 Convention Center Drive, Las Vegas, NV 89109.

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