Department of Energy
Yucca Mountain Site Characterization
Project Office
P. O. Box 98608
Las Vegas, NV 89193-8608

WBS 1.2.11
QA: N/A

MAR 1 0 1993

Carl P. Gertz, Project Manager, YMP, NV

VERIFICATION OF CORRECTIVE ACTION AND CLOSURE OF CORRECTIVE ACTION REQUEST (CAR) YM-92-073 RESULTING FROM YUCCA MOUNTAIN QUALITY ASSURANCE DIVISION (YMQAD) AUDIT YMP-92-022

The YMQAD staff has verified the corrective action to CAR YM-92-073 and determined the results to be satisfactory. As a result, the CAR is considered closed.

If you have any questions, please contact either Robert B. Constable at 794-7945 or Gerard Heaney at 794-7826.

R. E. Spence

Richard E. Spence, Director
Yucca Mountain Quality Assurance Division

YMQAD:RBC-2930

Enclosure:
CAR YM-92-073

cc w/encl:
~~K. R. Hooks, NRC, Washington, DC~~
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A. V. Gil, YMP, NV
B. J. Verna, YMP, NV

cc w/o encl:
J. W. Gilray, NRC, Las Vegas, NV
N. J. Brogan, SAIC, Las Vegas, NV
Gerard Heaney, SAIC, Las Vegas, NV

160143

ADD: Ken Hooks Ltr. Encl.
1 1

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NH03

ORIGINAL
THIS IS A RED STAMP

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
U.S. DEPARTMENT OF ENERGY
WASHINGTON, D.C.

8 CAR NO.: YM-92-073
DATE: 09-03-92
SHEET: 1 OF 1
QA

CORRECTIVE ACTION REQUEST

1 Controlling Document QARD, Revision 4	2 Related Report No. Audit YMP-92-22
3 Responsible Organization YMP	4 Discussed With A. Simmons

5 Requirement:

The QARD, Revision 4, Appendix A, Paragraph 20.1.B.6 states planning measures include: "The evaluation of data quality to assure that generated data is valid, comparable, complete representative, precise and accurate."

6 Adverse Condition:

The Reference Information Base (RIB), Version 4, Revision 6, contains different values for Thermal/Mechanical Stratigraphy data for Borehole USW G-4. Stratigraphy depths found in Table 1 "Thermal/Mechanical Stratigraphy for Borehole USW G-4" (found in chapter 1, section 1, item 2, page 2 of 3) does not agree with the "Thermal/Mechanical Stratigraphy" values in Figure 1 "Relationship of Stratigraphy, Lithology and Hydrostatigraphic Zones at G-4" (found in chapter 1, section 4, item 4, page 3 of 6) in all cases.

9 Does a significant condition adverse to quality exist? Yes___ No X If Yes, Circle One: A B C	10 Does a stop work condition exist? Yes___ No X ; If Yes - Attach copy of SWO If Yes, Circle One: A B C D	11 Response Due Date: 20 days after issue

12 Required Actions: [X] Remedial [X] Extent of Deficiency [X] Preclude Recurrence [ ] Root Cause Determination

13 Recommended Actions:

Identify the remedial action to correct the deficiency identified in Block 6.
Identify the extent of the deficiency and analyze for any adverse impacts.
Identify the planned corrective action to prevent recurrence.

7 Initiator Jerry Heaney *Jerry Heaney* Date 9-3-92	14 Issuance Approved by: QADD *R. C. Spence* Date 9/9/92
15 Response Accepted ~~QAR *Jerry Heaney* Date 11-11-92~~ *J.H. 11-11-92*	16 Response Accepted QADD Date
17 Amended Response Accepted QAR *Jerry Heaney* Date 11-11-92 *Jerry Heaney 12-30-92*	18 Amended Response Accepted QADD *R. C. Spence* Date 11/17/92 *R. C. Spence 1/4/93*
19 Corrective Actions Verified QAR *Jerry Heaney* Date 3-5-93	20 Closure Approved by: QADD *R. C. Spence* Date 3/9/93

ENCLOSURE

REV. 08/91

Department of Energy
Yucca Mountain Site Characterization
Project Office
P. O. Box 98608
Las Vegas, NV 89193-8608

WBS 1.2.9
QA:

QA RECEIVED

OCT 0 7 1992

OCT 0 1992

Richard E. Spence, Director, Yucca Mountain Quality Assurance Division,
YMP, NV

RESPONSE TO ISSUANCE OF CORRECTIVE ACTION REQUEST (CAR) YM-092-073 RESULTING FROM YUCCA MOUNTAIN QUALITY ASSURANCE DIVISION AUDIT YMP-92-22 OF SANDIA NATIONAL LABORATORIES

After careful review of CAR YM-092-073 (enclosure 1), I have concluded that this CAR should be withdrawn for the following reasons:

1. No Quality Assurance (QA) requirement has been violated. The requirement stated in Block 5 of the CAR is taken out of context. The stated requirement applies to planning measures included or referenced within a scientific investigation planning document. Work performed under Work Breakdown Structure 1.2.1.3.3, for the Reference Information Base (RIB) is not considered a scientific investigation, nor is the RIB a scientific investigation planning document.

2. The information items referenced in CAR YM-092-073 have two different purposes. The purpose of Item 1.1.2 (enclosure 2) is to specify a table of the corrected absolute Z-elevations for the thermomechanical units in USW G-4. The intent of Item 1.4.4 (enclosure 3) is to depict graphically the relationship between the conceptual hydrologic zones and the thermomechanical stratigraphy. The purposes of these items are clearly defined and the information sources are referenced.

3. It is clearly outside of QA's charter to review analyses, calculations, data, etc., for correctness. QA personnel do not necessarily have the technical expertise to undertake such a responsibility. Rather, QA's charter is to help establish and ensure that the processes and procedures defined for a particular effort are necessary, sufficient, and are adhered to. No violation of process or procedure has been discovered or recorded in the audit or resulting CAR.

Although no QA requirement has been breached, it is recognized that there is a potential for misuse of information presented in Figure 1 of Item 1.4.4. I appreciate the fact that the audit results pointed this out. Steps will be taken, in accordance with Yucca Mountain Site Characterization Project Administrative Procedure 5.3Q, to rectify the problem.

OCT 0 7 1992

If you have any questions, please contact either Stephen J. Bodnar at 794-1840 or Ardyth M. Simmons at 794-7998.

W. A. Girdley
FOR J. Russell Dyer, Director
Regulatory & Site Evaluation Division

RSED:AMS-329

Enclosures:
1. CAR YM-92-073
2. RIB Item 1.1.2
3. RIB Item 1.4.4

cc w/encls:
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Keywords: USW G-4 borehole thermal/mechanical stratigraphy

Description and Methodology

Borehole stratigraphy and thermal/mechanical unit contact criteria for borehole USW G-4 are shown in Table 1 and are based on information used in the preparation of a three-dimensional model of the repository site (Ortiz et al., 1985). Borehole USW G-4 was drilled in the vicinity of the proposed Exploratory Shaft Facility. The reference information presented here is based primarily on information from Table B-6 of Appendix B of the Ortiz report, which describes the model.

Nevada state plane coordinates (x,y) for the base of each thermal/mechanical unit identified have been corrected for the deviation of the borehole from the initial surface location. (The values of the "adjusted locations" tabulated in Table B-6 of the Ortiz report have been modified for the three-dimensional model through a "prefaulting" correction. Subtracting the faulting corrections yields the values listed here.) The corrected elevations were obtained by adding the vertical deviation correction to the unadjusted elevations, both sets of which are provided in Ortiz's report. The elevations were calculated in feet and converted to meters by multiplying by the correction factor 0.3048 and rounding to the nearest whole meter.

The corrected depth is the run (i.e., the difference between the ground-level elevation and the unadjusted elevation at the base of a unit) minus the vertical deviation correction. The corrected depth represents a vertical depth from the starting elevation (i.e., ground level) of the drill rig; it is not a vertical depth from the surface at the map coordinates (x, y) corresponding to that contact/borehole intersection point because topographic changes between the drill rig and this point (x, y) have not been accounted for. Total borehole depth for USW G-4 was taken from Figure 5 of the Ortiz report.

Criteria for the selection of contacts between thermal/mechanical units (Ortiz et al., 1985) are listed in the description of the respective stratigraphies. An uncertainty described by a "+" symbol indicates that the contact could be at a greater depth, while a "-" indicates that the contact could be at a shallower depth. Where mineralogy differs within a unit, the reference stratigraphic notation has been modified by the addition of an identifying symbol; e.g., the vitric and zeolitized regions within CHn1 of drillhole USW G-4 are identified as CHn1v and CHn1z, respectively. The notation TZZ refers to the top of prevalent zeolitization. Additional bibliographic references for lithologic logs are included in the Ortiz report.

Quality Assurance Information

The information presented in Table 1 was collected, analyzed, and interpreted under procedures for which satisfaction of the requirements of 10CFR60, Subpart G has not been demonstrated.

Source

Ortiz, T. S., R. L. Williams, F. B. Nimick et al., 1985. "A Three-Dimensional Model of Reference Thermal/Mechanical and Hydrological Stratigraphy at Yucca Mountain, Southern Nevada," SAND84-1076, Sandia National Laboratories, Albuquerque, NM.

ENCLOSURE 2

TABLE 1. THERMAL/MECHANICAL STRATIGRAPHY FOR BOREHOLE USW G-4[a]

Nevada State Plane Coordinates (x)	Nevada State Plane Coordinates (y)	Unit[b]	Corrected Elevation-z (ft)	Corrected Elevation-z (m)	Run (ft)	Corrected Depth (ft)
E563082	N765807	Ground Level	4,165	1,269	0	0
E563082	N765807	UO	4,135	1,260	30	30
E563082	N765807	TCw	4,047	1,234	118	118
E563081	N765806	PTn	3,922	1,195	243	243
E563076	N765803	TSw1	3,495	1,065	670	670
E563046	N765766	TSw2	2,874	876	1,293	1,291
E563042	N765761	TSw3	2,822	860	1,345	1,343
E563041	N765760	CHn1v	2,805	855	1,363	1,360
E563012	N765736	CHn1z	2,464	751	1,705	1,701
E563007	N765733	CHn2	2,409	734	1,761	1,756
E563004	N765731	CHn3	2,378	725	1,792	1,787
E562988	N765720	PPw	2,211	674	1,960	1,954
E562958	N765702	CFUn	1,915	584	2,258	2,250
E562906	N765682	BFw	1,495	456	2,682	2,670
E562899	N765681	CFMn1	1,445	440	2,733	2,720
E562896	N765680	CFMn2	1,422	433	2,756	2,743
E562886	N765675	CFMn3	1,351	412	2,828	2,814

Unit	Description[c]
UO	No data given.
TCw	Transition from devitrified to vitric tuff in lithologic log.
PTn	Transition from vitric tuff to devitrified tuff in lithologic. log.
TSw1	Contact assigned at the bottom of the lowermost ashflow of the Topopah Spring Member, which contains "common" lithophysae, based on the lithologic log.

[a] Total borehole depth = 3,001 ft.
[b] The stratigraphy is only for those thermal/mechanical units identified in this borehole.
[c] The description corresponds to the base of each unit listed.

TABLE 1. THERMAL/MECHANICAL STRATIGRAPHY FOR BOREHOLE USW G-4 (concluded)

TSw2	Transition from devitrified tuff to vitrophyre in lithologic log.
TSw3	Transition from vitrophyre to vitric ashflow in lithologic log.
CHn1	Transition from ashflow to basal-bedded unit of the Tuffaceous Beds of the Calico Hills in lithologic log.
CHn2	Transition from bedded unit to ashflow in lithologic log.
CHn3	X-ray data indicate a change from a mineralogy dominated by zeolites to a mineral assemblage indicative of devitrification at depths between 1,788 ft and 1,794 ft; contact assigned at the midpoint of the interval; uncertainty: +2 ft, -2 ft.
PPw	X-ray data show a change from a mineral assemblage indicative of devitrification to a mineralogy dominated by zeolites at depths between 1,952 ft and 1,968 ft; contact assigned at the midpoint of the interval; uncertainty: +8 ft, -8ft.
CFUn	X-ray data indicate a change from a mineralogy dominated by zeolites to a mineralogy assemblage indicative of devitrification at depths between 2,238 ft and 2,263 ft; contact assigned at 2,258 ft, based on density log; uncertainty: +5 ft, -20 ft.
BFw	X-ray data indicate a change from a mineral assemblage indicative of devitrification to a mineralogy dominated by zeolites at depths between 2,681 ft and 2,716 ft; contact assigned at 2,682 ft, based on density log; uncertainty: +34 ft, -1 ft.
CFMn1	Transition from ashflow to bedded tuff in lithologic log.
CFMn2	Transition from bedded tuff to ashflow in lithologic log.
CFMn3	X-ray data indicate a change from a mineralogy dominated by zeolites to a mineral assemblage indicative of devitrification at depths between 2,823 ft and 2,840 ft; contact assigned at 2,828 ft, based on density log; uncertainty: +12 ft, -5 ft.

TZZ	The base of TSw3 is at a depth of 1,345.4 ft, and x-ray data show zeolites present at a depth of 1,381 ft. An examination of the core suggests that the contact should be assigned at a depth of 1,363.5 ft; uncertainty: +2 ft, -2 ft (core examination); +17 ft, -19 ft (X-ray data).

Keywords: hydrogeologic properties, hydrogeologic stratigraphy, hydrogeologic zones

Description and Methodology

This Reference Information Base (RIB) Item identifies hydrogeologic zones at Yucca Mountain, Nevada. These hydrogeologic zones were delineated by the Performance Assessment Calculational Exercises for 1990 (PACE-90)(SNL, 1991). The modelers believed that the distribution of hydrogeologic properties based on the thermal/mechanical stratigraphy was inadequate. A different method was to capture the hydrologic properties of the rock mass, and thus provide the basis for a more realistic model of groundwater percolation flux on the scale of the site. A more detailed stratigraphy was developed using data on the geologic and hydrogeologic characteristics of the tuffs within the modeled region. The information used to define the PACE stratigraphy included data on lithology, porosity, grain and bulk density, saturated hydraulic conductivity, fracture conductivity, and moisture-retention characteristics obtained from drill holes in the area. As a result, the PACE stratigraphy delineated 19 units within a 600-m-thick section.

In developing the hydrogeologic zones, time-stratigraphic units were defined. The units were subdivided into layers having similar geologic characteristics. Characteristics used to distinguish layers include degree of welding, size and amount of pumice and lithic fragments, composition and amount of phenocrysts, extent of vapor-phase recrystallization, presence of zeolitization, extent of devitrification, lithophysal content, reworking of fragments, and formation of bedding. Individual candidate zones were categorized as bedded tuffs or densely, moderately, or nonwelded tuffs. Finally, the locations of the boundaries between adjacent zones were determined by the changes in porosity. Although porosity varies within each zone by as much as 30 percent, the mean value between adjacent zones varies by a greater amount. Characterization of candidate zones with similar lithologic properties relies primarily on measured moisture retention and saturated hydraulic conductivities (Peters et al., 1984). Where no measured moisture-retention data was available, data were extrapolated from similar zones, and modified as necessary to account for differences in degree of welding.

The relationship of these conceptual hydrogeologic zones for the USW G-4 drill hole location to the geologic and thermal/mechanical stratigraphy is shown in Figure 1 (SNL, 1991).

Table 1 contains a summary of the geologic and hydrologic characteristics of the hydrogeologic zones (SNL, 1991). The hydrologic characteristics in the table are based on limited data, and, at best, represent only the general nature of each zone. The location of these zones, and the corresponding properties, are presented in Tables 2 and 3 (SNL, 1991). The extent and location of the modeled region (and hence the hydrogeologic zones) were selected because this region was bounded by four drill holes (G-1, G-4, H-1, and UE-25a #1), from which site-specific lithologic and hydrogeologic data were available.

An apparently anomalous value of 2.4×10^{-6} m/s is presented in Table 2 for the saturated conductivity of the Topopah Spring nonwelded zeolitic zone (Tpt-TNV) in drill hole G-4. There was considerable variability in the permeability of this layer at various locations. It was decided that for drill hole G-4, a high value equal to that of the Tpc-BT layer would be used for Tpt-TNV; in drill hole G-1, a lower value of 3.0×10^{-10} would be used (SNL, 1991).

Table 4 lists the hydrogeologic properties for fractures (SNL, 1991).

Quality Assurance Information

Tables and figures were prepared as part of the PACE-90 "Nominal Configuration" exercise, which is considered as non-quality affecting. The material presented in these tables and figures was collected, analyzed, and interpreted under procedures for which satisfaction of the requirements of 10CFR60, Subpart G, has not been demonstrated.

Sources

Peters, R.R., E.A. Klavetter, I.J. Hall, S.C. Blair, P.R. Heller, and G.W. Gee, 1984. "Fracture and Matrix Hydrologic Characteristics of Tuffaceous Materials from Yucca Mountain, Nye County, Nevada," SAND84-1471, Sandia National Laboratories, Albuquerque, NM (YMP CRF Accession Number: NNA.870407.0036).

Sandia National Laboratories (SNL), 1991. "Technical Summary of the Performance Assessment Calculational Exercises for 1990 (PACE-90)" Volume 1, 'Nominal Configuration' Hydrogeologic Parameters and Calculational Results," SAND90-2726, edited by R.W. Barnard and H.A. Dockery, Sandia National Laboratories, Albuquerque, NM (YMP CRF Accession Number: NNA.910523.0001).

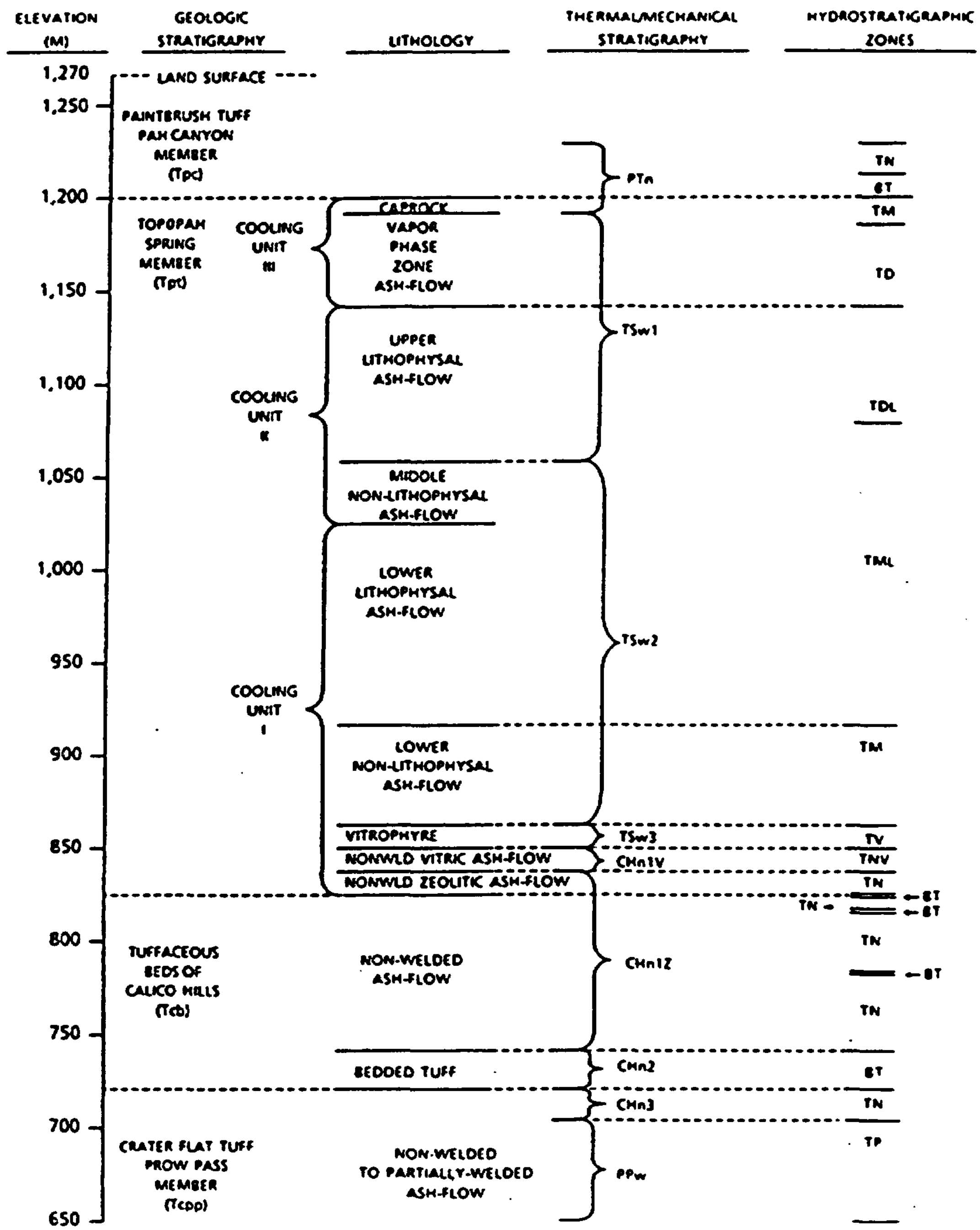

FIGURE 1. RELATIONSHIP OF STRATIGRAPHY, LITHOLOGY AND HYDROSTRATIGRAPHIC ZONES AT G-4
(Adapted from SNL [1991], Figure 3-5)

TABLE 1. HYDROGEOLOGIC ZONES WITHIN YUCCA MOUNTAIN [a]

Symbol	Hydrogeologic Zone Description	Significant Geologic Characteristics	Relationship of Vertical to Horizontal Conductivity
UO	Includes alluvium, and Tiva Canyon and Yucca Mt. Member of Paintbrush Tuff		
Tpc-TN	Ash-flow, non-welded	few fractures, high pumice content, zeolitic	K_v[b] < K_h[c]
Tpc-BT	Bedded tuff (reworked ash fall)	few fractures, high pumice, bedded, well-sorted sandstone, zeolitic	$K_v << K_h$
Tpt-TM	Ash-flow, moderately welded, non-lithophysal	highly jointed and fractured, non-zeolitic	$K_v >> K_h$ in fractures $K_v = K_h$ in matrix
Tpt-TD	Ash-flow, densely welded, non-lithophysal	moderately jointed, highly brecciated and fractured, vapor-phase mineralization, non-zeolitic	$K_v >> K_h$
Tpt-TDL	Ash-flow, densely welded, lithophysal	limited to no jointing or fracturing, abundant lithophysae, zeolitic	$K_v = K_h$
Tpt-TML	Ash-flow, moderately welded, lithophysal	highly jointed and fractured, zeolitic	$K_v > K_h$ in fractures $K_v = K_h$ in matrix
Tpt-TM	Ash-flow, moderately welded, non-lithophysal	jointed and fractured, non-zeolitic	$K_v >> K_h$ in fractures $K_v = K_h$ in matrix
Tpt-TV	Ash-flow, densely welded, vitrophyre	non-zeolitic, highly jointed and fractured	$K_v > K_h$
Tpt-TNV	Ash-flow, non-welded, vitric	few fractures, non- to partially welded, non-zeolitic	$K_v = K_h$
Tpt-TN	Ash-flow, non-welded	few fractures, zeolitic	$K_v = K_h$
Tcb-TN	Ash-flow, non-welded	few fractures, zeolitic	$K_v = K_h$
Tcb-BT	Bedded tuff (reworked ash-fall)	few fractures, high pumice content, bedded, well-sorted sandstone, zeolitic	$K_v << K_h$
Tcpp-TN	Ash-flow, non-welded	few fractures, zeolitic	$K_v = K_h$
Tcpp-TP	Ash-flow, partially to moderately welded	slightly fractured, non-zeolitic	$K_v = K_h$

[a] Adapted from SNL (1991), Table 3-1.
[b] K_v: vertical component of hydraulic conductivity.
[c] K_h: horizontal component of hydraulic conductivity.

TABLE 2. HYDROGEOLOGIC PROPERTIES AT G-4 AND UE-25A #1 [a]

Unit	Porosity (Total)	Bulk Density (g/cm³)	K_s [d] (Total) (m/sec)	Van Genuchten Coefficients alpha (m^{-1})	Van Genuchten Coefficients beta	S_r [e]	Grain Density (g/cm³)	Elevation at Base of Unit G-4 (m)	Elevation at Base of Unit UE-25a #1 (m)
UO [b]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	1219.2	1137.7
Tpc-TN	0.50	1.14	2.0×10^{-11}	0.004	1.5	0.15	[c]	1212.2	1127.1
Tpc-BT	0.22	1.95	2.4×10^{-6}	0.016	10.0	0.10	2.45	1200.6	1116.4
Tpt-TM	0.10	2.30	2.0×10^{-11}	0.005	1.9	0.10	2.57	1183.2	1093.6
Tpt-TD	0.06	2.45	5.0×10^{-12}	0.004	2.0	0.15	[c]	1148.2	1073.7
Tpt-TDL	0.08	2.40	2.0×10^{-12}	0.003	1.8	0.10	[c]	1082.9	1006.4
Tpt-TML	0.12	2.25	2.0×10^{-11}	0.010	1.7	0.05	2.50	930.2	871.1
Tpt-TM	0.10	2.30	2.0×10^{-11}	0.005	1.9	0.10	2.53	868.6	810.7
Tpt-TV	0.04	2.25	3.0×10^{-12}	0.002	1.7	0.00	2.38	860.1	797.3
Tpt-TNV	0.20	1.90	2.4×10^{-6}	0.030	2.2	0.15	[c]	850.9	787.2
Tpt-TN	0.36	1.54	3.0×10^{-12}	0.020	1.2	0.00	2.35	841.2	784.2
Tpt-BT	0.23	1.79	2.0×10^{-11}	0.002	1.6	0.10	2.32	840.6	783.3
Tcb-TN	0.36	1.54	1.0×10^{-11}	0.004	1.5	0.15	2.28	836.0	776.9
Tcb-BT	0.23	1.79	2.0×10^{-11}	0.002	1.6	0.10	2.32	835.4	775.9
Tcb-TN	0.36	1.54	1.0×10^{-11}	0.004	1.5	0.15	2.28	829.0	743.9
Tcb-BT	0.23	1.79	2.0×10^{-11}	0.002	1.6	0.10	2.32	826.3	739.1
Tcb-TN	0.36	1.54	1.0×10^{-11}	0.004	1.5	0.15	2.28	794.6	716.5
Tcb-BT	0.23	1.79	2.0×10^{-11}	0.002	1.6	0.10	2.32	793.7	715.6
Tcb-TN	0.36	1.54	1.0×10^{-11}	0.004	1.5	0.15	2.28	750.4	653.4
Tcb-BT	0.23	1.79	2.0×10^{-11}	0.002	1.6	0.10	2.32	733.3	639.4
Tcpp-TN	0.28	1.60	5.0×10^{-12}	0.001	3.0	0.20	2.33	730.6	630.3
Tcpp-TN	0.28	1.60	1.0×10^{-11}	0.004	1.6	0.15	2.33	721.4	604.4
Tcpp-TP	0.25	1.90	5.0×10^{-8}	0.010	2.7	0.05	2.59	660.5	584.9

TABLE 3. HYDROGEOLOGIC PROPERTIES AT G-1 AND H-1 [a]

Unit	Porosity (Total)	Bulk Density (g/cm³)	K_s (Total) (m/sec)	alpha (m^{-1})	beta	S_r	Grain Density (g/cm³)	G-1	H-1
UO [b]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	1280.2	1241.8
Tpc-TN	0.50	1.14	2.0×10^{-11}	0.004	1.50	0.15	[c]	1264.5	1225.1
Tpc-BT	0.22	1.95	2.4×10^{-6}	0.016	10.00	0.10	2.45	1253.8	1217.8
Tpt-TM	0.10	2.30	2.0×10^{-11}	0.005	1.90	0.10	2.57	1243.2	1207.1
Tpt-TD	0.06	2.45	5.0×10^{-12}	0.004	2.00	0.15	[c]	1191.9	1167.2
Tpt-TDL	0.18	2.06	2.0×10^{-12}	0.005	1.52	0.00	[c]	1064.7	1048.6
Tpt-TML	0.12	2.23	2.0×10^{-11}	0.005	1.52	0.00	2.50	959.7	923.7
Tpt-TM	0.08	2.30	2.0×10^{-11}	0.005	1.49	0.00	2.53	933.2	895.9
Tpt-TV	0.04	2.32	4.0×10^{-11}	0.005	1.46	0.00	2.38	916.4	883.7
Tpt-TNV	0.33	1.59	3.0×10^{-10}	0.020	4.00	0.20	[c]	900.6	852.6
Tpt-TN	0.36	1.57	3.0×10^{-12}	0.020	1.20	0.00	2.35	897.8	850.5
Tpt-BT	0.24	2.00	7.0×10^{-12}	0.003	1.65	0.06	[c]	891.1	843.8
Tcb-TN	0.36	1.57	2.0×10^{-11}	0.005	1.37	0.00	2.28	856.4	809.1
Tcb-BT	0.24	2.00	7.0×10^{-12}	0.003	1.65	0.06	2.32	855.8	806.5
Tcb-TN	0.36	1.57	2.0×10^{-11}	0.005	1.37	0.00	2.28	850.9	803.6
Tcb-BT	0.24	2.00	7.0×10^{-12}	0.003	1.65	0.06	2.32	850.2	802.9
Tcb-TN	0.36	1.57	2.0×10^{-11}	0.005	1.37	0.00	2.28	846.9	799.6
Tcb-BT	0.24	2.00	7.0×10^{-12}	0.003	1.65	0.06	2.32	846.6	799.3
Tcb-TN	0.36	1.57	2.0×10^{-11}	0.005	1.37	0.00	2.28	796.3	749.0
Tcb-BT	0.24	2.00	7.0×10^{-12}	0.003	1.65	0.06	2.32	776.2	736.8
Tcpp-TN	0.28	1.60	4.0×10^{-11}	0.006	1.48	0.00	2.33	767.7	729.8
Tcpp-TN	0.28	1.60	2.0×10^{-11}	0.020	1.40	0.00	2.33	746.3	693.2
Tcpp-TP	0.25	1.90	2.0×10^{-9}	0.010	2.70	0.05	2.59	715.9	601.2

[a] Adapted from SNL (1991), Tables 3-3 and 3-2. [b] Data for this interval are generally sparse and are not tabulated. [c] No data available. [d] K_s: saturated hydraulic conductivity. [e] S_r: residual saturation.

TABLE 4. HYDROGEOLOGIC FRACTURE CHARACTERISTICS[a,b]

Unit	$K_{f,s}$[c] (m/s)	Aperture (μm)	Frequency (#/m³)	Porosity (volume fraction)	$K_{f,b}$[d] (m/s)
Tpt-TM	4×10^{-5}	6	5	3.0×10^{-5}	1.2×10^{-9}
Tpt-TD	4×10^{-5}	6	5	3.0×10^{-5}	1.2×10^{-9}
Tpt-TDL	4×10^{-5}	6	3	1.8×10^{-5}	7.2×10^{-10}
Tpt-TML	4×10^{-5}	6	5	3.0×10^{-5}	1.2×10^{-9}
Tpt-TM	4×10^{-5}	6	5	3.0×10^{-5}	1.2×10^{-9}
Tpt-TV	4×10^{-4}	20	10	3.0×10^{-5}	8.0×10^{-8}
Tpt-TNV	4×10^{-4}	22	3	6.6×10^{-5}	2.6×10^{-8}
Tpt-TN	8×10^{-4}	30	3	9.0×10^{-5}	7.2×10^{-8}
Tpt-BT	3×10^{-5}	6	3	1.8×10^{-5}	5.4×10^{-10}
Tcb-TD	3×10^{-5}	6	3	1.8×10^{-5}	5.4×10^{-10}
Tcb-BT	3×10^{-5}	6	3	1.8×10^{-5}	5.4×10^{-10}
Tcb-TN	3×10^{-5}	6	3	1.8×10^{-5}	5.4×10^{-10}
Tcb-BT	3×10^{-5}	6	3	1.8×10^{-5}	5.4×10^{-10}
Tcb-TN	3×10^{-5}	6	3	1.8×10^{-5}	5.4×10^{-10}
Tcb-BT	3×10^{-5}	6	3	1.8×10^{-5}	5.4×10^{-10}
Tcb-TN	3×10^{-5}	6	3	1.8×10^{-5}	5.4×10^{-10}
Tcb-BT	3×10^{-5}	6	3	1.8×10^{-5}	5.4×10^{-10}
Tcpp-TN	3×10^{-5}	6	3	1.8×10^{-5}	5.4×10^{-10}
Tcpp-TN	3×10^{-5}	6	3	1.8×10^{-5}	5.4×10^{-10}
Tcpp-TP	4×10^{-4}	20	3	6.0×10^{-5}	2.4×10^{-8}

[a] Adapted from SNL (1991), Table 3-7.
[b] Van Genuchten coefficients (all fractures): alpha = 1.28 m^{-1}; beta = 4.23; S_r = 0.04.
[c] $K_{f,s}$: intrinsic fracture hydraulic conductivity.
[d] $K_{f,b}$: bulk fracture hydraulic conductivity.

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DATE: 10-29-92
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QA

OFFICE OF CIVILIAN
RADIOACTIVE WASTE MANAGEMENT
U.S. DEPARTMENT OF ENERGY
WASHINGTON, D.C.

CORRECTIVE ACTION REQUEST (Continuation Page)

1) Corrective Action Amended Response for CAR # YM-92-073

   A. Remedial Action - Make corrections to data if necessary

   B. Investigative Action - Perform technical review of data items 1.1.2 and 1.1.4 of RIB document

   C. Root Cause Determination - N/A

   D. Corrective Action to Preclude Recurrence - Investigate AP 5.3Q for procedural clarity

2) Completion Date - December 15, 1992

3) Responsible Manager - [signature] Date 30 OCT 92

Ltr dtd 10/30/92 - RSED:AMS-754

REV. 08/91

OFFICE OF CIVILIAN
RADIOACTIVE WASTE MANAGEMENT
U.S. DEPARTMENT OF ENERGY
WASHINGTON, D.C.

CAR NO. YM-92-073
DATE: 12/15/92
PAGE: ____ OF ____
QA

CORRECTIVE ACTION REQUEST (Continuation Page)

1) Corrective Action Response for CAR # YM-92-073

A. Remedial Action - Delete RIB Item 1.4.4 Hydrogeologic Zones. This action removes the apparent inconsistency described in the CAR.

B. Investigative Action - Principal Investigators at SNL reviewed the information contained in Items 1.1.2 and 1.4.4 of the RIB. The conclusion of the review was that a more detailed technical assessment was necessary to recommend changing either Item. Because the RIB contains the best available data at a given point in time, it was determined that the best available Stratigraphic Data is contained in RIB Item 1.1.2 which has more utility at this time than RIB Item 1.4.4. Therefore, to eliminate an apparent inconsistency, RIB Item 1.4.4 will be removed. Updated hydrogeologic data will replace the current information as it becomes available.

C. N/A

D. Corrective Action to Preclude Recurrence - An RIB administrator will be appointed within the next month to provide a check against submitted data and provide clarification of AP-5.3Q when necessary. In the interim, the M&O's Technical Data Manager will provide this check and balance service.

2) Completion Date - December 15, 1992

3) Responsible Manager - [signature] Date 12/15/92

Ltr dtd 12/15/92 - RSED:AMS-1518

Department of Energy
Yucca Mountain Site Characterization
Project Office
P. O. Box 98608
Las Vegas, NV 89193-8608

WBS 1.2.5.3
QA: N/A

QA RECEIVED

JAN 1? 1993

JAN 1 2 1993

Richard E. Spence, Director, Yucca Mountain Quality Assurance Division,
YMP, NV

RESPONSE ON DATE OF CORRECTIVE ACTION COMPLETION FOR CORRECTIVE ACTION REQUEST (CAR) YM-92-073

Reference: Ltr, Spence to Gertz, dtd 1/5/93

Per your request to provide a completion date for CAR YM 92-073 (reference), the corrective action completion date given in the amended response to the CAR was mistakenly stated to be December 15, 1992. Initiation of removal of Reference Information Base (RIB) Item 1.4.4 has been initiated and will be completed by March 1, 1993. Verification of removal of this RIB item will be provided to the Yucca Mountain Quality Assurance Division.

If you have any questions, please contact Ardyth M. Simmons at 794-7998.

J. Timothy Sullivan
for J. Russell Dyer, Director
Regulatory & Site Evaluation Division

RSED:AMS-1840

cc:
N. J. Brogan, SAIC, Las Vegas, NV
Gerard Heaney, SAIC, Las Vegas, NV
J. W. Estella, SAIC, Las Vegas, NV
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B. J. Verna, YMP, NV
R. B. Constable, YMP, NV

CAR NO. YM-92-073
DATE: 03-05-93
PAGE: ____ OF ____
QA

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT U.S. DEPARTMENT OF ENERGY WASHINGTON, D.C.

CORRECTIVE ACTION REQUEST (Continuation Page)

The following corrective actions were verified to be completed:

1) RIB Item 1.4.4 Hydrogeologic Zones has been deleted by Document Action Request 733.

2) Steve Bodner and Bob Lewis have been appointed RIB administrators in support of the Project Office.

Gerard Heaney — 3-5-93

Gerard Heaney — Date