NN1.880902.0025

FORENSIC REVIEW OF USW-G4 BOREHOLE DATA AS EXISTING DATA IN LICENSING

BY

JACK KEPPER

Revision 1

July 11, 1988

ENCLOSURE 1

FORENSIC REVIEW OF USW-G4 BOREHOLE DATA AS EXISTING DATA IN LICENSING

EXECUTIVE SUMMARY

The quality assurance status of geologic core gathered by various organizations within the Nevada Nuclear Waste Storage Investigation Project (NNWSI) prior to January, 1988 has been questioned many times by the Waste Management Project Office (WMPO) Quality Assurance (QA), the Nuclear Regulatory Commission (NRC) and other subcontractor QA organizations. Because of the importance of the core in the Project, extensive research during the last six months has been conducted to attempt to gather into one document all information known to exist relative to the core. For the purposes of this document, the core selected was from the drill hole known as USW-G4. All organizations involved agreed that this hole was the best documented and, if it was deemed as not fulfilling requirements, other samples from other holes would be less likely to fulfill those requirements. The purpose of this report is to provide the following:

- Document the problems concerning the qualification of the USW-G4 borehole data for the use in licensing (i.e., determine whether the core meets QA requirements; which would impact the resulting data from the core).

- Develop recommendations for attempting to use existing QA records and technical criteria as a basis for qualifying this borehole data for use in licensing and quantifying the degree of risk to the Project in implementing the recommendations.

This effort has shown that NNWSI drilling activities over the 1981-1983 timeframe did not meet the requirements of 10CFR50, Appendix B which defines the Quality Assurance requirements which should have been applied to the work. Major problems centered around the adequacy of procedures, lack of verification of activities performed at the drill site, inadequate sample identification, and improper handling, storage and transportation of the core to the core library and insufficient records.

Because there are some records and logs traceable to USW-G4 scattered within several participating organizations, it may be possible to make a case for the qualification of some data through the application of the guidelines in the Nuclear Regulatory Commission (NRC) Generic Technical Position (GTP) on the Qualification of Existing Data. To use this GTP, the core must be classified as existing data. This approach would require that current procedures relative to the qualification of existing data be revised.

There are two related but independent data sets for USW-G4. The borehole stratigraphy as a data set includes the lithologic description of the stratigraphic units and depths to contacts between these units. The second data set is the core samples. One or both of these data sets might be suitable for qualification under the GTP, but it must be recognized that neither data set has a complete set of QA records which contain approved procedures and verification records. In compiling the information necessary for this report it was evident that the logs and other existing records (many records required do not exist) covering the activities at the USW-G4 drill site are distributed among several participant organizations. A specific activity directed at the development of data package(s) covering all of the activities at any borehole should be performed. This could be performed at the Sample Management Facility and be available for distribution from this facility. A management decision regarding the acceptability of the risk related to the use of these data can only be made by the WMPO. This paper provides recommendations relative to that decision.

The depths to lithologic units within the borehole stratigraphy are based on the geolograph readings at the drill site. These readings were confirmed on a daily basis by pipe tallies and are corroborated by depths based on an interpretation of several different geophysical logs and by a drilling time curve. Records verifying this data exists at various locations, however, there is a substantially better set of documents supporting the borehole stratigraphy data set than geologic core.

Waxed core samples and oriented core samples have special markings associated with the drill site and can be documented by several drill site logs. If the lithology of these core samples compares with that in the original logs (which can be further corroborated by relogging the USW-G4 core at the Sample Management Facility), then a case possibly can be made for the qualification of these specific samples. Waxed core samples, because of the marking requirements, may be useful in tracing core from pre-USW-G4 boreholes, however, these samples and any related documents are not defined as a package in a quality program implemented at the time of their drilling.

The review of all the documents surrounding USW-G4 clearly indicates that there was a Project-wide failure to implement QA requirements and to understand the role of the QA program in licensing.

RECOMMENDATIONS

This study indicates that there are at least three options regarding the existing borehole core and related data:

1. Redrill a hole in the general area of USW-G4 (deemed technically acceptable) and repeat the testing of samples in order to duplicate the USW-G4 data. These results could either corroborate USW-G4 data or replace it. This is the lowest risk option.

2. Since USW-G4 is very near the location of the Exploratory Shaft Facility (ESF), a confirmatory testing program during shaft excavation could be used to corroborate data from selected intervals.

3. Conduct a thorough programmatic and technical review of all of the USW-G4 records and technical logs and compile an "official" document containing all the appropriate records for the borehole. Build a case for the qualification of the existing borehole data

for use in licensing and present the case to the NRC in an Appendix 7 setting. Based on the results of this meeting decide whether to exercise this option or not. This is, of course, probably the highest risk option since the decision relative to this data would be dependent upon the meeting with the NRC and, at this formative stage of development it is not known what position they would take. It is known that the related problems with geologic core at USW-G4 is well known within the NRC and they have some serious concerns.

Options 2 and 3 have increasing risks since the QA deficiencies will always exist and there is always the probability that the data could be judged as unqualified; thus, jeopardizing any data based on borehole samples up through and including USW-G4.

The first priority of the Project must be to develop a fully implemented and effective Quality Assurance Program. High quality technical work must be supported by a high quality QA program if the site is to be licensed as a repository. "Reasonable assurance" as used by the Nuclear Regulatory Commission must be the primary goal of all involved.

INTRODUCTION

The purpose of this review is to develop arguments for the qualification of core samples and of the borehole stratigraphy from USW-G4 for use in the licensing process. It was necessary to determine if the geophysical logs and a drilling time curve based on geolograph data corroborate depths to stratigraphic datums derived from lithologic descriptions of core run samples. Procedures required for the traceability of core samples from the storage facility back to the drill site did not meet quality assurance (QA) requirements in NQA-1 and Appendix B. The core derived data are currently considered unqualified for use in QA Level I and II licensing documents. There are, however, records of drilling and logging activities at USW-G4 which can be traced back to the drill site. This paper will develop a case for traceability which might be used in conjunction with corroborative data and confirmatory testing to qualify the USW-G4 borehole data for use in licensing documents.

The USW-G4 borehole is located on the east side of Yucca Mountain within the proposed repository boundary (Attachment A). It was spudded on August 23, 1982, and completed on January 1, 1983. The borehole is an important one because it is located very close to the proposed exploratory shaft (ES). The information on rock properties along with the borehole stratigraphy are considered significant data in the planning and design of the ES facility. USW-G4 was the last geologic hole drilled for the NNWSI Project and is considered to be the best documented of the four geologic boreholes.

During the period in which USW-G4 was drilled, the Waste Technology Services Division (WTSD) of Westinghouse Electric Corporation conducted QA monitoring and surveillance (Attachment B) of the drilling activities for the NNWSI Project. The drill sites visited, along with the dates and activities reviewed, are given in weekly QA reports which were transmitted to H. L. Melancon, Project Engineer, DOE/WMPO-NV. Two of these reports are pertinent to core handling at USW-G4 - For the week of September 7 through 16, 1982, "In accordance with the requirements of QMP # 11-01, Rev. 0, Quality Assurance Requirements and Responsibilities on NNWSI Drill Holes, a surveillance has been conducted during core drilling from approximately 100 to 452 feet which included activities related to removal of inner core barrel, unloading of core material, cleaning, and labeling of core samples. These operations were performed in accordance with USGS procedures and F&S geologists direction. Witnessed oriented core operation ..." - For the week of November 15 through 19, 1982, "all core was properly labeled, packaged, and transported to the core library." A letter from A. R. Hakl, Manager of the WTSD, to D. L. Vieth, Director of the WMPO, dated April 20, 1983, documents a number of deficiencies in NNWSI Project drilling practices and in the QA program over the surveillance periods identified (Attachment C).

An Appendix 7 meeting with the Nuclear Regulatory Commission (NRC) at the Nevada Test Site (NTS) Core Library in September 1985 (Attachments D and E) resulted in the formulation of 16 questions regarding the core handling procedures. A letter (November 18, 1985) from J. J. Linehan, NRC Section Leader, Repository Project Branch, to D. L. Vieth, listed the NRC concerns regarding core handling procedures and referenced the 16 questions (Attachment F). On February 26, 1986, D. L. Vieth responded to each of the NRC questions largely by utilizing existing procedures and reports from the U.S. Geologic Survey (USGS) and the NTS subcontractors (Attachment G). (Note that this response was based on a report by James P. Knight, DOE/HQ dated October 17, 1986) Linehan responded to Vieth's reply on May 19, 1986, and indicated that the procedures were still inadequate (Attachment H).

A team comprised of SAIC and DOE/WMPO personnel conducted a surveillance of the core sample control activities at the NTS Core Library on February 25, 1986. The surveillance report (WMPO/NV 86-0023, Attachment I) detailed several programmatic and procedural problems at the Core Library. A corrective action report (CAR 86-01) and a nonconformance report (NRC WMPO/NV-006) were issued on March 11, 1986 to document these deficiencies. T. O. Hunter, Sandia National Laboratory, in a letter to D.L. Vieth (dtd. 10/20/86) in response to the surveillance report indicated 1
that QA levels should be assigned to activities; not to core. (Attachment I) A letter from J. Blaylock, Project Quality Manager/WMPO, to D. L. Vieth, dated February 28, 1986 (Attachment J) recommended a suspension of work covering (1) all coring activities, and (2) all lab testing utilizing core samples for licensing activities. A determination of the traceability of the core samples requested by Lawrence Livermore National Laboratory (LLNL) from USW-G4 was also asked for in this letter. A letter from Vieth to W. W. Dudley, Jr., Technical Project Officer/USGS, dated April 28, 1986 (Attachment K) implemented this suspension. A WMPO Action Item (#86-1395 Attachment L) created a Steering Committee for the Core Library (June 9, 1986) which, in turn, formed a task force (June 26, 1986) charged with determining the traceability of existing NNWSI Project core samples (Attachment M).

In July 1986, the task force, comprised of representatives from SAIC, the USGS, the DOE, Sandia National Laboratory (SNL), and Los Alamos National Laboratory (LANL), set out with the purpose of determining the traceability of core samples from the USW-G4 borehole to the Core Library. This group visited the Core Library and examined all the documentation that was available for core samples from the depth of 1100 to 1300 feet in USW-G4. After their visit to the Core Library and a review of available documentation, the task force concluded that the traceability of the core samples in terms of a "paper trail" did not meet regulatory requirements suitable for use in QA Level I and II activities as required in 10 CFR 60 subpart G. It was noted that there was a QA program in effect at the time of drilling, but that it was neither completely implemented nor effective. In the task force report (Attachment N), it was suggested that technically the core could be traced back to USW-G4 because, (1) the core boxes were marked as to borehole number and depth interval, and (2) run and piece numbers were on the core in the Core Library. Similar statements were made by the WMPO (J. Blaylock letter dated 2/28/86) after the surveillance report (Attachment O). A letter from D. T. Oakley, Technical Project Officer/LANL to the WMPO in July 1986 (Attachment P) stated that establishing the pedigree of the existing core should have the highest priority since traceability could potentially impact the entire NNWSI Project. It was suggested that a peer review and an NRC Appendix 7 meeting be held to resolve the problem.

The traceability problem with the core will be detailed later in this report, but first in order to complete this background, the problems encountered must be presented. The WMPO had no approved documents directing that run and piece numbers be placed on the core samples at the drill site during the period stated earlier, and it had no documents verifying that such marking was conducted. What this means is that the identity of individual pieces of core may have been lost during transport of the core samples or storage activities subsequent to sample collection at the drill site. Several of the criteria as delineated in 10 CFR 50 Appendix B and NQA-1 were not met by the activities performed at the USW-G4 drill site or at the Core Library Facility. These criteria include Criteria-5, Instructions, Procedures, and Drawings (no procedure/ inadequate procedure in this case); Criteria-6, Document Control (lack of review and approval of some procedures); Criteria-8, Identification and Control of Material, Parts, and Components (question of marking run and piece numbers on core); Criteria-13, Handling, Storage, and Shipping (transport of core and activities at Core Library); and Criteria-17, Quality Assurance Records (absence of some or most records furnishing evidence of activities affecting quality, i.e., verification of marking of the core at the drill site).

At a meeting on November 13, 1987, between C. Gertz, J. Blaylock, and S. Leedon, from WMPO/NV, and J. Kepper, QA Officer/SAIC, three options with regard to the acceptance of borehole data for licensing documents were outlined. Option I involves the least risk and simply requires that another core hole be drilled in the general vicinity of USW-G4 and that the NNWSI Project ensure the implementation of an effective and fully developed QA program for all drilling and core recovery activities. Data from this new hole might corroborate the existing USW-G4 information. Option II utilizes samples from the exploratory shaft facility (ESF) which will be taken under an approved QA program and which could validate the existing data from USW-G4 (located near the ESF). This has an element of risk since the traceability problem still exists. Option III essentially says take all of the available documentation and records for USW-G4, perform a technical review of the core and related logs, and, in an Appendix 7 setting, advise the NRC of the intention to use core derived data from USW-G4 in licensing documents. This option also has risks because of the traceability question, although there are programmatic concerns when the whole drilling activity is examined, and the Project would have to make a decision based on the NRC comments. The last two options require that the core be defined as existing data. This paper is an effort to develop the data set that would be available to support options II or III.

It is important to recognize at this point that there are in fact two data sets from USW-G4 which are related but are also independent of one another. The first data set is the borehole stratigraphy based on lithologic descriptions of core run samples. Depths to datums within this stratigraphy come from geolograph readings and supporting pipe tallies and can be confirmed by geophysical logs and a drilling time curve. Some core samples might be traceable back to the drill site by special marking and handling procedures and, in turn, located within the stratigraphic column. But it is possible that the borehole stratigraphy, which is better documented, could be qualified and the core samples, because of procedural and verification problems, could be considered unqualified data in accordance with the NNWSI Project QA Program requirements.

There is a question that revolves around the "E" or "extra core" reported on the core index log and preserved in the core boxes as segments of blue painted core that were placed at the beginning of the run in which they were recovered. Of the total 356 core runs, 56-or 16%-contained "E" core. This type of core is primarily the result of the recovery of a stub left intact at the bottom of the hole and picked up on the subsequent run, or it is mislatch caused by the dropping of a piece of core during trip out and the piece's subsequent recovery. It sometimes represents a segment which has fallen from a higher stratigraphic level. Unless it is badly ground up in the drilling of the subsequent core run, the stub or the mislatch can often be matched with a broken piece from the bottom of the previous run. In using the geologist log for the recording of mismatches and examining all of the color photographs of USW-G4, it appears that most of the "E" core could have been correctly placed at the drill site. However, instead of doing this, R. Scott, USGS, in a memorandum to the site geologists dated February 4, 1982 (Attachment Q), directed them to place all "E" core at the beginning of the run in which it was recovered and to further segregate it by marking it with blue paint. Reassembly of such core is difficult after it has been jostled during transport and after (in the case of USW-G4) it was rebroken to fit into smaller boxes. It has been verbally asserted that this "E" core might cause problems in determining the depth to various stratigraphic units. This is clearly not the case since the depth for each core run is based on the geolograph not the amount of recovered core. From examination of the color photographs and the core index log, it is evident that all of the "E" core came from within stratigraphic units rather than at stratigraphic boundaries, so that any descriptive data from "E" core are correctly located with respect to a stratigraphic unit, but not to the correct depth. There is no record of how "E" core samples, if any, were placed with respect to depth, or if any of this "E" core has been used in subsequent core analyses (e.g., in fracture analyses or in the percentage of core recovered). Finally, there is no correlation between "E" core and rock properties since densely welded devitrified tuff was just as likely to produce "E" core as nonwelded bedded tuff.

A second question deals with uncertainties over the depth of core samples within a run (10 to 20 [foot core] barrels used) when recovery was not 100%. Core loss blocks indicating the probable depth interval over which the loss occurred were not used at USW-G4. Again, such questions can only be addressed at the site of recovery and are irresolvable after that. Core recovery at USW-G4 was approximately 92%, so this problem is not significant. In WMPO/NV surveillance report 86-022, there is reference to a discrepancy between the amount of core recovered on the Fenix & Scisson (F&S) Daily Drilling Report and that given by the well site geologist (Attachment R). The F&S report should be ignored because it is an inaccurate copy of other well site reports. This is borne out by the fact that often the same drilling specialist signed the reports for all three shifts. The REECo daily drilling log, the geologist log, and the core index log all agree with regard to the core runs and recovery information.

STRATIGRAPHY AND ROCK PROPERTIES

In order to interpret the geophysical logs and the drilling time curve, the stratigraphy and the associated rock properties which might influence a particular geophysical tool must be known. Attachment S illustrates the two stratigraphies currently being used at Yucca Mountain. These include a geologic stratigraphy (Spengler et al., 1984; USGS OFR 84-789) and a reference stratigraphy based on thermal/mechanical properties (Ortiz et al, 1984, SAND84-1076, and the Reference Information Base). Although these stratigraphies are closely related, they are based on different criteria such that unit boundaries and the number of units recognized are not the same in all cases. However, it is possible to recognize units from both the geologic and the reference stratigraphies on the geophysical logs and the drilling time curve.

The geologic stratigraphy is based primarily on lithologic criteria. It is the one used on geologic maps, cross sections, and in the initial borehole descriptions. This stratigraphy consists of a sequence of compositionally distinctive ash flow tuffs separated by thin intervals of bedded airfall tuff, reworked tuff, and tuffaceous sediments. Contacts between the bedded units and the ash flow tuffs range from sharp to gradational depending on the time-space relationship between the deposition of the airfall tuff and the subsequent eruption of the ash flow. If these events are very close together, the contact may be gradational. The geologic stratigraphy largely reflects cauldron sources and the mode of emplacement of the material.

There are a number of processes superimposed on the original materials which significantly modified their physical and chemical properties and in turn led to the development of the reference, or thermal/mechanical, stratigraphy. In the case of the ash flows, a zonal pattern related to the temperature of emplacement and a subsequent cooling history is manifest by a more or less systematic variation in the degree of welding as well as various mineralogical, textural, and structural changes. Welding, related to temperature and the thickness of the flow, is a consequence of the compression of the original porous mass of glass shards, pumice fragments, and crystals leading to a denser porosity rock or vitrophyre. Mineralogical changes, along with textural and structural changes in part, stem from a variety of processes associated with the volatile phase of the flow. Devitrification in which the initial glass phase is altered to an intergrowth of alkali feldspar and silica minerals, lithophysae (largely unconnected gas cavities) formed from exsolved gases in the denser portion of the flow, and vapor phase minerals precipitated in the open spaces within the flow are all examples of such processes. Cooling joints may also develop in the denser portions of the flow. Virtually all of the above are tied into the cooling history of the flow.

There are a number of largely post-cooling physical and chemical processes which further altered both the geologic and the reference stratigraphy. These include tectonic joints and faults with the former best developed in the more densely welded horizons. After deposition some of the glass may become hydrated. Magmatic fluids or ground waters may supply silica or carbonate as fracture fillings. The more porous, less welded to nonwelded tuffs subjected to ground water may be replaced by zeolites or clay minerals. Such alteration zones commonly cut across geologic stratigraphic boundaries and may be gradational with adjacent unaltered tuff units over many feet of section.

Summary

The physical and chemical characteristics of the stratigraphy are the result of a set of compositional, textural, and structural features related to three stages in tuff history: (1) cauldron source and mode of emplacement, (2) cooling history, and (3) post-cooling processes. Although some of the processes (e.g., emplacement) can lead to sharp boundaries between lithologic units, most of them lead to gradational relationships. The geologic stratigraphy emphasizes the first stage, while the reference, or thermal/mechanical, stratigraphy largely reflects the last two stages. Hydrologic and engineering properties are more strongly related to the reference stratigraphy.

GEOPHYSICAL LOGS

The measurement made by a geophysical logging tool is influenced by a number of factors, including physical and compositional characteristics of the rock, formation fluids, borehole conditions (size, rugosity, drilling medium), rate and direction of movement of the tool along with the time constant; and design of the tool (number of detectors, source-detector spacing, sidewall tool, etc.) The bulk of the literature on geophysical logging covers measurements in sedimentary sequences within a fluid saturated environment. In contrast, the stratigraphy at Yucca Mountain consists largely of volcanic rocks and much of the sequence is in the unsaturated zone. This means that a number of tools cannot be used effectively because they require a fluid filled hole in a saturated environment (spontaneous potential, most resistivity, and most acoustic tools, for example). Some tools, such as the densilog and neutron devices, can be used, but meaningful derivative information, including the porosity of the formation, cannot be directly measured due to the requirement of saturation. If the value of either porosity or saturation can be determined from core samples or some experimental technique, the other value can then be determined from the volume fraction of water from the neutron log in the unsaturated as well. There are some brief descriptions on the application of geophysical logs to volcanic sequences in both the saturated and unsaturated zone at the NTS and at Yucca Mountain. These include Eckel (1968), Studies of the Geology and Hydrology of the Nevada Test Site; Geologic Society of America Memoir 110 (papers by Snyder, pp. 117-124, and by Carroll, pp. 125-134); and numerous USGS Open File Reports: (1) Hagstrum et al. (1980), OFR 80-941; (2) Daniels et al. (1980), OFR-81-389; (3) Muller et al. (1983), OFR 83-321; (4) Spengler et al. (1984), OFR 84-789; (5) Muller, OFR 84-649; and (6) Muller, OFR 86-46. A paper by L. A. Anderson (USGS OFR 84-552) describes rock property measurements from USW-G3 and USW-G4 core samples that could be used to evaluate inhole geophysical log data.

Geophysical Logging Tools Used at USW-G4

Caliper logs were run with both the three- and six-arm tools that measure the borehole diameter. Sets of opposing arms are linked electronically to display a borehole diameter. Calibration was accomplished by comparing the recorded diameter of each set of arms to the known diameter of two steel rings: one ring that was closest to borehole diameter and one that was at least 10 inches larger. The arm diameters were also recorded while open to their maximum. The three arm positions were recorded on the log before and after logging. A measured accuracy of 0.25 in. was required between the before and after calibration readings.

Whether a borehole is stable and remains close to bit size or caves and washes out in an unstable zone is partly controlled by rock properties. However, the nature of the drilling medium, drilling practices, and whether the hole is in the unsaturated or saturated zone can play additional roles. In general, vitric nonwelded tuffs and lithophysal-rich zones in densely welded units tend to cause hole instability. The latter is well-illustrated in the rugose nature of the caliper trace in the lithophysal zones of the Tiva Canyon and Topopah Spring Members (Attachment T). Where rapid changes in hole stability correspond to unit boundaries, the break in the caliper trace is often sharp (Attachment T) and is within a range of $\pm$ 1.0 feet of the core run boundary. The effectiveness of many of the other geophysical tools, particularly radiation emitting/detecting devices, is strongly influenced by hole size, and these tools were used in conjunction with a caliper log.

Gamma logs record either total gamma radiation emitted by the rock unit, or they are spectral gamma logs which distinguish gamma counts from uranium, potassium, and thorium. Geiger-Muller tubes or scintillationtype detectors are devices used to measure the radiation. Before and after a run these tools are calibrated in the field against a manufacturer certified radioactive source (radium-226) placed at a set distance from the detector. The radiation recorded in American Petroleum Industry (API) counts per second (cps) is tied to the known response of a particular tool model to the radioactive source (or radioactive calibrator) and to the API gamma ray calibrator pit in Houston, Texas. According to C. Douglas, Senior Logging Engineer for F&S, the counts on the before and after runs must be within 4.0% (in cps) to be acceptable. The spectral log sonde uses a sodium iodide crystal to measure both total radiation and the spectral radiations. It is calibrated against measured concentrations of potassium, uranium, and thorium. Where the borehole is opened up due to caving, the intensity of radiation decreases. In air-filled boreholes with diameters over 10 inches, radiation is greatly attenuated. The gamma tool can be used in cased holes even though the intensity of the radiation is reduced. This reduction is sharp at the casing joints and shows up as regularly spaced spikes on the gamma trace. The joints are approximately 40 feet apart (range from 38.15 to 41.97 feet in USW-G4) and can give a rough measure of depth in the hole.

Potassium seems to be the major source of radiation in the volcanics. The principle sources include alkali feldspar, clinoptolite, and illite, or a mixed layer illite-smectite clay. Because the clay and zeolite minerals are chiefly produced by secondary alteration processes and may cut across formation or member boundaries, the gamma logs are of limited use in defining the stratigraphy (Attachment U). Uranium seems to concentrate in the fracture filling cements, but detection of such fracture zones is difficult because of the relatively high background radiation from uranium.

Neutron logging tools measure thermal or higher energy level neutrons backscattered from hydrogen sources (nuclei) in the rock. This tool measures the lower energy thermal neutrons which are not only influenced by hydrogen sources, but also exhibit a matrix effect where elements like silicon and calcium capture neutrons and reduce the count. Both long and short spaced instruments were used. The logs recorded at USW-G4 include the neutron count and/or the long and short spaced neutron counts and a long space/short space ratio log. Despite the borehole compensation, the hole rugosity associated with caving in in the lithophysal zones in the Tiva Canyon and Topopah Spring gives a spikey trace to the neutron curves, reflecting variations in intensity as a function of hole diameter and possibly porosity. Porosity curves were derived from the neutron counts, and, as noted earlier, these values can be used directly in the saturated zone but require additional data to be useful in the unsaturated zone.

Each particular model of neutron tool is calibrated (in API units) in the API neutron calibration pit and at the same time its response to a standard neutron calibrator is measured. This calibrator is the secondary source used in field calibrations of the neutron tool. Each model has a specific response to a manufacturer certified neutron source or calibrator which is used at the drill site by the logging company. The before and after calibrations from a particular run must be within 4.0% (C. Douglas, Senior Logging Engineer, F&S).

In general, high neutron counts indicate a paucity of hydrogen sources, while low neutron counts indicate an abundance of hydrogen sources. In these volcanic sequences, hydrogen sources include water in the matrix and fracture pores, water of hydration (in glasses), and structural or absorbed water (or OH) in zeolites and clay minerals. In vitric nonwelded units we might expect low counts (pore water + hydration), while a densely welded devitrified unit might give a higher count (Attachment V). However, if the densely welded unit is highly fractured or contains an abundance of lithophysae (particularly if they were interconnected), a low neutron count might occur as a reflection of the porosity. Some care must be applied to the interpretation of neutron counts in the unsaturated zone where levels of water saturation can vary considerably. Water-bearing secondary minerals such as clay or zeolites may be distributed across stratigraphic boundaries so that the core run based contacts between lithologic units may not agree precisely with log based contacts. There appears to be no established relationship between the percentage of these minerals in a rock and a threshold response from the neutron tools.

The densilog tool is a sidewall tool with a gamma source (cobalt or cesium sources) and two detectors (borehole compensated) which measure the back scatter of gamma radiation from the formation. Back scatter is a function of the electron density of the material in the rock. High density material leads to low count rates and low density material to higher count rates. The device measures density and derived values of bulk density and porosity. However, the latter is only effective in fluid saturated boreholes in the saturated zone. The densilog tool is calibrated in the field against a manufacturer certified aluminum or magnesium block of known bulk density. Calibrations performed before and after the run must be within ± 4.0% (C. Douglas, Senior Logging Engineer, F&S).

In general, nonwelded or highly altered (argillic or zeolitic) stratigraphic units have low bulk densities, while densely welded vitrophyres or devitrified ash flow tuffs tend to have higher values. However, the vitrophyre has a lower grain density than the devitrified welded tuff and may be distinguished on the log as such (Attachment V). Lithophysal zones within a densely welded tuff may have lower bulk density than an adjacent nonlithophysal bearing unit. Because the densilog is a sidewall tool, contact with the borehole walls is important and hole rugosity will effect the gamma count. The spikiness (Attachment V) in the densilog trace in the lithophysal zones in the Paintbrush Tuff is a consequence in part of hole rugosity (a function of caving, hole enlargement, and radiation attenuation).

Acoustic logging tools are useful below the water table since they require a fluid filled borehole and a saturated formation. The acoustic log traces represent sonic compressional waves or sonic shear wave velocities. Sonic velocity increases as a function of the bulk density of the rock matrix. The latter is chiefly a function of the rock composition, the matrix porosity, and the fluid(s) in the matrix pores. Secondary porosity, such as fractures or isolated lithophysal cavities, is reportedly not completely sensed by some of the acoustic tools. In general, acoustic log traces should correspond with the degree of welding and/or alteration. Because the acoustic logs did not supply additional significant information, they were used to support the depth for only one datum that was also defined by other logs.

Resistivity log measurements were made at USW-G4 using a dual induction focused logging tool which did not require a fluid filled borehole. A transmitter-receiver combination generates and records an electrical current which is transmitted through pore fluids within the rock formation. Conductivity and its reciprocal resistivity is recorded by a series of shallow and deep focus resistivity tools. Some important parameters which influence resistivity include porosity, the resistivity of the pore fluid and that of the drilling medium, and the composition of the rock. In the latter case, zeolites and clay minerals, because of their contained water and ion exchange capacity, tend to lower the resistivity of altered tuffs relative to their unaltered equivalents. Very high resistivity (above 200 ohm/meters) causes unreliable responses with these sondes such that low porosity high grain resistivity volcanic rocks in the unsaturated zone will not give satisfactory measurements. Induction tools are calibrated before and after a run using a calibrated loop which induces a signal in the tool receiver that corresponds to a fixed conductivity value. Resistivity was measured in USW-G4 in the upper 500 feet of the unsaturated zone, where resistivity was too high to obtain meaningful data; and from 1375 to TD (3001 feet), most of which is in the saturated zone (water table at 1765 feet). Attachment X illustrates the use of resistivity traces in the saturated zone to define some stratigraphic boundaries.

The spontaneous potential tool, which is normally run with the resistivity sondes, requires a fluid filled borehole, saturated conditions in the rock, and a drilling medium with a distinctly different resistivity than the formation fluid. These conditions were not met at USW-G4, so the tool was of no use.

Drilling time log

It has been standard practice in the petroleum industry for many years to use drilling time logs as corroborative data for stratigraphic units defined on the geophysical logs (see paper by G.F. Shepherd in Leroy (1950), Subsurface Geologic Methods, pp. 455-475). The premise here is that the rate of penetration by the drill is in part a function of the physical-chemical makeup of the rock. There are, however, a number of contributing factors to drilling time other than the rock properties per se. These include size of the hole, type and condition of the bit, drilling weight, drilling practice, rotary speed, torque, and friction. Drilling time curves are developed from geolograph data and plotted as minutes/foot against depth. Because of the variety of controls on the penetration rate, qualitative changes in this rate between adjacent footages are sought rather than absolute values.

The drilling time curve for USW-G4 (Attachment Y) does corroborate some of the core run and geophysical log depths (Figure 11), but it is not a tool which will consistently distinguish degrees of welding or induration. The base of the densely welded Tiva Canyon Member at 118 feet from the core run data shows a sharp decrease in drilling time at the same depth. Vitrophyres in the Topopah Spring Member are easily penetrated and show up on the log as a sharp decrease in the penetration rate at 240 and 1315 feet. The lithophysal zone, which occupies the middle portion of the Topopah Spring (400 to 1128 feet) shows up with a spikey pattern similar to that seen on some of the geophysical logs. Two sub-intervals in this zone are represented by small lithophysae (470 to 620 feet from core runs and 510 to 610 on the curve) and a middle nonlithophysal zone (680 to 770 core run and 675 to 760 on the drilling time curve) involve an increase in drilling time. Only the lower part of the nonlithophysal zone (710 to 780) shows up on the densilog. Below the Topopah Spring a few other units can be clearly defined, including the top of the bedded tuff in the basal Calico Hills (1705 on the core run data and on this curve) and the top thinly bedded unit at the base of the Prow Pass (2237 core run and 2230-2240 on the drilling time curve). The drilling time curve does confirm depths based on the coring and the geophysical logs.

Comparison between core run based depths and geophysical log and drilling time log depths. Table 1 (Attachment 2) illustrates the comparison between depths to stratigraphic boundaries based on lithologic descriptions from core run data and to the same boundaries as defined by various geophysical logs. A significant element concerning this use of the geophysical logs is that we have several different tools responding to different combinations of rock parameters which allows us to cross-check depth readings. These depths can then be used to confirm those defined from the core runs. With this kind of corroboration we can have confidence that the core run depths drawn from the geolograph/pipe tally data are reasonably accurate.

In Table 1, the depth values under the individual geophysical logs record the depth to the midpoint of the inflection (response trace on the log) for a particular contact. The plus and minus values represent the depth at the beginning and at the end of the trace inflection. Depths recorded under the core run column are based on the interpretation of the lithologic descriptions of core samples (Spengler et al., OFR 84-789) and are the basis for the geologic stratigraphy column. The values in parentheses are from Ortiz et al. (1984), SAND84-1076, and are used in the Reference or Thermal/Mechanical stratigraphic column. The plus and minus values for the three (3) deepest units are from Ortiz et al. (1984) and reflect uncertainties in picking boundaries that were strongly affected by secondary zeolitization. As noted earlier, clay or zeolite alteration tends to cut across stratigraphic boundaries. The threshold levels for parameters controlling the responses of the geophysical tool (e.g., what percentage of zeolite or clay affects the densilog or neutron tools) is not known. Thus the contact between a zeolitized welded tuff and a zeolitized bedded tuff might be obscured by this secondary alteration.

The geologic unit contacts are commonly based on a contact between a welded and a nonwelded tuff of some type. The depths in the densilog column agree closely with the core run based depths where the degree of compaction is the controlling parameter; but where a second parameter such as zeolitization (which reduces grain density) enters the picture, the agreement between depths is not as close, but still acceptable. We see a similar effect with the neutron logs. Units 3, 8, and 12 are indicators of the close correspondence between core run and geophysical log depths. In the case of units 2 and 9, both the drilling time curve and the geophysical logs confirm the core run depths. With the recognition of the mitigating factors governing geophysical tool responses and the rate of penetration of the drill bit, it is evident that depths based on these tools corroborate depths based on the lithologic descriptions from the core runs. Of the 12 chosen stratigraphic datums from the lithologic log, 7 of the depths as defined by the geophysical logs are within ± 4 feet of the lithologic datums, and 5 are within ± 8 feet of the lithologic datums. Caliper logs defined some datums within ± 0.5 feet.

THE CASE FOR QUALIFICATION OF THE USW-G4 BOREHOLE STRATIGRAPHY AND CORE SAMPLES

INTRODUCTION

The Steering Committee on the Core Library, through the efforts of its task force, concluded that the USW-G4 core samples could not be traced back to the USW-G4 drill site with the available documentation. The root cause for this is the failure of NNWSI Project personnel to understand the ramifications of the application to the licensing of a geologic repository of QA requirements derived from 10 CFR 60, subpart G, and 10 CFR 50 Appendix B, and NQA-1. Drilling, logging, and core handling activities were not adequately covered by approved procedures and the proper performance of these activities, with few notable exceptions, was not documented. If a case can be made for the qualification of this core for use in Level I and II licensing documents, it would most likely use the guidelines in the NRC Generic Technical Position (GTP) on the Qualification of Existing Data (Attachment AA). With the core defined as existing data under the guidelines established within the NNWSI Project, USW-G4 data could be corroborated or confirmed by duplicate testing with samples collected during the development of the exploratory shaft facility (ESF).

Using ESF samples in a corroborative role is one of three options available to the Project for obtaining qualified data from existing boreholes associated with the NNWSI activity. The first option involves the least risk of rejection in the licensing process and requires that existing boreholes which may be the source of licensing data be redrilled under a fully implemented and approved QA program. The second option utilizes the ESF samples in a corroborating or confirmatory testing mode for existing information already obtained from USW-G4. This effort would probably concentrate in selected core intervals in the Topopah Spring or Calico Hills and would most likely require an Appendix 7 meeting as noted in the third option. The risk here revolves around the traceability problem at USW-G4. Option III also accepts this risk, but combines existing (1981-82) procedures with a technical review (including the relogging of USW-G4) of the borehole logs and records to develop a case for using USW-G4 data in licensing for QA Level I and II activities. This case would be presented in the context of an Appendix 7 meeting before the NRC during which the Project would advise them of the intention of using such information for QA Level I and II work. Based on the comments from the NRC, the WMPO would either proceed or move back to one of the other options. The outcome of an Appendix 7 meeting is of course unknown, but there is the risk of rejection at some level in the licensing process. Nonetheless, options II and III require that the WMPO review all of the records and procedures governing activities at USW-G4, review the logs including the relogged core (performed after the transfer to the SMF), and attempt to build a case for qualification of (1) the borehole stratigraphy, and (2) the core samples.

Before building such a case, it is necessary to look at the definition of existing data in current documents. The NRC Generic Technical Position on the Qualification of Existing Data states that existing data include data generated prior to the implementation of a 10 CFR 60, subpart G QA program by the DOE and its contractors. Data are qualified if they are initially collected under a 10 CFR 60, subpart G QA program or existing data qualified according to this GTP. Existing data, according to the NRC, may be qualified by the use of (1) peer review, (2) corroborating data, (3) confirmatory testing, (4) an equivalent QA program, or (5) any combination of these. At the Project level, SOP-03-03, "Acceptance of Data or Data Interpretations Not Developed Under the NNWSI QA Plan," includes as existing data those data were generated by Project participants, predecessor organizations, or their subcontractors involved in siting the geologic repository prior to the NNWSI QA Plan (NVO-196-17 RO) dated August 1980. Data generated after August 1980 and not meeting the QA requirements must be handled by nonconformance procedures in accordance with SOP-15-01.

The evidence presented here documents the lack of approved and adequate procedures and verification documentation and clearly shows that the NNWSI Project QA program was not implemented. Indeed, if we look at the current list of unapproved and, in many cases, unwritten APs, or at the current lack of adequate procedures for many of the drilling activities, the argument that the QA program is still not implemented is valid. If the WMPO interprets implementation to mean that the QA program was not entirely in place and operational in 1982, we can conclude that the USW-G4 core and derived data are existing data. As such it is subject to the qualification guidelines in the NRC GTP (references).

If we cannot define information from the USW-G4 borehole as existing data, but must instead use the August 1980 cutoff date, then these data must be handled by nonconformance procedures (NNWSI SOP-15-01). The only way we might be able to apply some of the borehole data to QA Level I and II activities is through the use of a technical review to justify a "use as is" approach. Since the NCR and CAR were only directed at core handling, it is possible that the borehole stratigraphy (core run data corroborated by geophysical logs) might be easier to qualify through a "use as is" mode. This nonconformance route offers many uncertainties and a thorough technical review requires as much effort as options II and III under the existing data label. The better approach would appear to be to describe the borehole data from USW-G4 as existing data and follow the NRC guidelines if option II or III is chosen.

Qualification of the Borehole Stratigraphy

The prime question to be answered here is what assurance do we have that the core descriptions detailed in the lithologic logs refer to material occurring at the depths assigned in those logs? A corollary question asks whether the logs involved in defining the stratigraphy can be traced to USW-G4. There were two independent methods used at USW-G4 for determining depth in the borehole. These methods include the geolograph (a Record-O-Graph on the Ideco 37 drill rig at USW-G4) and the pipe tally. These methods were utilized during each of the three daily shifts when drilling was occurring. Pipe tallies include the number of stands pulled from the hole (measured with steel tape) and the length of the core barrel. The point from which the measurements were made must also be known (i.e., kelly position or ground surface). The pipe tally, done at the end of each shift, gives the depth to the bottom of the hole (uncorrected for the deviation from the vertical). The geolograph supplies a strip chart showing the penetration rate in terms of minutes/foot and has a gauge giving the depth for each core run (or just depth when not coring). The REECo Daily Drilling Report (Attachment BB) includes the pipe tally for each of the three shifts, the depth interval for each core run (geolograph data), and a reading of the geolograph at 6 AM (graveyard shift) each day. The core run depths are also recorded in various logs kept by the well site geologist and, in the case of USW-G4, there is agreement between these various sources. The 6 AM reading of the geolograph is normally from the last or next to last core run for that shift. Comparing the pipe tally to the last core run depth and to the 6 AM reading on several different records from October and November 1982 shows that the depths match. The important point is that there were independent means to determine depth and that these methods served as a daily check on the precision of the two methods. Note that precision means that the methods were giving us the same depth. The agreement between the pipe tally and the geolograph (core run depths) was also considered to define the accuracy of the measure (i.e., how close this is to the true depth). The Drilling Program for USW-G4 (Attachment CC) required pipe tallies to be done for each 500 foot interval, for the depths to be recorded to the nearest 0.1 foot, and for the depths to be correlated with the core runs. Correlation or how close the two depths must be is not specified in the document. Penetration rates from the USW-G4 geolograph strip chart were used to plot the drilling time curve discussed earlier in this paper.

The geolograph used at USW-G4 was a Record-O-Graph made by Martin-Decker, and their field manual for the calibration of the instrument (Attachment DD) was used by the subcontractor performing calibrations (Instrument Specialist Company). A signed copy of the calibration for the geolograph at USW-G4 dated September 15, 1982, is available (Attachment EE).

Geophysical logging at USW-G4 was performed by commercial logging companies (Birdwell and Dresser-Atlas). Both of these companies have detailed field manuals which include operating instructions, equipment preparation, panel set up, calibration set up procedures, and logging procedures for each model of a geophysical tool. As tools are modified or replaced, dated and numbered revisions are added to the manual and the older procedures removed. In the current manuals (Birdwell, 1984; and Dresser-Atlas, 1985) most of the tool procedures used at USW-G4 in 1982-83 have been replaced, but according to C. Douglas (Senior Logging Engineer, F&S) the same kind of field manuals were in use then. However, copies of some of the procedures from the 1981 Birdwell manual (for depth measurements, caliper, gamma and induction logging - Attachment FF) and the 1983 Dresser-Atlas manual (calibration verification and procedures for the densilog and neutron log - Attachment GG) are included with this report. These manuals are used by the logging companies in all of their operations and represent standard industry practices accepted by petroleum and mining companies as well as others utilizing such services. The manufacturer's certification of the calibration standards is not documented. In future operations, copies of all of the tool procedures as well as the certifications of the standards should be in the NNWSI Project files.

Because of the possibility of stretching when the cable carrying the tools is extended down the borehole, procedures have been devised to check for this utilizing a test borehole at the NTS (Attachment FF). The cable itself is not identified by a serial number, but it is used on a particular truck which is so numbered. A single dated but unsigned record with the appropriate truck number for the cable used at USW-G4 is available. The measurement is repeated several times before and after the tool is used, but these records have not been seen. The accuracy loss expected between the before and after readings of the geophysical logs is specified in the F&S contract with the logging company (Attachment HH) and is 1.0 feet in 1000 feet.

All geophysical tools are calibrated before and after a run as required in F&S QAP 9.16 5.4 (Attachment LL). These readings must be within 4.0% to be acceptable (C. Douglas, Senior Logging Engineer, F&S), but note that the individual calibration procedures in the field manuals also specified industry accepted deviations. Although most of the USW-G4 records adhered to the 4.0%, some did not. However, for stratigraphic purposes, relative changes in instrument response are what is important and not absolute values. Where the calibrations do not agree (some of the neutron curves), it might not be advisable to use the data for derived values like porosity. The calibration procedures are noted under the section on geophysical logs. These procedures represent standard industry practice and are documented, even though some of the 1982 record is not available at this time. The geophysical logs along with the calibrations (Attachment JJ) are on the same log record, which is dated and witnessed by the logging company and the F&S logging engineer. The header on each log (Attachment II) includes the borehole number, location, hole elevation, total depth, and information on the tool, including serial numbers and model numbers. A log quality report (Attachment KK) indicating the acceptability of a particular log is dated and witnessed by the logging company and the F&S logging engineer. All of the above procedures for the surveillance of logging activity are in F&S QAP 9.16 (August 24, 1982). The geophysical logs are traceable back to the USW-G4 borehole.

Criterion 2, Quality Assurance Program, in 10 CFR 50 Appendix B requires that qualified personnel perform the drilling and logging activities. REECo has experience requirements for its drillers (Attachment NN) which are determined at the time of hiring. There is no record available for the certification of the 1982 drillers. F&S similarly has requirements for its geologists and logging engineers and a certification procedure (for geologists - NWM-USGS-FS-02 R0). Copies of the 1982 certifications for F&S are in Attachment MM.

The review of existing drilling and logging procedures and records, along with the geophysical logs and the drilling time curve, suggests the following conclusions regarding the borehole stratigraphy at USW-G4. (The following represents the records available from USW-G4 regarding its traceability):

1. There is a traceable record from the logs back to the USW-G4 borehole.

2. The depths to selected lithologic datums as reported in the lithologic logs are corroborated by the depths interpreted from the geophysical logs and the drilling time curve. Core run depths based on the geolograph recorder are corroborated by the daily pipe tallies.

3. Items 1 and 2 support the inference that the depths to selected lithologic datums as reported in the geologic and the reference stratigraphic columns for USW-G4 are located within the borehole with an accuracy of $\pm$ 8.0 feet or better.

4. We do not have a complete record of all of the USW-G4 drill site activities, but the key elements of traceability, calibration, and corroboration of depths by independent methods exist.

5. A review of the geophysical logs by an outside logging engineer coupled with further efforts to find some of the missing documentation and a relogging of the USW-G4 core should support an attempt to qualify the borehole stratigraphy through the guidelines in the NRC GTP on the Qualification of Existing Data.

Qualification of the Core Samples from USW-G4

The history of the questions on the credibility of the core samples assigned to USW-G4 and currently stored in the USGS Core Library at the NTS is outlined in the introductory section of this paper. Of concern here is the assurance that core samples in the labeled (as to borehole and interval) core boxes and currently marked with run and piece numbers are the same set of cores removed from the core barrel at the 1982 drill site. The task force assigned to examine this question concluded that the traceability of the core back to the drill site had been compromised. Specifically, there were no approved procedures requiring that run and piece numbers be placed directly on the core samples and no documents to verify that such marking might have been performed at the drill site. The run and piece numbers allow us to place the core samples at their appropriate depth in the USW-G4 borehole, but without assurance that the marking was done at the drill site, the location of these samples at Yucca Mountain is in question. Because not all of the requirements in 10 CFR 50 Appendix B were met by the drilling activities at USW-G4, the core samples and the derived data are not considered useable in licensing documents. As was noted earlier, if the core can be treated as existing data, it might be feasible, using qualified ESF samples, to attempt to qualify some cored intervals from USW-G4. The remainder of this paper deals with the case for using existing documents and sample markings along with various logs to build a reasonable case for traceability.

There is some information available which will allow a case to be made for tracing USW-G4 core samples back to the drill site. This information consists of the following:

1. NWM USGS MDP 01 R0, Identification, Handling, Storage, and Disposition of Drill-Hole Core and Samples (Attachment OO). Requires downhole arrows to be marked on the core samples. It also requires waxed core samples to be sealed and marked with hole #, core run, depth, and agency for whom the sample was intended. Note the phrase "waxed core" is not used, but the preparation procedure is for waxed core in this MDP.

2. QMP 11 01, QA Requirements and Responsibilities on NNWSI Drill Site (Attachment PP). Requires core samples shall be properly cleaned, boxed, wrapped, labeled, marked, and blocked for proper depth per applicable USGS procedures.

3. April 22, 1982; letter from R. Scott, USGS, to USGS, F&S, and National Laboratory personnel requiring the drill site geologist to mark downhole arrow along with run and piece number on the core. Not an approved document (Attachment QQ and TT).

4. NWM USGS UTP 10 R0, F&S Drill Site Unit Task Procedure (Attachment RR). Requires F&S geologist to label core according to procedures at the drill site.

5. USW G4 Drilling Program R 1 (Attachment SS). Requires that an F&S geologist ensure cores are properly cleaned, labeled, and marked for proper depth.

6. Verbal statement from F&S geologist during the February 26, 1986 surveillance (WMPO/NV 86-022) that the core was marked as required in the Scott letter.

7. Westinghouse 1982 surveillance reports indicating core handling procedure being followed at the USW-G4 drill site.

8. The current run and piece numbers on the core were placed on the samples by different people since the script varies for sections of core runs. The inference is that (a) different site geologists marked the core at the drill site, or (b) different persons at the Core Library marked core.

In addition to this information, there are a number of written drill site records dated and initialed by F&S geologists which can be traced to USW-G4. Pertinent to this traceability are the geologist daily log (Attachment UU), the lithologic log (Attachment VV), the core index log (Attachment WW), the waxed sample log (Attachment XX), and the oriented core logs (2) (Attachment YY). These logs identify the borehole and the core run interval from which the samples were taken. It is important to recognize at this point that not all core samples are equal in terms of records or markings. Waxed core samples are wrapped in aluminum foil, sealed with tape and beeswax, and marked as noted earlier. The purpose of this operation is to preserve in-situ conditions and they are required to be prepared at the drill site. It would make no sense to prepare them days later in the Core Library. These samples are referenced in the waxed core log prepared at the drill site. Oriented cores are not discussed in any of the 1982 procedures; however, when an oriented core is cut, scribe lines are grooved into the core during the drilling such that a permanent marking is made on it. Oriented cores along with the associated run numbers are listed in all of the drill site records referenced previously.

An argument can be made that if a waxed core or oriented core sample (particularly an isolated oriented core run, not bracketed by other oriented cores) were found in a USW-G4 core box at the Core Library, the lithology of the sample and the run number could be matched with the drill site documents. Once the USW-G4 core is transferred to the Sample Managment Facility at the NTS, relogging of the core should confirm the original descriptions and further support the match. From the work of Spengler et al. (1984), OFR84-789, and Byers (1985), LA 10561-MS, it is evident that there are a number of textural, structural, and compositional attributes that would be useful in distinguishing stratigraphic units in USW-G4 (Attachment XX). Most of the megascopic attributes such as degree of welding, phenocryst types, alteration mineralogy, and presence or absence of lithophysae were identified in the original drill site lithologic log and relogging of the core should confirm the original descriptions of the core runs. Geophysical logs can also confirm the core run from which the sample was reportedly taken, since the specimen should have the physical or chemical characteristics sensed by the tool over that lithologic interval. It is also possible that downhole television pictures might be used to confirm textures and structures reported on the lithologic logs from certain core runs and studies of the stratigraphic variation in magnetic properties might supply additional confirmatory evidence. The case is circumstantial, meaning that the evidence tends to prove a fact by proving other events or circumstances which offer a basis for reasonable inference of the occurrence of the fact at issue. If the core can be defined as existing material, it would certainly be feasible to attempt to qualify selected cored intervals using the NRC GTP on Qualification of Existing Data. Qualified samples of the same stratigraphic interval collected in the development of the ESF would be used to confirm data derived from USW-G4 core samples. The purpose of this case for traceability is to give some level of confidence that the sample from the USW-G4 core box, which is being confirmed or corroborated by an ESF sample, actually came from the USW-G4 drill site. Utilizing ESF samples represents option II as outlined earlier in this report.

If ESF data were not used to support USW-G4 borehole data and they can be treated as existing data, all of the available procedures, records, and logs would have to be assembled for programmatic and technical review. Relogging of USW-G4 would be used to substantiate the earlier lithologic log. An outside logging engineer might be used to review the application of the geophysical logs to the recognition of stratigraphic datums. At the conclusion of this extensive review the WMPO would prepare a report supporting option III and inform the NRC of its intention to use USW-G4 data in licensing documents. The case for this use of USW-G4 data would most likely be presented in an Appendix 7 meeting with the NRC, and the WMPO would have to decide whether or not to exercise option III depending on either a concurrence from the NRC or an evaluation of its comments. Corroboration or confirmatory testing of core from holes drilled in the future at Yucca Mountain might be used in support of the USW-G4 data. However, the QA questions raised over the activities associated with USW-G4 open up the real possibility that data derived from this borehole could be declared unqualified for use in licensing documents. Such data are fundamental to many of the major scientific questions regarding the suitability of Yucca Mountain as a geologic repository and the risk is that unqualified data would disqualify the site.

A final observation from having read most of the 1981-82 record surrounding USW-G4 is that the qualification question came about because of a Project-wide failure in the implementation of an effective QA program. It does not take much "reading between the lines" to recognize that there was a lack of qualified personnel to prepare adequate procedures and the associated documentation of drilling activities and that across the Project there was little understanding of the importance of the QA requirements in licensing a repository. If this report accomplishes nothing else, it should serve as a warning to Project management that the first priority is to put in place a fully implemented and effective QA Program. High quality technical work by the USGS and the National Laboratories must be backed by a quality QA Program if the licensing of a geologic repository is to be successful. The NRC, the Atomic Licensing Board, and ultimately the public through its representatives will accept nothing less.

Department of Energy
Post Office Box 98518
Las Vegas, NV 89193-8518

HQ.880113.0007

JAN 12 1988

Lawrence D. Ramspott, LLNL, Livermore, CA
Larry R. Hayes, USGS, Denver, CO
Donald T. Oakley, LANL, Los Alamos, NM
Thomas O. Hunter, SNL, 6310, Albuquerque
Michael E. Spaeth, SAIC, Las Vegas, NV
Joseph C. Calovini, H&N, Las Vegas, NV
Robert F. Pritchett, REECo, Mercury, NV
Richard L. Bullock, F&S, Las Vegas, NV

USE OF EXISTING GEOLOGIC SAMPLES AND RELATED DATA

The credibility of data obtained through tests on the subject samples for use as primary data in licensing has been questioned for some time. A comprehensive review of all records and logs for USW-G4 (which was agreed as the best documented hole) has revealed that the method of handling, storage, and identification of core do not meet licensing requirements, i.e., implementation of quality assurance (QA) programs meeting the requirements of 10CFR60, Subpart G.

Scientific investigations requiring the subject core or using previously published results from the subject core will continue; however, data based on these results cannot currently be used as primary data for licensing. This data can be used as corroborative data, and also may be used as primary data if processed in accordance with a project approved plan for acceptance of data not generated under a 10CFR60 Subpart G QA program and found acceptable under the criteria of that plan. In addition, data from the subject core are acceptable for use as input to the Environmental Assessment and the activities related to 10CFR960 for the selection of the potential sites for site characterization.

All future borehole and sample collection activities which are intended to provide primary data for licensing must be performed in accordance with a Waste Management Project Office approved Quality Assurance Program Plan and appropriate implementing procedures for collection, identification and control, and storage of samples meeting the requirements of the Nevada Nuclear Waste Storage Investigations Project QA Plan.

SAIC/T&MSS

JAN 13 1988

CCF RECEIVED

ENCLOSURE 2

JAN 12 1988

At this juncture, each participating organization is to proceed under the assumption that the existing core and derived data have not been qualified for use in licensing. Each participant must ensure that this existing data is identified as required by NVO-196-17 and that such data is not entered into documents or systems which are to contain qualified data only. Questions relative to this should be directed to Jim Blaylock (FTS 575-8913 or 295-8913).

Additional guidance will be forthcoming on this issue.

Carl P. Gertz, Project Manager
Waste Management Project Office

WMPO:JB-777

cc:
V. J. Cassella, HQ (RW-222) FORS
G. J. Parker, HQ (RW-241) FORS
K. D. Summers, HQ (RW-359) GTN
S. H. Klein, SAIC, Las Vegas, NV
M. A. Fox, REECo, Mercury, NV
J. R. A, USGS, Denver, CO
R. R. Richards, SNL, 6310, Albuquerque, NM
M. J. Regenda, F&S, Las Vegas, NV
P. R. Guthals, LANL, Los Alamos, NM
C. O. Wright, H&N, Mercury, NV
J. J. Dronkers, LLNL, LLNL, Livermore, CA
M. P. Kunich, WMPO, NV