OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS REVIEW OF THE U.S. DEPARTMENT OF ENERGY KEY TECHNICAL ISSUE AGREEMENT RESPONSE TO GEN.1.01 COMMENTS FOR A POTENTIAL GEOLOGIC REPOSITORY AT YUCCA MOUNTAIN, NEVADA

1.0 INTRODUCTION

By letter dated August 31, 2004, the U.S. Department of Energy (DOE) submitted (Ziegler, 2004a) a report titled "Key Technical Issue Letter Report (Response to GEN 1.01), Revision 1," to satisfy the informational needs of General (GEN) Agreement GEN.1.01. DOE indicated (Ziegler, 2004a) that the letter transmitted the final response to Key Technical Issue (KTI) Agreement GEN.1.01. However, DOE's August submission (Ziegler, 2004a) did not include the necessary details to understand where the information requested in 12 of the 49 comments of Agreement GEN.1.01 had been provided. Subsequently by letter dated September 30, 2004, DOE submitted (Ziegler, 2004b) a revised report titled "Key Technical Issue Letter Report (Response to GEN.1.01), Revision 2," to satisfy the informational needs of agreement GEN.1.01. The GEN.1.01 agreement addresses 49 separate U.S. Nuclear Regulatory Commission (NRC) comments on many different issues in the DOE's Supplemental Science and Performance Analyses (Bechtel SAIC Company, LLC, 2001a; Bechtel SAIC Company, LLC, 2001b). The information was requested by NRC during a technical exchange in September 2001 (Reamer, 2001). DOE's initial response to these comments, provided at the September 2001 technical exchange (Reamer, 2001), related the specific GEN.1.01 comments to other KTI agreements. DOE has responded to the majority of comments in GEN.1.01 in DOE responses to other KTI agreements, either in individual KTI letter reports or in technical basis documents. DOE's specific response to the Agreement GEN.1.01 (Ziegler, 2004b) identifies in Table 1 either where the information requested in each of the GEN.1.01 comments had been provided to NRC or when the NRC's review of the information provided by DOE in each of the GEN.1.01 comments had been completed.

Specific comments of Agreement GEN.1.01 addressed in this NRC review of the information provided by DOE (Ziegler, 2004b) include Comments 3, 8, 12, 15, 18, 41, 42, 50, 56, 75, 78, 83, 93, 96, 97, 98, 102, 103, 109, 110, 113, 116, 118, 120, 122, 123, 124, and 126. This review summarizes where NRC has provided reviews of DOE response to individual GEN.1.01 comments and reviews DOE's response to specific GEN.1.01 comments (Ziegler, 2004b) not previously provided to NRC. This review also addresses all of the GEN.1.01 comments associated with other KTI high-risk significant agreements.

2.0 AGREEMENTS

Wording of the agreement is provided next.

GEN.1.01[1]

"For NRC comments 3, 5, 8, 9, 10, 12, 13, 15, 16, 18, 21, 24, 27, 36, 37, 41, 42, 45, 46, 50, 56,

[1]In the agreement below, the phrase attachment 2 refers to attachment 2 of the enclosure of Reamer (2001).

64, 69, 75, 78, 81, 82, 83, 93, 95, 96, 97, 98, 102, 103, 104, 106, 109, 110, 111, 113, 116, 118, 119, 120, 122, 123, 124, and 126, DOE will address the concern in the documentation for the specific KTI agreement identified in the DOE response (Attachment 2). The schedule and document source will be the same as the specific KTI agreement."

3.0 RELEVANCE TO OVERALL PERFORMANCE

NRC synthesized existing information to categorize the key technical issue resolution agreements according to the risk significance of the agreement (NRC, 2003). In classifying agreements into the three categories (i.e., low-, medium-, and high-risk significant), risk information (i.e., risk insights) was drawn and synthesized using many types of existing quantitative analyses. Complementing the risk insights is the concept of multiple barriers (i.e., both engineered and natural barriers) in geologic disposal of high-level radioactive wastes (NRC, 2003). Multiple barriers, as an element of a defense-in-depth approach, results in a robust repository system that is more tolerant of failures and external challenges (e.g., poor or highly degraded performance is necessary in multiple areas to have a significant effect on risk). The baseline of risk insights (NRC, 2003) also addressed the risk significance of general post-closure performance assessment review items (i.e., system description and demonstration of multiple barriers; scenario analysis and event probability; model abstraction; and demonstration of compliance with the post-closure public health and environmental standards). These review topics relate to post-closure performance objectives and to items needed to support confidence in the total system performance assessment risk calculations. For these topics, the risk ranking also considered the significance of the information to build confidence in the calculations and the safety attributes of the repository system (NRC, 2003). The specific comments of GEN.1.01 are related to other KTI agreements, whose risk significance varies from low-risk to high-risk significance. Although GEN.1.01 was assigned as high-risk significance, the individual comments within GEN.1.01 were not separately categorized within the significance framework. Nevertheless, this review addresses those GEN.1.01 comments associated with other high-risk significance agreements.

4.0 RESULTS OF THE NRC REVIEW

The disposition for agreement GEN.1.01 Comments 3, 8, 12, 15, 18, 41, 42, 50, 56, 75, 78, 83, 93, 97, 98, 102, 103, 109, 110, 113, 116, 118, 122, 123, 124, and 126 is provided in Table 1 below. DOE provided specific responses to comments 8, 12, 123 (Ziegler, 2004b) and reviews of DOE's response to Comments 8, 12, and 123 are provided in Sections 4.1, 4.2, and 4.3, respectively.

Table 1. Disposition of GEN.1.01 Comments.

Comment	Status	NRC Review of DOE Response to Comment, Including ADAMS Accession Number
3	Complete	Kokajko L. E., 2005a, ML043570441
8	Complete	Addressed in Section 4.1
12	Complete	Addressed in Section 4.2

Comment	Status	NRC Review of DOE Response to Comment, Including ADAMS Accession Number
15	Complete	Reamer, C. W., 2004a, ML042330348
18	Complete	Schlueter, J. R., 2003a, ML031120724
41	Complete	Reamer, C. W., 2004b, ML042860253
42	Complete	Schlueter, J. R., 2002a, ML022460283
50	Complete	Reamer, C. W., 2004c, ML041170118
56	Complete	Schlueter, J. R., 2002b, ML022890278
75	Complete	Schlueter, J. R., 2002c, ML022340254
78	Complete	Kokajko L. E., 2005b, ML043650122
83	Complete	Kokajko L. E., 2005a, ML043570441
93	Complete	Reamer, C. W., 2004c, ML041170118
96	Complete	Kokajko L. E., 2005b, ML043650122
97	Complete	Kokajko L. E., 2005a, ML043570441
98	Complete	Reamer, C. W., 2004c, ML041170118
102	Complete	Reamer, C. W., 2004b, ML042860253
103	Complete	Schlueter, J. R., 2003b, ML030360229
109	Complete	Kokajko L. E., 2005c, ML043620153
110	Complete	Reamer, C. W., 2004c, ML041170118
111	Complete	Kokajko L. E., 2005b, ML043650122
113	Complete	Reamer, C. W., 2004c, ML041170118
116	Complete	Kokajko, L. E., 2004, ML043490118
118	Complete	Reamer, C. W., 2004c, ML041170118
120	Complete	Kokajko L. E., 2005b, ML043650122
122	Complete	Reamer, C. W., 2004d, ML042520298
123	Complete	Addressed in Section 4.3
124	Complete	Kokajko, L. E., 2004, ML043490118 and Reamer, C. W., 2004d, ML042520298
126	Complete	Kokajko, L. E., 2004, ML043490118

4.1 GEN.1.01 Comment 8

Wording of the GEN.1.01 Comment 8:

"The determination of the probability for improper heat treatment of the waste package closure welds is not transparent. Non-destructive evaluation methods to determine if the final closure weld have been properly heat treated by induction annealing have not been identified or demonstrated.

Basis: Improper heat treatment of the closure weld is considered in the SSPA [Supplemental Science and Performance Analyses]. The probability of improper heat treatment is calculated to be $2.23 \times 10^{!5}$ based on an event tree analysis provided in the Analysis of Mechanisms for Early Waste Package Failure AMR. This probability includes the probability of an independent laboratory check to verify that the heat treatment was done properly (with a probability of success to be 0.99 or alternatively a probability of failure of 0.01). For the final closure weld, a non-destructive assessment of the final heat treatment may not be possible. Methods to assess the final closure weld after induction annealing have not been presented in DOE documents. If the final assessment cannot be performed then the probability of improper heat treatment may increase. This may have a significant impact on dose to the early waste package failures."

NRC Review:

The report titled "Key Technical Issue Letter Report (Response to GEN 1.01), Revision 2" (Ziegler, 2004b) indicates induction annealing is no longer considered by the DOE for the waste package closure welds. The mitigation of residual stresses in the waste package closure welds will be performed using laser peening or alternatively, controlled plasticity burnishing. These mitigation methods will provide a region of compressive stress on the outer surface of the closure welds which will mitigate stress corrosion cracking. Laser peening and controlled plasticity burnishing may also increase strength, reduce ductility and toughness and possibly accelerate thermal aging processes. The DOE response indicated an analysis of the events leading to improper laser peening treatment is contained in Bechtel SAIC Company LLC (2003a).

The DOE response to GEN.1.01 Comment 8 (Ziegler, 2004b) is satisfactory because DOE has indicated that induction annealing of the waste package closure welds will not be performed, and therefore the comment is moot. Laser peening and controlled plasticity burnishing may alter mechanical properties but because these mitigation methods are conducted at low temperatures, formation of brittle secondary phases as a direct result of the stress mitigation processes will not occur.

4.2 GEN.1.01 Comment 12

Wording of the GEN.1.01 Comment 12:

"The use of cyclic potentiodynamic polarization may not be an appropriate method to obtain critical potentials for the initiation of localized corrosion. During the anodic potential scan, transpassive dissolution may occur rather than localized corrosion. Alternative test methods that avoid high potentials and limit transpassive dissolution may result in the consistent initiation

of localized corrosion as well as significantly lower critical potentials for the initiation of localized corrosion.

Basis: The potential based localized corrosion initiation model is based on the initiation of localized corrosion at critical potentials obtained in cyclic potentiodynamic polarization tests. The use of potentiodynamic polarization may result in the initiation of transpassive dissolution rather than localized corrosion. If transpassive dissolution is initiated the measured current density rapidly increases as a function of potential. During the reverse scan of the potentiodynamic polarization curve, the transition from transpassive dissolution to passive dissolution will likely occur [at a] much higher potential compared to repassivation potentials if localized corrosion is initiated. Recent tests conducted at the CNWRA [Center for Nuclear Waste Regulatory Analyses] have shown that cyclic potentiodynamic polarization does not result in the consistent initiation of localized corrosion of Ni-Cr-Mo alloys. During the anodic scan, there is insufficient time for the initiation of localized corrosion prior to reaching high potentials where transpassive dissolution is observed. A modified test method using a combination of a potentiostatic hold at a potential where localized corrosion is initiated preferentially to transpassive dissolution, followed by a slow scan rate to reach the repassivation potential yields critical potentials for the initiation of localized corrosion that are much lower than those obtained using the cyclic potentiostatic polarization method."

NRC Review:

The information contained in the report titled "Key Technical Issue Letter Report (Response to GEN.1.01), Revision 2" (Ziegler, 2004b) regarding GEN.1.01 comment 12 is satisfactory. DOE has conducted numerous additional tests to measure the critical potential for localized corrosion. In addition to cyclic potentiodynamic polarization tests, the DOE has examined alternate test methods such as the Tsujikawa Hisamatsu electrochemical test method using crevice corrosion test samples. The DOE response indicates that additional data will be obtained to cover a range of environments and temperatures using both creviced and uncreviced specimens. DOE has documented the results of these tests in Bechtel SAIC Company, LLC (2003b). The information provided by the DOE suggests that sufficient information will be available at the time of the license application.

4.3 GEN.1.01 Comment 123[2]

The wording of the GEN.1.01 Comment 123:

"In p. 7-67, most of archaeological evidence came from the reducing environment? If that is the case, are the quoted examples relevant to the YM [Yucca Mountain] project?"

NRC Review:

The information contained in the report titled "Key Technical Issue Letter Report (Response to GEN.1.01), Revision 2" (Ziegler, 2004b) indicates that the DOE is no longer using the approach

[2]The page number in the wording of the agreement refers to the page number in Bechtel SAIC Company, LLC. (2001a).

described in the Supplemental Science and Performance Analysis (Bechtel SAIC Company, LLC., 2001b) for corroborating the long-term general corrosion of the waste package outer barrier using natural and archaeological analogs. The abstraction for long term performance of the container material is based on experimental data on passive film characterization on Alloy 22 and other industrial analogs, such as stainless steels and other nickel alloys (Bechtel SAIC Company, LLC., 2003c, 2004a), and both short and long term electrochemical tests (Bechtel SAIC Company, LLC., 2003c, 2004b).

The DOE response to GEN.1.01 Comment 123 (Ziegler, 2004b) is satisfactory because DOE has indicated that the long term performance of the waste package container materials will be supported by additional data and comparisons to chromium containing industrial analogs, and therefore comment is moot. The information provided by DOE suggests that sufficient information will be available at the time of the license application.

5.0 SUMMARY

NRC reviewed DOE's KTI agreement response within "Key Technical Issue Letter Report (Response to GEN.1.01), Revision 2" (Ziegler, 2004b) to determine whether any important aspect of Comments 8, 12, and 123 of Agreement GEN.1.01 was excluded from the response. In addition, NRC performed an independent assessment to determine whether the information provided would support submission of a potential license application for a geologic repository. Finally, the staff determined that DOE has provided information addressing all the comments of GEN.1.01, however the NRC staff have not yet completed their review of this information on all the GEN.1.01 comments. The NRC staff have identified where NRC has previously responded to DOE on many GEN.1.01 comments. Notwithstanding new information that could raise new questions or comments concerning this agreement, the information provided satisfies the intent of Comments 3, 8, 12, 15, 18, 41, 42, 50, 56, 75, 78, 83, 93, 96, 97, 98, 102, 103, 109, 110, 111, 113, 116, 118, 120, 122, 123, 124, and 126 of Agreement GEN.1.01. On the basis of this review, the information assembled in response to Comments 3, 8, 12, 15, 18, 41, 42, 50, 56, 75, 78, 83, 93, 96, 97, 98, 102, 103, 109, 110, 111, 113, 116, 118, 120, 122, 123, 124, and 126 of Agreement GEN.1.01 is adequate to support the submission of a license application for the potential repository at Yucca Mountain.

6.0 STATUS OF THE AGREEMENTS

Based on the preceding review, the information provided with respect to Comments 3, 8, 12, 15, 18, 41, 42, 50, 56, 75, 78, 83, 93, 96, 97, 98, 102, 103, 109, 110, 111, 113, 116, 118, 120, 122, 123, 124, and 126 of Agreement GEN.1.01 is adequate to support submission of the license application. Therefore, NRC considers Comments 3, 8, 12, 15, 18, 41, 42, 50, 56, 75, 78, 83, 93, 96, 97, 98, 102, 103, 109, 110, 111, 113, 116, 118, 120, 122, 123, 124, and 126 of Agreement GEN.1.01 to be closed.

7.0 REFERENCES

Bechtel SAIC Company, LLC. "Transmittal of Appendices N and S of the Technical Basis Document No. 6: Waste Package and Drip Shield Corrosion, Revision 1, Addressing Key Technical Issue (KTI) Agreement Related to Container Life and Source Term (CLST) 1.08, 1.09, and 2.03 Additional Information Need (AIN)–1." Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2004a.

Bechtel SAIC Company, LLC. "Transmittal of Appendices O, P, U, and V, Technical Basis Document No. 6: Waste Package And Drip Shield Corrosion, Rev. 01, Addressing Key Technical Issue (KTI) Agreements Related to Container Life and Source Term (CLST) 1.03, 1.10, 1.11, and 6.01 and Preclosure Safety (PRE) 7.05." Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2004b.

Bechtel SAIC Company, LLC. "Analysis of Mechanisms for Early Waste Package/Drip Shield Failure." CAL-EBSMD-000030 REV 00B. Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2003a.

Bechtel SAIC Company, LLC. "General And Localized Corrosion of the Waste Package Outer Barrier." ANL-EBS-MD-00003 Rev 01. Las Vegas NV: Bechtel SAIC Company, LLC. 2003b.

Bechtel SAIC Company, LLC. "Technical Basis Document No. 6: Waste Package and Drip Shield Corrosion." Rev. 1. Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2003c.

Bechtel SAIC Company, LLC. "FY01 Supplemental Science and Performance Analyses, Volume 1: Scientific Bases and Analyses." TDR-MGR-MD-000007 REV 00 ICN 01. Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2001a.

Bechtel SAIC Company, LLC. "FY01 Supplemental Science and Performance Analyses, Volume 2: Performance Analyses." TDR-MGR-PA-000001 REV 00. Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2001b.

Kokajko, L. E. "Pre-Licensing Evaluation of Agreements in 'Technical Basis Document Number 4, Mechanical Degradation and Seismic Effects' and Three Other Associated Agreements." Letter (January 11, 2005) to J. D. Ziegler DOE. Washington, DC: NRC. 2005a.

Kokajko, L. E. "Pre-Licensing Evaluation Total System Performance Assessment and Integration (TSPAI) Key Technical Issues Agreements TSPAI.1.02, 3.37, 3.38 Additional Information Needed (AIN)-1, 3.39 AIN-1, 3.41 AIN-1, 4.01 AIN-1, 4.03, 4.04, 4.06 and Comments 78, 96, 111, and 120 of General (GEN) Agreement GEN.1.01." Letter (January 28, 2005) to J. D. Ziegler DOE. Washington, DC: NRC. 2005b.

Kokajko, L. E. "Pre-Licensing Evaluation of 'Evolution of the Near-Field Environment' (ENFE.2.05, 2.06, 2.10, 2.13, and 2.17), 'Total System Performance Assessment and Integration' (TSPAI.3.09), and 'General' (GEN.1.01, Comments 47 and 109)." Letter (January 13, 2005) to J. D. Ziegler DOE. Washington, DC: NRC. 2005c.

Kokajko, L. E. "Pre-Licensing Evaluation of Agreements CLST.3.03, CLST.3.03 AIN-1, CLST.3.04, CLST.3.04 AIN-1, CLST.3.06, CLST.3.06 AIN-1, CLST.3.07, CLST.3.08, CLST.3.08 AIN-1, CLST.3.09, CLST.3.09 AIN-1, ENFE.3.03, TSPAI.3.08, TSPAI.3.14, GEN.1.01 Comment 116, GEN.1.01 Comment 124, U.S. Department of Energy Initial Response to GEN.1.01 Comment 124, and GEN.1.01 Comment 126." Letter (December 29, 2004) to J. D. Ziegler DOE. Washington, DC: NRC. 2004.

NRC. "Final Staff Response to March 19, 2003, Staff Requirements Memorandum on the Waste Arena Briefing - M030303A." Memorandum to Commission (June 5). Washington, DC: NRC. 2003. <http://www.nrc.gov/waste/hlw-disposal/reg-initiatives/resolve-key-tech-issues.html#process>

Reamer, C. W. "Pre-Licensing Evaluation of 'Unsaturated and Saturated Flow Under Isothermal Conditions' Key Technical Issue Agreement 4.01 [Status: Complete], 'Thermal Effects on Flow' Technical Issue Agreement 2.08 [Status: Complete], 'Total System Performance Assessment and Integration' Key Technical Issue Agreement 3.25 [Status: Complete], and General Agreement 1.01, Comment 15 [Status: Complete]." Letter (September 16, 2004) to J. D. Ziegler DOE. Washington, DC: NRC. 2004a.

Reamer, C. W. "Pre-Licensing Evaluation of 'Unsaturated and Saturated Flow Under Isothermal Conditions' Key Technical Issue Agreements 5.02, 5.04, and 5.12 [Status: Complete], "Radionuclide Transport" Key Technical Issue Agreements 1.04, 2.01, 2.03, 2.06, 2.07, 2.08, and 3.03 [Status: Complete], and General Agreement 1.01, Comments 41 and 102 [Status: Complete]." Letter (October 20, 2004) to J. D. Ziegler DOE. Washington, DC: NRC. 2004b.

Reamer, C. W. "Staff Review of Information Addressing, 'Evolution of the Near-Field Environment' Key Technical Issue Agreements 2.09, 2.11, AND 2.15, 'Total System Performance Assessment and Integration' Key Technical Issue Agreement 3.13; and 'General' Agreement 1.01: Status Complete." Letter (June 25, 2004) to J. D. Ziegler DOE. Washington, DC: NRC. 2004c.

Reamer, C. W. "Staff Review of Information Addressing In-Drift Chemical Environment-Related Agreements for Key Technical Issues 'Container Life and Source Term' (CLST 1.01), 'Evolution of the Near-Field Environment' (ENFE 2.04, 2.14), and 'General' (GEN 1.01, Comments 122, 124): Status Complete." Letter (October 20, 2004) to J. D. Ziegler DOE. Washington, DC: NRC. 2004d.

Reamer, C. W. "U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Range of Operating Temperatures (September 18-19, 2001)." Letter (October 2) to S. Brocoum DOE. Washington, DC: NRC. 2001.

Schlueter, J. R. "Review of Documents Pertaining to Agreement Total System Performance Assessment and Integration (TSPAI).3.23 (Status: Complete) and Agreement General (GEN).1.01, Comment 18 (Status: Complete), Comment 24 (Status: Not Received), and Comment 69 (Status: Not Received)." Letter (April 22, 2003) to J. D. Ziegler DOE. Washington, DC: NRC. 2003a.

Schlueter, J. R. "Additional Information Needed for Unsaturated and Saturated Flow Under Isothermal Conditions (USFIC).5.11 Agreement and Completion of General (GEN).1.01, Comment 103." Letter (February 5, 2003) to J. D. Ziegler DOE. Washington, DC: NRC. 2003b.

Schlueter, J. R. "Radionuclide Transport Agreement 2.03 and 2.04." Letter (August 30, 2002) to J. D. Ziegler DOE. Washington, DC: NRC. 2002a.

Schlueter, J. R. "Total System Performance Assessment and Integration Key Technical Issue Agreements." Letter (October 11, 2002) to J. D. Ziegler DOE. Washington, DC: NRC. 2002b.

Schlueter, J. R. "Unsaturated and Saturated Flow Under Isothermal Conditions Agreement 4.07." Letter (August 20, 2002) to J. D. Ziegler DOE. Washington, DC: NRC. 2002c.

Ziegler, J. D. "Response to Key Technical Issue (KTI) Agreement General (GEN) 1.01." Letter (August 31) to Director, Division of High-Level Waste Repository Safety, NRC. Las Vegas, NV: DOE. 2004a.

Ziegler, J. D. "Revised Response to Key Technical Issue (KTI) Agreement General (GEN) 1.01." Letter (September 30) to Director, Division of High-Level Waste Repository Safety, NRC. Las Vegas, NV: DOE. 2004b.