CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: Nickel Institute Workshop #6 on Yucca Mountain Waste Container and Drip Shield
Project No. 20.06002.01.322; AI No. 06002.01.322.611

DATE/PLACE: April 5–6, 2006
Las Vegas, Nevada

AUTHORS: X. He

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PERSONS PRESENT: X. He, Center for Nuclear Waste Regulatory Analyses (CNWRA) and about 40 representatives from industry, national laboratories, and government agencies. D. Galvin and C. Brown from the U.S. Nuclear Regulatory Commission (NRC) were also present. The attendance list is attached.

BACKGROUND AND PURPOSE OF TRIP:

The workshop was organized by the Nickel Institute to provide updates on the waste container and drip shield materials for the potential Yucca Mountain geological repository. The Nickel Institute is the former Nickel Development Institute and Nickel Producers Environmental Research Program. The members of the Nickel Institute are major nickel producers with offices in Canada, United States, England, Belgium, Japan, India, China, Korea, and Australia. The main goals of attending the workshop were to

- Attend the presentations given by representatives from Bechtel SAIC Company, LLC, the U.S. Department of Energy's (DOE) primary Yucca Mountain Project contractor

- Gain information on the availability of nickel and the manufacturer's ability to produce Alloy 22 plates

SUMMARY OF PERTINENT POINTS:

At the workshop, representatives from Bechtel SAIC Company, LLC, provided historical information and updates on the waste container and drip shield materials for the potential geologic repository. Additional information was provided on the nickel industry's ability to produce Alloy 22 nickel plates for waste containers and the development of a new neutron absorber material using a nickel-chromium-molybdenum-gadolinium alloy. The agenda, list of participants, and a copy of business cards of some of the attendees at the symposium are attached.

J. Cogar from Bechtel SAIC Company, LLC, provided the history and updates on the waste package design, provided details on the progress of the first full-scale prototype, and proposed waste package development work. The fabrication of the subscale waste package mock-up was initiated in 1995. In 1996, DOE produced an Alloy 625 subscale waste package mock-up. In 1998, the second mock-up waste package was produced with Alloy 22 as the inner container and carbon steel as the overpack material. The third waste package, a full-diameter and quarter-length mock-up waste package based on the current design, was produced in 2000. This waste package mock-up was tested for residual stress, flaw distribution, and corrosion performance over the past several years.

The fabrication of the first full-size prototype waste package continued at Joseph Oat Corporation in Camden, New Jersey. Except for some minor changes on the closure weld, trunnion, and middle lid, there were no major changes to the waste package from the current design. E. Marinock from Joseph Oat Corporation indicated that solution annealing of the Alloy 22 outer container was scheduled to be performed in early May 2006. After this, the waste package will be shipped to Idaho National Laboratory for closure lid welding. The technologies for welding and outer-lid stress relieving are under development. During the question and answer period, Cogar stated that the recently initiated work on the multipurpose transport, aging, and disposal (TAD) canister does not affect the fabrication of the waste package. No schedule of the mass-production of waste packages was provided. Cogar also stated that DOE does not plan to fabricate additional prototype waste packages and prototype drip shield.

G. Gordon from Areva NP, Inc. (contractor of Bechtel SAIC Company, LLC) gave overview presentations on the waste package outer container material, Alloy 22, and the titanium alloy drip shield materials. DOE evaluated several potential degradation modes of Alloy 22, including general corrosion, localized corrosion, stress corrosion cracking, and microbially induced corrosion. These results were included in Bechtel SAIC Company, LLC, Technical Basis Documents No. 6 and Analysis and Model Reports. No new information was presented. In addition to the discussion on Alloy 22 degradation modes, Gordon presented an overview on Alloy 22 thermal aging. Thermal aging of Alloy 22 may result in precipitation of secondary phases at grain boundaries and grains depending on temperature and time. The possible secondary phases include topologically close-packed phases, which are enriched in molybdenum, tungsten, and chromium; and long-range ordering, which are rich in nickel and molybdenum. The solution heat treatment of the first mock-up Alloy 22 waste package fabricated in 2000 was performed by solution annealing followed by water quenching. Water quenching was conducted in a water bath from only one-side of the waste package. The pictures taken during the quenching process and the measured temperature from emplaced thermocouples indicated that this one-sided quench resulted in nonuniform temperature distribution from the inside and outside of the waste package. Gordon stated that the single-sided quench is likely to result in distortion. To avoid distortion, the water quenching of the first full-scale prototype waste package, which is under fabrication at Joseph Oat Corporation, will be performed from both sides.

R. Rebak from Lawrence Livermore National Laboratory presented an overview on fabrication effects on the corrosion behavior of Alloy 22. The presentation was divided into four parts:

(i) heat-to-heat variability, (ii) effect of black annealing scale, (iii) effect of stress-relieving methods (laser shock peening and low-plasticity burnishing) on Alloy 22 general corrosion and localized corrosion, and (iv) mock-up container testing. Coupons cut from weld seams fabricated from several heats of Alloy 22 plates and filler wires were tested in ferric sulphate and sulfuric acid following a standard procedure (ASTM G28A). No effect of heat-to-heat variability was observed. Based on the test results on Alloy 22 general corrosion and localized corrosion, Rebak stated that the black annealing scale and the surface stress mitigation method have no effect on the corrosion behavior of Alloy 22. Corrosion tests from the mock-up container also showed that the fabrication process of the mock-up container did not affect the corrosion performance of Alloy 22.

D. Agarwal from ThyssenKrupp VDM USA, Inc., presented the company's capability to manufacture Alloy 22 large plates for the potential waste packages. The dimensions of plates that can be produced are limited by the allowable weight of the slab. Agarwal stated that the waste package can be fulfilled by one-, two-, three-, or four-piece construction upon negotiation. In the current design, the waste package consists of two Alloy 22 plates with two longitudinal weld seams and one circumferential weld seam. J. Grubb from ATI Allegheny and a representative from Specialty Metals also presented their capabilities to manufacture Alloy 22 plates.

G. Coates from the Nickel Institute presented an overview on the current status of the availability of nickel. The majority of the nickel produced is used in the production of stainless steel. Because of the increasing demand for stainless steel in the world, the price of nickel has increased by a factor of three in the past 5 years. Coates stated that there are sufficient nickel reserves in the world and many new projects to produce nickel are underway. The production of waste packages for nuclear waste disposal only counts for a small portion of the total nickel produced and will not be affected by the increasing nickel usage in other areas. During the question and answer period, Coates also stated that in addition to nickel, there are also sufficient amount of chromium and molybdenum available to be used in the production of Alloy 22.

The second presentation given by G. Gordon was an overview and update on titanium drip shield design and materials performance. The functions of drip shield are to divert water and protect the waste package from rockfall and drift degradation. Titanium Grades 7 and 24 were selected as the materials for drip shield. DOE evaluated several potential degradation modes of Titanium Grade 7, including general corrosion, localized corrosion, galvanic corrosion, and environmentally assisted cracking. Very limited data on Titanium Grade 24 are available from the literature. No new information on Titanium Grade 7 corrosion performance was presented. Due to the unavailability of Titanium Grade 24, DOE may use Titanium Grade 29 or Grade 23 plus palladium as the structural support material of the drip shield. On-going tests on these materials are conducted at General Electric Global Research, and funded by DOE. Gordon also provided DOE's evaluation on drip shield creep. After the emplacement of the drip shield, rock rubble loads in lithophysal zones or seismic induced rockfall in nonlithophysal zones may lead to drip shield creep rupture or collapse. Gordon stated that drip shield creep deformation can occur under rock rubble loading, but recent calculation shows that the resulting strains are acceptable.

R. Mizia from Idaho National Laboratory presented updates on the development of the nickel-chromium-molybdenum-gadolinium alloy as a neutron absorber in the waste package. The laboratory had some success in the past in producing the material to meet the ASTM standard (ASTM B932–04). Corrosion test comparison showed that the developed material has a higher corrosion resistance than borated Type 304 SS. Mizia summarized that the gadolinium alloy can be made with conventional ingot metallurgy techniques and will meet the performance requirements. Thermal neutron absorption performance of this alloy is exceptional and consistent with published data. The mechanical properties will meet the ASME requirements for Section III (nuclear power), Division 3, (NUPAC). Data are being developed for as-welded condition for submittal to ASME. In 2006, the laboratory will focus on material welding development and product scale-up issues. Mizia stated that it may take another couple of years to commercialize this material.

In addition to the presentations on waste package and drip shield, one discussion session on the TAD canisters and their effects on Yucca Mountain was scheduled. However, due to the attendees' lack of knowledge on this issue, no main points were generated.

CONCLUSIONS

The Nickel Institute workshop provided a venue to obtain the current status of the DOE repository program on waste package and drip shield materials, and industry capabilities to manufacture Alloy 22 plates. The information gained has enhanced my understanding of corrosion processes in relevant repository environments and will assist in the review of the potential DOE license application section pertaining to the fabrication and corrosion of the waste package and drip shield.

PROBLEMS ENCOUNTERED

Hard copies of all presentations were not available at the workshop. The organizer is collecting the electronic copies of the presentations and will distribute electronic copies to attendees in the near future, but no date was provided.

PENDING ACTIONS

None.

RECOMMENDATIONS

The information presented at the workshop was very informative and highly focused on the waste package and drip shield. Future participation in this meeting is highly recommended.

SIGNATURES

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THE NICKEL INSTITUTE
WORKSHOP #6
THE SUNCOAST HOTEL, LAS VEGAS NV
APRIL 5 AND 6, 2006

DRAFT AGENDA
3/14/06

WEDNESDAY APRIL 5

9:00-9:15	Welcome, review of the agenda and introductions	Ralph Moeller
9:15-9:30	BSC Welcome	Jerry Cogar
9:30- 10:30	History, update of the waste package design, first prototype progress, and proposed work	Jerry Cogar
10:30-11:00	Questions and discussions	
11:00-11:15	Coffee Break	
11:15-12:00	Update on materials and materials issues	Gerry Gordon
12:00-12:30	Questions and Discussions	
12:30- 1:15	LUNCH	
1:15-2:00	Fabrication Effects on the Corrosion behavior 0f Alloy 22	R.B.Rebak
2:00-2:30	Specification, production, and size issues concerning the alloy 22 plate	D. C. Agarwal
2:30-3:00	Current status of the availability of Nickel	Gary Coates
3:15-3:30	Coffee Break	
3:30-4:30	Update on the Titanium Drip Shield	Gerry Gordon
4:30-5:00	Questions concerning the drip shield	

THURSDAY APRIL 6

9:30-10:00	Update on the development of the Ni-CR-Mo-Gd Alloy	Ron Mizia
10:00-10:30	Discussion of the TAD transfer canisters and its effect on Yucca Mountain	
10:30-11:00	The purpose of Aging Pads	
11:00-11:30	The "GLOBAL NUCLEAR ENERGY PARTNERSHIP" Will this affect the timing of Canister Production?	
11:30-12:00	General Discussions	

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