Disposal of U-233 as Low Level Waste at the Nevada Nuclear Security Site – 14175

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ABSTRACT

Certain materials destined for disposal at the Nevada National Security Site's (NNSS) Area 5 Radioactive Waste Management Site raise questions about the appropriateness of the waste classification schemes used in the U.S. The NNSS Area 5 Radioactive Waste Management Site accepts Department of Energy (DOE) low-level radioactive (LLW) and mixed low level wastes as well as certain classified wastes; the Nuclear Regulatory Commission (NRC) does not regulate DOE's LLW disposal activities. DOE is nearing completion of clean-up activities at the Oak Ridge National Laboratory, and has a significant quantity of special nuclear material, referred to as uranium-233 (U-233), although the uranium content by isotope is 76% U-235 and 10% U-233. Small quantities of U-232 make this material radiologically hot, leading to a requirement for remote handling. The material to be disposed is from the Consolidated Edison Uranium Solidification Project (CEUSP) and exists in a ceramic matrix solidified in small stainless steel canisters. Storing the material in its current form requires significant annual operating expenses to meet material-handling requirements. Because of the mounting costs of this cleanup, DOE proposed a new approach to dispose of this material directly, without further processing. The plan is to dispose the material at the NNSS which could save DOE up to $600 million. The principal questions to be asked, however, are: *Is special nuclear material truly low-level radioactive waste?*, and, *Is shallow land burial appropriate for this material?* DOE's rationale that these uranium materials can be considered low-level radioactive waste is based on the argument that the materials meet the requirements of the NNSS Waste Acceptance Criteria document, which references NRC's 10 CFR part 61 rule regulating commercial LLW disposal. Examination of the Environmental Impact Statement (EIS) supporting the promulgation of 10 CFR part 61 clearly shows that NRC removed the uranium isotopes from the rule because waste generators successfully argued against having to test for isotopes that were not going to be in commercial nuclear waste streams. The EIS clearly indicates that should waste streams change, that decision would need to be revisited. In other words, it appears that there never was an intention for disposal of special nuclear material such as highly enriched uranium in the same manner as low level waste.

The NRC is currently re-examining LLW disposal requirements including those for depleted uranium, which was also excluded during the 10 CFR 61 EIS process. Several years ago DOE disposed limited quantities of depleted uranium, as low level waste, in an NRC licensed LLW facility. Controversy, however, arose regarding the treatment of depleted uranium as low level waste, so DOE has stopped that practice. It seems odd that DOE would believe that highly enriched uranium could be considered LLW, while knowing the controversy surrounding the treatment of depleted uranium as LLW. DOE further argues that disposal of the U-233 (and U-235) would be in compliance with the performance assessment requirements for the NNSS low level waste facility. This is likely to be true, but it should be noted that some high-level radioactive wastes, such as those destined for disposal in a deep geologic repository, likely would also meet those requirements under the analytical assumptions used to calculate compliance (1000 year performance assessment time frame and current conditions for investigation of longer times). More importantly, though, the requirements for disposal of materials in deep repositories specify a need to examine how conditions could change over the required times for performance assessments – 10,000

years required in general disposal regulations and 1,000,000 years required in Yucca Mountain regulations. These time frames are certainly more appropriate for materials with the half lives of these uranium isotopes or for disposal of significant quantity of special nuclear material, especially highly enriched uranium.

CONSOLIDATED EDISON URANIUM SOLIDIFICATION PROJECT: BACKGROUND

Issues related to the disposal of the CEUSP uranium-233 at the Radioactive Waste Management facility at the Nevada National Security Site began with Oak Ridge National Laboratory activities to process the materials for safe storage. Uranium-233 (U-233) was produced from thorium-232 in research reactors and investigated for use in nuclear weapons and as a reactor fuel but was not used. It has a half-life of 159,200 years and is classified as a special nuclear material, which means it is a fissile material. The CEUSP wastes are uranyl nitrates transferred from West Valley to Oak Ridge National Laboratory in 1969 and stored as a liquid for nearly 20 years. Gadolinium and cadmium were added for neutron absorption, and the solution was denitrified at high temperature in small batches, within canisters, in 1986, resulting in ceramic-like U_3O_8 monoliths, bonded to the inside of the containers. Each canister contains, on average, 2.6 kg total uranium, comprising 76% U- 235 and 10% U-233. The containers also contain 126 ppm U-232, which is responsible for the high radiation field of 300 R/hour on contact [1].

The Atomic Energy Commission consolidated the U-233 into Building 3019 and created a national repository beginning in 1962. Building 3019 is now the oldest operating nuclear facility in the world and is currently used only for U-233 storage. In a study [2] of disposition of surplus weapons usable fissile material (U-233) by making it inaccessible and unattractive for use in nuclear weapons disposition options performed by Oak Ridge National Laboratory, five storage and seventeen disposal options were identified. Among the options examined, there were several that illustrated points germane to the current issues of disposal of the U-233 as low level waste at the Nevada National Security Site. Specifically, the study considered that the U-233 could be defined as spent nuclear fuel and disposed of as spent nuclear fuel, converted into light water reactor fuel for irradiation in power reactors, which would then lead to the spent nuclear fuel disposal pathway, or blended with transuranic wastes in a form acceptable for disposal at Waste Isolation Pilot Plant. Regarding shallow land burial, the study concluded that the U-233 could be diluted by a factor of about 100,000 to meet the definition of low-level waste and then disposed of in shallow-land disposal facilities. It was noted however, that there were significant legal, technical, and economic uncertainties associated with this option. Overall, the study made no recommendation for a preferred storage or disposition option.

The Department of Energy prepared an Environmental Assessment [3] to examine the processing of uranium-233 stored at the Oak Ridge National Laboratory, and other small quantities of similar material currently stored at other Department of Energy sites, in order to render it suitable for safe, long-term, economical storage. The Department determined that there was no programmatic use for the uranium-233 currently in storage at Oak Ridge other than as a possible source of medical isotopes. The Oak Ridge National Laboratory inventory of uranium-233 represented most of the readily available source of thorium-229 in the Western Hemisphere. Actinum-225 and its daughter product, bismuth-213, are isotopes in the decay chain of uranium-233/thorium-229 that showed significant promise for ongoing cancer research, and were being explored for treatment of cancers of the lungs, pancreas, and kidneys.

A contract for disposition of the material was awarded by the Department's Office of Nuclear Energy in 2003; it began as a medical isotope extraction project. By 2007, the scope had evolved to the design and construction of modifications to Building 3019 to support dissolution and downblending of the U-233 inventory with depleted uranyl nitrate to reduce the attractiveness level and eliminate the potential for nuclear criticality, conversion of the downblended material to magnesium diuranate, and production of a final waste form intended to be compliant with the Nevada National Security Site waste acceptance criteria. Complicating factors caused design delays and cost growth. A new alternatives analysis favored a combination of direct disposition and co-processing that would transfer components desired by other Department of Energy programs, directly dispose the Consolidated Edison Uranium Solidification Project (CEUSP) material, and co-process the remaining inventory with other Oak Ridge National Laboratory wastes. This resulted in a plan to dispose of the 403 canisters from the Consolidated Edison Uranium Solidification Project waste directly, without further processing at the Nevada National Security Site projecting a cost savings of up to $600 million [4]. The Nevada National Security Site Area 5 facility is an unlined landfill for the disposal of low level radioactive wastes.

LOW LEVEL WASTE DISPOSAL

Disposal of commercial low level waste is governed by the Nuclear Regulatory Commission under their regulation 10 CFR Part 61 [5]. While not applicable to Department of Energy low level waste disposal activities on Department of Energy sites, that regulation is cited as a source of requirements in the Nevada National Security Site Waste Acceptance Criteria document [6], specifically sections of the rule addressing waste characteristics. The Nuclear Regulatory Commission regulation also addresses waste classification; the history of the development of the Nuclear Regulatory Commission regulation; while the Department of Energy does not use the Nuclear Regulatory Commission waste classification system, the logic behind it is of interest to the issue of disposal of U-233 at the Nevada National Security Site low level waste facility. While 10 CFR Part 61 notes that consideration *must be given to the concentration of long-lived radionuclides ….. whose potential hazard will persist long after such precautions as institutional controls, improved waste form, and deeper disposal have ceased to be effective*, uranium is not listed in the tables of nuclides to be considered. The reason for that is found in the Environmental Impact Statement [7] prepared by the Nuclear Regulatory Commission to support development of their regulation.

In the discussion on isotopes considered for waste classification purposes, it was noted that in the draft Environmental Impact Statement, a total of twenty-three different radionuclides had been considered in the numerical analysis, and that these nuclides were nearly all moderately or long-lived radionuclides. Based upon these twenty-three radionuclides, concentration limits were proposed in the draft Environmental Impact Statement for eleven individual radionuclides plus alpha-emitting transuranics, enriched uranium and depleted uranium. It is worth emphasizing that enriched uranium and depleted uranium were originally candidate isotopes for isotope limits considered for waste classification purposes. In response to public comments, however, limits for enriched uranium, depleted uranium, and cesium-135 were eliminated, as were limits for nickel-59 and niobium-94 except as contained in activated metal. A separate limit was provided for curium-242, a transuranic nuclide with a162.9.day half-life.

These changes were principally in response to comments on proposed Part 61 regarding the costs and impacts of compliance with the proposed waste classification requirements of the Draft Environmental Impact Statement. In particular, many commenters were concerned that they would have to directly measure every isotope in every waste package, which would be difficult to do because measurement of many of the listed isotopes, which would usually be present only in trace quantities, could not be performed except by complex radiochemical separation techniques by laboratories. Commenters expressed concerns that costs and personnel radiation exposures would be significantly increased.

Thus, to ease the burden of compliance, the number of isotopes treated generically in the waste classification table was reduced to those judged to be needed on a generic basis for waste classification purposes. In other words, uranium is not regulated in the disposal of low level waste either because no generators thought they would be disposing of meaningful quantities of uranium as low level waste, or it was not thought to be low level waste. The isotopes with specified limits in the Environmental Impact Statement process and in current 10 CFR Part 61 are shown in Table 1

Isotopes Considered for Limits in Draft EIS	Isotopes Considered for Limits in Final EIS	Isotopes with Limits in Current 10 CFR Part 61
Hydrogen-3	Hydrogen-3	Hydrogen-3
Carbon-14	Carbon-14	Carbon-14
Nickel-59	Nickel-59 (in activated metal)	Carbon-14 (in activated metal)
Nickel-63	Nickel-63	Nickel-59 (in activated metal)
Cobalt-60	Cobalt-60	Nickel-63
Niobium-94	Niobium-94 (in activated metal)	Nickel-63 (in activated metal)
Technitium-99	Technitium-99	Cobalt-60
Iodine-129	Iodine-129	Strontium-90
Cesium-135	Cesium-137	Niobium-94 (in activated metal)
Cesium-137	Plutonium-241	Technitium-99
Plutonium-241	Alpha-emitting transuranics	Iodine-129
Uranium-235 (enriched)	Curium-242	Cesium-137
Uranium-238 (depleted)		Plutonium-241
Alpha-emitting transuranics		Alpha-emitting transuranics
		Curium-242

Table 1. Isotopes with specified limits in the Environmental Impact Statement process and in current 10 CFR Part 61

Of particular importance to the issue of disposal of U-233 at the Nevada National Security Site, the Final Environmental Impact Statement noted that other isotopes could be added later either generically or in specific waste streams, and that they could include wastes from future spent-fuel reprocessing facilities or other fuel cycle wastes that were not considered when the current regulations were developed. As an example of the intent of this conclusion, the Nuclear Regulatory Commission today is in the process of amending its regulations to establish new requirements for the disposal of some low-level radioactive wastes [8]. The new regulation would require a site-specific analysis to determine if a proposed disposal site is appropriate and adequate for safely disposing of wastes that were not considered when the current Nuclear Regulatory Commission regulations were developed. These unique waste streams primarily would include large quantities of depleted uranium from DOE uranium enrichment operations, and could also include other fuel cycle wastes that were not considered when the current regulations were developed. At this point, the Department has not proposed disposal of depleted uranium at one of its own low level waste disposal sites.

The issue of classification is important because it dictates how safety should be assessed. While it is true that low level waste is defined by what it is not, there are a few points that bear noting. Low level waste is defined by law and regulation; for example, DOE Order 435.1 [9] states: *low-level radioactive waste is radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in section 11 e (2) of the Atomic Energy Act of 1954, as amended), or naturally occurring radioactive material.* The Order defines byproduct material as: *(1) Any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material, and (2) the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. [Source: Atomic Energy Act of 1954, as amended, section 11(e)].* Special nuclear material is defined by Title I of the Atomic Energy Act of 1954 [10] as: *plutonium, uranium-233, or uranium enriched in the isotopes uranium-233 or uranium-235. The definition includes any other material that the Commission determines to be special nuclear material, but does not include source material.* Source material is also defined in the Order: *(1) uranium or thorium, or any combination thereof, in any physical or chemical form or (2) ores which contain by weight one-twentieth of one percent (0.05%) or more of (i) uranium, (ii) thorium or (iii) any combination thereof. Source material does not include special nuclear material.* Summarizing, low level waste does not include byproduct material, which does not include special nuclear material, which does not include source material, which includes uranium, but which does not include special nuclear material. It is extremely difficult to build from these definitions, a coherent argument that the regulatory structure governing radioactive wastes explicitly intended special nuclear material to be low level waste.

Furthermore, the Nuclear Waste Policy Act [11] defines high-level radioactive waste as: *the highly radioactive material resulting from the reprocessing of spent nuclear fuel (fuel that has been withdrawn from a nuclear reactor following irradiation), including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations.* In fact, although the low level waste regulations do not include limits for the uranium isotopes, the high-level radioactive waste regulations do. The Table 1 Release Limits for Containment Requirements of 40 CFR Part 191[12] include limits for U-233, U-234, U-235, U-236, and U-238. Additionally, the Department already made a decision to dispose surplus weapons grade plutonium along with high level radioactive waste. It is not clear why the same considerations for disposal of the surplus plutonium would not apply to the highly enriched uranium in the CEUSP containers.

U-233 DISPOSAL PROGRAM AT THE NEVADA NATIONAL SECURITY SITE

The Nevada National Security Site Area 5 Low Level Waste Disposal Facility [13] shown in Figure 1, is the current facility that resulted from a program that began in the early 1960s, under the authority of the Atomic Energy Act. The Nevada National Security Site, then known as the Nevada Test Site, began disposing of low level waste in the southeastern portion of the site known as Area 5. Initially, wastes generated through onsite nuclear weapons testing and research were disposed, but operations later evolved to include the acceptance of cleanup-related waste. In 1978, the Nevada National Security Site waste disposal program was formalized, establishing criteria for the acceptance of low level waste generated at the Nevada National Security Site and other Department of Energy and Department of Defense approved facilities throughout the United States. The expanded Nevada National Security Site waste management practices were formally established when the Low Level Waste Policy Act Amendments of 1985 clarified the Department of Energy’s responsibility for the disposal of the Department’s generated low level waste and classified Department of Defense-generated low level waste.

Figure 1. Nevada National Security Site Area 5 Radioactive Waste Management Site

The Area 5 Radioactive Waste Management Site is currently the only active disposal site on the Nevada National Security Site. The Area 5 Site covers 300 hectares, of which approximately 80 hectares have been developed for radioactive waste storage and disposal. The Area 5 Site is made up of 38 excavated disposal cells; 31 of these cells are filled and closed. In general, waste containers are stacked in Area 5 disposal cells, one upon the other in a stair-step configuration, until the stack reaches slightly more than a meter below the top of the cell walls. The waste is placed in a 6 meter by 6 meter grid system inside each cell so that waste can be tracked once containers are covered with soil. A specially engineered mixed low level waste disposal cell was also constructed in Area 5 with a state-of-the-art liner and leachate collection system designed in accordance with a Resource Conservation and Recovery Act permit issued by the state of Nevada. The state does not regulate low level waste disposal; instead, the state and Department of Energy are co-signers to an Agreement In Principle [14] that permits the State of Nevada to review the Department of Energy's Low Level Waste operations at the Nevada National Security Site with respect to applicable criteria identified in Department of Energy Order 435.1 or its successor and associated guidance, or subsequent applicable requirements and guidance. It is important to note that the Nevada National Security Site does not accept commercially generated low level waste.

The principal questions to be asked are: *Is this material low level radioactive waste, a*nd *Is shallow burial appropriate for this material?* The Department of Energy is not regulated by the Nuclear Regulatory Commission, and has decided that the CEUSP U-233 wastes can be disposed in the low level waste facility at Nevada National Security Site. While not applicable to Department of Energy low level waste disposal activities, the Nuclear Regulatory Commission regulation 10 CFR Part 61 is cited as a source of requirements in the Nevada National Security Site Waste Acceptance Criteria document. The Department of Energy's rationale that these uranium materials can be considered low level radioactive waste is based on the argument that the materials meet the requirements of the Nevada National Security Site Waste Acceptance Criteria. The Nuclear Regulatory Commission regulations are developed for commercial waste streams and do not specifically cover special nuclear materials and other defense sourced materials that are not typically disposed of as waste at commercial facilities. If these U-233 wastes were not classified as low level waste, however, and instead were more appropriately classified as Greater than Class C or high-level radioactive waste, then deep geologic disposal would be required.

As noted earlier, the various uranium isotopes are not specifically covered by the Nevada National Security Site Waste Acceptance Criteria because there never was an intention for disposal of special nuclear material such as highly enriched uranium as low level waste. Nonetheless, the Department further argues that disposal of the U-233 (which is 76% U-235 and 10% U-233) would be in compliance with the performance assessment requirements for the Nevada National Security Site low level waste facility. This is likely to be true, but it should be noted that some high-level radioactive wastes, such as those destined for disposal in a deep geologic repository, likely would also meet those requirements under the assumptions used.

A further concern for disposal of these wastes as low level waste is related to their significant radioactivity. The high radiation levels exist because this material contains another uranium isotope, U-232, which makes handling and storage today difficult and costly. It should also be noted that because of the high radiation levels, the wastes will need to be handled remotely and shipped in a Type B Legal Weight Truck shipping container, modified to accommodate the geometric characteristics of the U-233 canisters. Type B shipping containers are used to transport used nuclear fuel and have heavy thick shells to shield radiation from the public and workers and to protect the waste in the event of an accident.

PERFORMANCE ASSESSMENT

The Nevada National Security Site Area 5 Low Level Waste facility operations are supported by quantitative performance assessments of radiological releases from the disposal system over time and an evaluation of resultant doses. The performance assessments use numerical models of chemical and physical processes affecting the disposal facility over 1000 years. In an addendum to the Area 5 performance assessment, the models were transitioned to a fully probabilistic assessment [15]. The model conceptualized the hydrological processes in the unsaturated zone of Frenchman Flat: an arid desert setting; low precipitation; high evapotranspiration; no groundwater pathway under current conditions; and disposal trenches located in the region of upward flow in the unsaturated zone. Results of the model indicate compliance with the performance objectives of Department of Energy Order 435.1. The presentation noted that the compliance calculation was based on the 1,000 year regulatory compliance period, emphasized that the performance assessment was based on current conditions, and noted that there was a question about earthquake recurrence. To investigate uncertainty, a 10,000 year calculation was done, as well as a peak dose calculation, presented for information only.

The existing regulations for disposing other types of enriched uranium, specifically, spent nuclear fuel , incorporate significantly longer regulatory compliance times: 10,000 years in the generic disposal standard 40 CFR Part 191, and 1,000,000 years in the site specific standard for Yucca Mountain at 40 CFR Part 197 [16]. Of particular importance relative to the long-term performance of a disposal facility for isotopes with such long half lives (the wastes are 76% U-235, which has a half life of 704 million years) are changes in the features, events, and processes that affect performance. For the Area 5 Low Level Waste facility, earthquakes are of potential long-term concern; the Frenchman Flat region has experienced historical earthquakes of magnitude between 5 and 6 [17], so larger magnitudes would not be unexpected over longer time periods. Climate change could be an important process for the long-term performance. As noted, the 1,000 year model looks at the disposal trenches as being located in the region of upward unsaturated zone flow; in a wetter climate, especially as Frenchman Flat, the location of the Area 5 facility is a playa, ponded water and a change to downward flow are distinct possibilities. A long-term performance assessment that considered that current conditions are likely to change over long periods of time should be used to assess the safety of disposing materials with half lives of hundreds of millions of years. Both 10 CFR Part 60 [18] and 10 CFR Part 63 [19], the Nuclear Regulatory Commission regulations that implement 40 CFR Part 191 and 40 CFR Part 197 respectively, require the consideration of features, events and processes that have a probability of occurrence of at least one chance in 10,000 of occurring over 10,000 years.

To investigate long-term impacts of including the CEUSP wastes in the Area 5 Radioactive Waste Management Facility, a Special Assessment was undertaken by the DOE. [20] Several questions were raised about the features, events and processes that were considered in the analysis, particularly, whether their identification was consistent with regulatory requirements for long-term disposal of other than low level wastes. Subsequently, Nevada National Security Site personnel afforded Nye County Nuclear Waste Repository Project Office technical staff an opportunity, on December 19, 2013, to meet with their technical experts and address the concerns. Questions related to whether the identification of the features, events and processes that were considered in the analysis was consistent with regulatory requirements for long-term disposal of other than low level wastes were, with one exception, addressed by a more detailed review of the Special Analysis and by clarifying discussions with Nevada National Security Site technical staff. Documentation was addressed that clearly showed that the process of identifying the applicable features, events, and processes followed the approach outlined in 40 CFR 191 for high-level and transuranic wastes.

The exception dealt with several examples of geologic evidence related to tectonically induced fractures potentially creating pathways from the ground surface to the water table. Reconnaissance mapping [21] in the Frenchman Flat playa suggested the presence of young faults that have displaced the playa in eastern and southern Frenchman Flat. The authors cited a particular valley fault that they considered to be the most recent and described it as a crevice about four and one-half meters deep and three meters wide, representing the fault’s surface displacement, which was probably produced by a relatively large displacement in the underlying bedrock.. They noted further that linear sagebrush growths on the playa suggested the presence of similar faults on the playa. Such faults would be an ideal collecting trough for water, which could also affect the subsurface hydrology. A different investigation [22] examined inflow to a crack that developed in 1969 in the playa deposits of Yucca Lake to the north of the Frenchman Lake playa and concluded that runoff from nearby areas used for past surface testing of nuclear devices possibly could contribute residual radioactive contaminants directly to the regional flow system by draining into this and similar cracks. The 1969 crack at Yucca Lake was reported to be a tensional and erosional opening with no visible lateral or vertical offset. Finally, a tectonic synthesis of the Nevada National Security Site [23] noted that the frequency and intensity of faulting increased dramatically in the Yucca and Frenchman Flat area, and reported a young crack in Frenchman flat that looked fresh in photographs taken in 1951. The cracks were interpreted to be extension cracks at the opposite end of the shear and flexure zone related to active extension in the Nevada National Security Site region. The author concluded that the stress episode that resulted in the formation of deep alluvium filled trenches began sometime between 10 million years ago and possibly less than 4 million years ago at the Nevada National Security Site and is currently active.

The question to be addressed was: *Why wasn't a tectonic process that has been characterized as active, with evidence that has been described as fresh within the time the Nevada National Security Site has been operational, and which has the potential to affect the hydrologic regime that the DOE is relying on for containment of the wastes in the Area 5 Radioactive Waste Management Facility, considered in the performance assessment?*

Discussion of this question focused primarily on interpretation of the three aforementioned geologic and tectonic investigations in the context of a more current hydrographic framework model [24] The hydrographic framework model does not contradict the three older geologic and tectonic investigations; rather, it provides a basis for developing arguments for screening out the feature of tectonically induced fractures potentially creating pathways from the ground surface to the water table from the performance assessment model. Features, events and processes may be eliminated from consideration (screened out) based either on likelihood of occurrence (probability cut-off of 1 in 10,000 in 10,000 years) or consequence. Plate 1 of the hydrographic framework model report, shown in Figure 2, illustrates a structural interpretation of the Frenchman Flat playa region that provides a technical basis supporting an argument that the likelihood of occurrence of the young faults that have displaced the playa in eastern and southern Frenchman Flat is below regulatory concern.

The young faults described in the Johnson and Hibbard and Carr reports are associated with the west-southwesterly trending Rock Valley Fault zone and were interpreted as ancillary features associated with lateral offsets of that fault zone. The current hydrographic framework model shows that the Rock Valley fault zone transitions on the east side of Frenchman Flat to a series of north-northeasterly trending imbricate faults in the Buried Hills region. The significance of these imbricate faults is that they can accommodate lateral offsets of the Rock Valley fault zone, providing an explanation for why the ancillary fault structures do not occur north of Frenchman Lake Playa in the vicinity of the Area 5 Radioactive Waste Management Facility. The presence of the imbricate faults has been confirmed by geophysical profiling. Geomorphological investigations in the northern Frenchman Flat region show that the surface features are hundreds of thousands of years old. The absence of evidence of young faulting or the young ancillary faults (approximately fifty years old), seen in the southern and eastern Frenchman Flat region, in the area north of Frenchman Lake Playa lends credence to the argument for screening out the feature of tectonically induced fractures potentially creating pathways from the ground surface to the water table. Furthermore, the hydrographic framework model shows that the structural activity in the Yucca Lake region is decoupled from that in the Frenchman Flat region.

Additionally, two other lines of argument, based on consequence, support screening out the feature of tectonically induced fractures potentially creating pathways from the ground surface to the water table. The Area 5 Radioactive Waste Management Facility lies outside of the boundaries of the 100-year probable maximum flood [25]; even if a tectonically induced fracture could be created, there is not likely to be a sufficient amount of water to infiltrate and move radionuclides to depth. Furthermore, an ancillary fault structure is likely to penetrate only to shallow depth, and surficial and gravity processes would be likely to cause it to collapse and infill, thus closing the fracture. This is likely the origin of the vegetation lineaments mentioned in the reconnaissance studies.

Finally, the effects of modeling future climate change were addressed; the glacial transition climate used to model post 10,000 year performance was deemed to be appropriate. The possibility of long-term water table rise [26] in the lower aquifer was also addressed. Evidence related to head differences in the aquifers indicated that such change was not likely to affect the upper aquifer, and thus could be screened out for the Special Analysis.

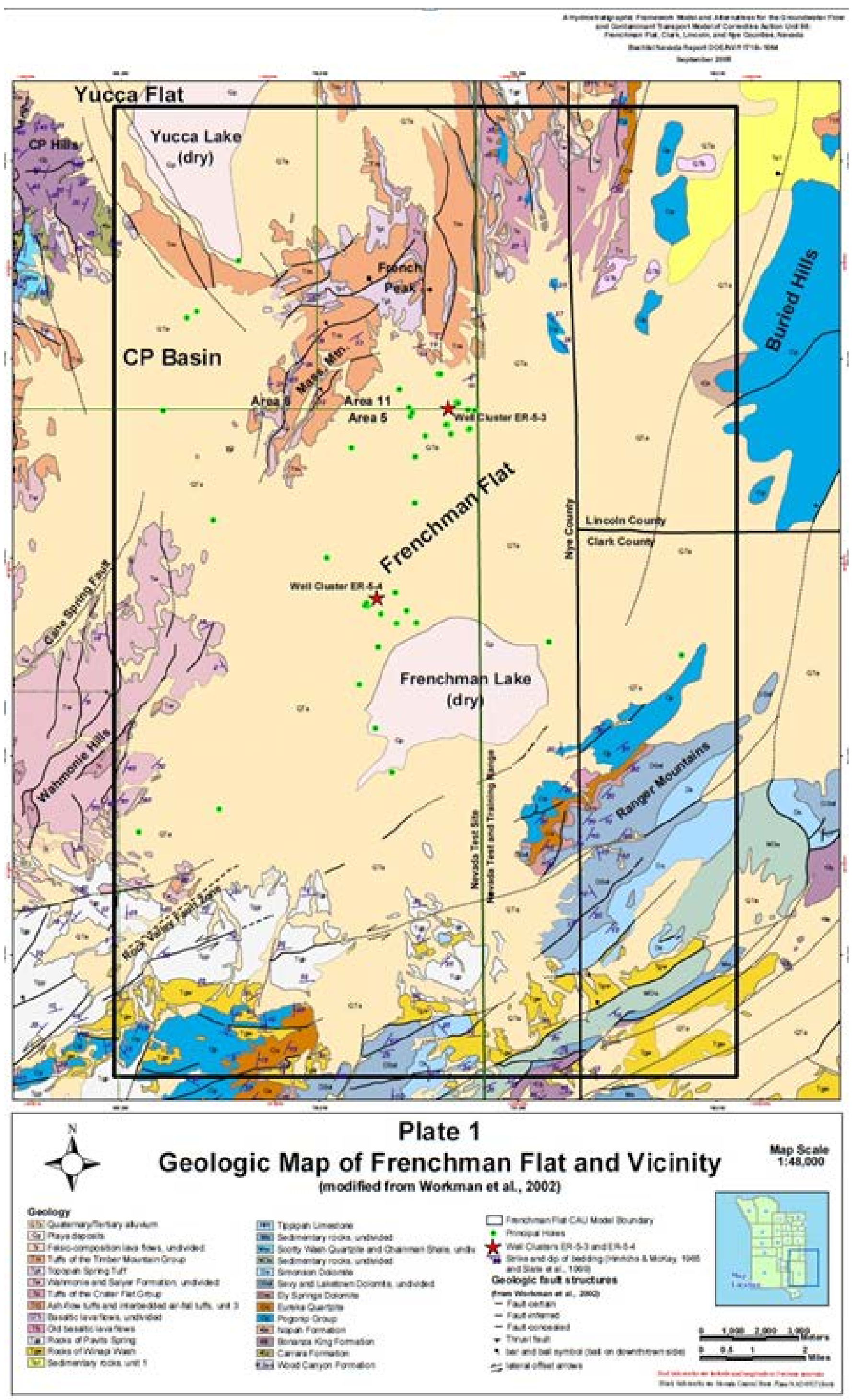

Figure 2. Geologic Map of Frenchman Flat and Vicinity. (DOE /NV/11718-1064. September, 2005)

NEVADA REACTIONS AND NEWS COVERAGE

As plans for disposal of the U-233 at the Nevada National Security Site became public, the initial reaction in Nevada was one of little concern [27]. Nevada lawmakers, with one exception, expressed little concern over the Department of Energy plan to bury bomb-usable uranium waste at the Nevada National Security Site when asked about the plan. Representative Mark Amodei said he was taking his cues from Gov. Brian Sandoval and monitoring what the state was doing; ditto, said Senator Harry Reid. When lawmakers were asked about the DOE plan after a meeting of the state's six members of Congress, Senator Dean Heller, and Representatives Joe Heck and Steven Horsford did not comment when asked whether any other lawmaker had views on the matter. Representative Dina Titus expressed concern about the transportation and landfill disposal of material that contained components that experts said would remain dangerous for thousands of years and that had drawn criticism from nonproliferation experts. Sen. Harry Reid was criticized by Nye County Commissioner Dan Schinhofen for his stance on nuclear waste disposal [28]. Commissioner Schinhofen was referring to Senator Reid's approval of disposing 403 canisters containing long-lived enriched uranium-233 in a low level waste landfill despite the Senator's long-standing opposition to disposal of spent nuclear fuel at Yucca Mountain. The article quoted Senator Reid as saying *[T]his is not bomb grade material. The (Nye) County Commission should understand the difference between 403 canisters and 70,000 tons.*

A Senior Scholar at the Institute for Policy Studies, Robert Alvarez, noted [29] that more than 20 years after significant environmental, safety and security vulnerabilities were first officially identified, the Department planned to waive its safeguard and waste acceptance requirements to allow for direct shallow land disposal of uranium-233. He further noted that waivers for safeguard termination and waste acceptance criteria for disposal for uranium-233 set a bad precedent in terms of international safeguards and for disposal of wastes containing high concentrations of fissile materials. Anti-nuclear and environmental activists urged Nevada Governor Brian Sandoval to turn away shipments of what they described as the potent uranium waste planned for burial in the desert landfill [30]. One of the activists noted that *[a]fter all this time fighting high-level waste to Yucca Mountain, here comes something they can scrape by, by suddenly calling it low-level waste.*

The State's position eventually came to parallel that of the anti-nuclear and environmental activists, with Nevada officials lodging protests against the Department of Energy's plans to relocate 403 canisters of the hotly radioactive mix of uranium-233, uranium-235 and uranium-232 from Oak Ridge National Laboratory in Tennessee to the Nevada National Security Site [31]. Governor Sandoval told Energy Secretary Ernest Moniz he opposed the Department's plan to dispose of the bomb-usable uranium material at the Area 5 Low Level Waste facility. After discussion, however, Secretary Moniz stated that the Department had agreed to do a different, deeper emplacement [32]. He did not state how deep the burial would be; twelve meters is the typical depth for ordinary low level waste packages. He further stated that they had agreed and did the analysis to look at a 10,000-year time horizon versus the standard rule of looking at a 1,000-year time horizon. Transportation of the wastes has been turned over to the Office of Secure Transportation, and it seems that little additional information will be forthcoming to the public.

CONCLUSIONS

Enriched uranium and depleted uranium were originally candidate isotopes considered for limits for waste classification purposes in the low level waste regulation Environmental Impact Statement. To ease the burden of compliance, the number of isotopes treated generically in the waste classification table was reduced to those judged to be needed on a generic basis for waste classification purposes. The Final Environmental Impact Statement noted that other isotopes could be added to those limited at a later time. The NRC today is in the process of amending its regulations to establish new requirements for the disposal of certain low-level radioactive wastes, including primarily large quantities of depleted uranium from uranium enrichment operations that were not included when the current regulations were developed. Considered together, a logical conclusion is that the Nuclear Regulatory Commission should reopen the Environmental Impact Statement to address disposal of fissile uranium as low level waste. Additionally, it would be appropriate to address directly the regulatory definition of the relationship between special nuclear material and other radioactive wastes, particularly if the country is going to dispose of special nuclear material as radioactive waste.

Controversy arose previously regarding the treatment of depleted uranium as low level waste, when DOE disposed limited quantities of depleted uranium (U-238) several years ago as low level waste, in an NRC licensed facility, and the Department has stopped that practice. It seems odd that DOE would believe that highly enriched uranium could be considered low level waste while being responsible for the controversy surrounding the disposal of depleted uranium as low level waste. While no definitive answer is forthcoming regarding the appropriate classification of this material, it appears that every effort has been made to assure its safe disposal at the Nevada National Security Site. Nuclear Waste Repository Project Office technical staff concluded that the concerns raised about the safety of the disposal of the CEUSP wastes had in fact been appropriately addressed in the Special Assessment, and that the Special Assessment demonstrated safe disposal of the Consolidated Edison Uranium Solidification Project wastes. However, the Nye County Board of County Commissioners remain concerned about long-term monitoring and policy issues, as well as mitigation measures to address County Commissioner concerns about relevant operations and transportation issues related to the hundreds of shipments of low level nuclear waste that pass through Nye County every year on the way to the Nevada National Security Site. Issues related to safety and non-proliferation related material accessibility risks would be exacerbated if significant quantities of concentrated fissile materials such as the CEUSP wastes (76% U-235) were considered for shallow land burial. Should that be the case, and absent clarifying actions in regulatory definitions, disposal of the material as high-level radioactive waste in a deep geologic repository is likely to be a more acceptable solution.

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