DOWNLOAD PDF TANK WASTE RETRIEVAL, PROCESSING, AND ON-SITE DISPOSAL AT THREE DEPARTMENT OF ENERGY SITES

Chapter 1 : Book Tank Wastes Planned For On Site Disposal At PDF Free Download

The purpose of the waste processing described in this chapter is to separate the radioactive constituents in wastes that have been retrieved from Department of Energy (DOE) tanks, as discussed in Chapter III, from the much larger amount of nonradioactive constituents. 1 This separation process has.

For a problematic tank, decoupling waste removal from grout closureâ€”that is, allowing opportunity for objective assessment of the results and reassessment of the path forwardâ€”is essential. Advantages of Decoupling There are several advantages to decoupling tank closure from tank cleanup. Filling a tank with grout is essentially an irreversible action. The second advantage of decoupling tank closure is to allow periodic reassessment of technology developments and alternatives to reduce long-term risks presented by the tank heels. A third advantage in delaying closure of these tanks is that it allows time to gather operational experience for tanks containing cooling coils and other waste retrieval challenges see Chapter III. DOE obtained reasonable results in retrieving waste from Tanks 17 and 20, leaving behind very little residual waste. Tanks 18 and 19, which have undergone waste removal, are estimated to have an order of magnitude more radioactivity than Tanks 17 and 20, but the greater challenges lay ahead. DOE started its tank waste removal and closure campaign with Type IV tanks, which are simpler to work with because of the absence of cooling coils. This approach makes sense with respect to retrieval technology, because it allows DOE to learn from the simpler tanks before tackling the more complex ones. Tanks with coils may present an additional challenge because they are likely to have more solids encrusted on the interior surfaces and those solids will be difficult to reach. This is because a there is more surface area to which waste material can adhere and b there are more obstructions that make retrieval more difficult. DOE has developed operational experience with in-tank activities such as sampling, slurrying, pumping, removing waste heels with water jets sluicing , and operating other remotely controlled equipment. In some cases, DOE may need more time than is allowed by the Savannah River Site Federal Facility Agreement closure milestone to apply what it has learned, test, identify any new challenges, and evaluate new technologies to maximize the removal of waste and stabilize residual waste in the more difficult tanks see also Chapter IX. The fourth advantage of delaying closure of these tanks is that it would allow for a focused research and development program to enhance tank waste removal, improve waste immobilization, and improve tank stabilization as recommended in Chapter IX. A previous National Research Council report also recommended further research in waste retrieval and immobilization prior to tank closure NRC, a. To lend confidence to the assumptions used in the performance assessment, a delay in tank closure would give DOE more time to evaluate grout formulation and techniques and to conduct studies of projected long-term performance by laboratory and field testing of tank fill materials see Chapter IX. DOE itself recognizes the potential benefits of decoupling tank cleanup from tank closure. In these documents, tank lay-up is viewed as a potential necessity to bridge the time gap between tank cleanup and final closure, because sometimes the decision to close a tank is not made for many years after the tanks have been emptied e. The reports clearly discuss how lay-up depends on the number and physical condition of the tanks; expected lay-up period; uncertainty in closure requirements; perceived risks associated with waste heels; and the regulatory environment. The more recent of the two reports Elmore and Henderson, a; pp. Tank lay-up activities are expected to reduce the perceived risks associated with the tanks. Lowering the hazard classification for certain facilities, which could impact conduct of operations, hazardous waste management, emergency preparedness, and training Reduction in the number of safety-class, safety-significant, and defense-in-depth structures, systems, and components, which could reduce the number of required engineered and administrative controls Reduction in the number of technical safety requirements e. The National Academies Press. The most recent summary report on tank lay-up activities also recommends that DOE share lessons learned on tank closure activities among its sites Elmore and Henderson, b. The committee does not advocate decoupling the removal and closure schedule based only on the future possibility of discovering better technologies for cleanup and closure without identifiable current prospects. Rather, the committee encourages developing or adapting specific technologies that are at least in the applied research stage and researching a narrow set of questions that, if answered, could enhance tank heel removal and closure effectiveness. The committee selected a time frame 5 to 10 years that is in reasonable accord with the overall schedule for tank farm closure and would not extend tank closure indefinitely into the future. These representatives argued that unless previously agreed to milestones for tank closure continue to be met, progress will stall. This concern could be addressed if separate milestones were established for tank waste retrieval and for closure. The committee notes that to delay grouting of specific tanks may not delay the final closure milestone for the entire tank farm, which will take several years. Even if the decoupling did result in some delay, the federal facility compliance agreements could be modified, as they have on many other occasions, provided that the action improves the outcome. The second objection raised against delaying tank closure is that a tank could collapse due to lateral pressure from the surrounding soil, or from the weight of the overburden. In its interim report, the committee recommended that DOE consider the risks from postponing tank closure compared to the risk reductions that could be achieved if the postponement improves heel removal. A qualitative assessment by DOE of the issues associated with aged and abandoned underground structures and vessels includes the potential for roof and side wall collapse; filling with water from runoff bathtub effect ; and internal seepage, which can lead to overflowing, leaking, or leaching; and buoyancy Langton et al. However, the committee is not advocating abandoning the empty tanks on-site and has seen no quantitative assessment of the risks of postponing tank grouting. According to DOE, the tanks are not in near-term danger of collapsing after bulk waste retrieval; 4 indeed, the structural support provided by the tank fill is not likely to be needed until DOE is ready for ultimate closure of the tank farm. In most cases, postponing closure of tanks that contain significant amounts of residual waste for several years would appear to have essentially no effect on near- or long-term risk, while leaving open the possibility of further risk reduction if more of the waste can be removed. The third objection against delaying tank closure is that once equipment is in place for tank waste removal e. This may be a valid concern if DOE is using a superstructure that is difficult or costly to move; it is not clear how much of an inconvenience this would impose. Therefore, the committee recommended in its interim report that DOE evaluate advantages and disadvantages for the entire waste management operation at a given site from both a risk and a cost perspective. If DOE can relax other constraints on tank waste removal, such as the tank space problem, delaying tank closure could free up funds planned for closure activities, and those funds could be devoted to 3 At Hanford the closure schedule is for single-shell tanks and for double-shell tanks; at the Savannah River Site the closure milestones are for Type I, II, and IV, and for Type III tanks; at Idaho the tanks will be closed in six phases from to ; there are no milestones for closing the calcine bins. The emptied tanks, therefore, need not be filled until immediately prior to closure of the entire tank farm and placement of the engineered cap if used. Page 71 Share Cite Suggested Citation: Similarly, research and development require funds, but could, if successful, result in lower costs and increased safety overall see Chapter IX. Grouting and other technologies e. Immobilization of wastes left on-site cannot be a substitute or justification for not removing tank wastes from the sites to the maximum extent practical e. When a tank has a relatively simple configuration i. However, when the residue in a given tank after cleaning still contains significant amounts of radioactive material, proceeding immediately to closure effectively precludes any further removal of residue from the tank. In its interim report, the committee recommended that DOE consider decoupling tank cleanup and closure activities. In cases where significant amounts of radioactive residues remain after tank cleaning, efforts should be directed to emptying and cleanup of other tanks while more effective retrieval techniques are sought. The committee judges that this approach would result in improved risk reduction. This decoupling need not delay the scheduled closure of the overall tank farm. In the near term, decisions about the formulation of grouts for tank fill are being made on the basis of experience in very different applications and, in some cases, on data from short-term tests on saltstone. The committee has not seen any reports of long-term testing or more fundamental research directed at the unique aspects of DOE applications, particularly the binding capacity of grouts and changes in various properties over the extended times contemplated by DOE. The committee recommends that DOE initiate a focused research and development program over a 5- to year period, and longer where necessary, to improve fundamental understanding of the long-term performance of tank fill material and tailoring grout formulations to different tanks or group of tanks. The program should involve collaboration among government laboratories, universities, and industry. Further details, findings, and recommendations on research and development can be found in Chapter IX. Page 62 Share Cite Suggested Citation:

Chapter 2 : Book Saltstone And Radionuclide Interactions PDF Free Download

Tank Waste Retrieval, Processing, and On-site Disposal at Three Department of Energy Sites: Final Report Committee on the Management of Certain Radioactive.

Other uncertainties associated with values of radioactivity and the time lines have not been determined. Values in curies include contributions from the daughter products of cesium and strontium Facility; and 2 to free up tank space to support site operations and batch preparation for the Salt Waste Processing Facility Hintze, ; Spears, The DDA process would alleviate some of the space problem. Because mixing the low-activity waste into a waste-form grout saltstone is an essentially irreversible action, the decision to send the DDA waste stream directly to saltstone permanently commits a substantial amount of radioactivity to the site. Even though these higher levels of radioactivity, primarily from cesium, may not cause projected doses from the Saltstone Vaults to exceed dose limits, the limited separation achieved with DDA raises the question: Does this process remove radionuclides to the maximum extent practical? Table IV-1 compares the efficacies of salt waste treatment processes. DOE indicated that up to 5 MCi 1. The contribution of radioactivity sent to saltstone from DDA alone could be as high as 4. The committee is further concerned about the implications of further delays in startup of the high-capacity process to remove radionuclides from salt wastes. In fact, DOE recently announced a month delay in initial operation of the SWPF as a result of a change in seismic design specifications. Given the constraints under which DOE states it must operate e. The committee is unable to offer further insights on this issue because DOE was still formulating its plans as this report was finalized. If realized, this possibility would make available tank space even more scarce. In 5 Several General Accounting Office now the Government Accountability Office reports have commented on the challenges of bringing on-line and operating large-scale waste processing facilities GAO, a, b, , , Page 56 Share Cite Suggested Citation: The National Academies Press. More generally, the committee cautions that in a schedule-driven system there is the danger that wastes could be sent through the process that is currently available rather than one that is most suited to removing radionuclides to the maximum extent practical from each waste stream. The committee recognizes, of course, that other considerations e. In its interim report, the committee offered some suggestions to address this tank space crisis see Appendix E. Low-Level Waste Immobilization and Disposal at the Savannah River Site At the Savannah River Site, the low-activity salt solution resulting from the separation processes described above is mixed into a waste-form grout known as saltstone. Depending on the specific constituents of the salt solution, the grout is formulated using appropriate proportions of portland cement, fly ash, and ground granulated blast-furnace slag, water, and chemical admixtures. The grout is pumped into concrete vaults, where it solidifies. Saltstone has a low oxidation-reduction potential Eh to stabilize key radionuclides such as technetium in less soluble forms to reduce the likelihood of their leaching out or migrating in the groundwater Rosenberger et al. The concrete vault has a concrete roof and will eventually have an engineered cap covering the entire installation. The engineered cap, together with the roof, walls, and floor of the vault, directs water away from the saltstone to minimize the leaching of radionuclides or toxic heavy metals from the salt-stone into the groundwater. As of , DOE had poured 25, m3 , cubic feet of saltstone containing only Ci 8. Waste Processing at Hanford With the notable exception of the campaign to extract cesium and strontium from its tank wastes in the s see Sidebar II-1 , Hanford has had relatively less experience in waste processing than the Savannah River Site and its tank wastes are more heterogeneous. As noted earlier, the Hanford approach to radionuclide removal is conceptually the same as that at the Savannah River Site Figure IV DOE plans to process the retrieved waste to concentrate most of the radioactivity in a high-activity waste stream and leave most of the nonradioactive chemicals and relatively small amounts of radionuclides in a relatively low-activity waste. This reduces the volume of high-activity waste to be vitrified and sent to a geological repository. The current plan at Hanford is to produce up to 14, canisters 15, m3 of vitrified waste DOE, containing approximately MCi 6. However, the planned vitrification facility for low-activity waste part of the Waste Treatment and Immobilization Plant discussed below does not have the capacity to process all of the low-activity waste by the completion date agreed to in the federal facility agreement for Hanford Hanford FFACO, The Waste Treatment and Immobilization Plant, which is now under construction, will include processes for separating retrieved tank wastes into high and low activity fractions as well as vitrification facilities to be discussed below. The high activity fraction will be vitrified and shipped off-site to a geologic disposal facility i. The Waste Treatment and Immobilization Plant will also vitrify about half of the low activity fraction, which will be disposed of on-site. The Waste Treatment and Immobilization Plant recently encountered schedule and cost overrun problems. Waste Treatment and Immobilization Plant Pretreatment The objective of pretreatment is to separate the waste into a low-radioactivity fraction that contains the bulk of the chemical waste for on-site disposal as low-activity waste and a highly radioactive fraction containing the bulk of the radioactivity and minimal chemical mass for off-site disposal in a federal geologic repository as HLW. The treatment approach depicted in Figure IV-5 results in the on-site disposal of approximately 90 percent of the waste mass and the off-site disposal of about 10 the balance of the total. Off-site disposal of the HLW coupled with off-site disposal of radioactive materials resulting from prior radioactive isotope removal 6 Page 57 Share Cite Suggested Citation: Page 58 Share Cite Suggested Citation: In its presentations to the committee, DOE calculations show 40 to 60 percent of the low-activity waste undergoing bulk vitrification. Mann, ; Schepens, Dividing the waste into high-level and low-activity fractions occurs primarily by solid-liquid separation ultrafiltration. The solids removed contain nearly all of the actinides, nearly all of the strontium, and approximately 25 percent of the cesium The solids are washed to remove bulk chemicals e. The washed sludge solids are mixed with glass formers and fed to the high-level waste melters. The filtered liquid waste stream contains the cesium and other soluble radionuclides. Cesium is removed by ion exchange except as explained below for low cesium wastes. The pretreated liquids are mixed with glass formers and the chemicals washed from the sludge and then are fed to the low-activity waste melters in the Waste Treatment and Immobilization Plant. Some low-activity wastes from the plant may also be sent to supplemental treatment, as indicated in Figure IV Solids-liquids separations are a key pretreatment step to remove the actinides and strontium for subsequent processing as high-level waste. Wastes from that processing, which contained the complexants, are stored in two tanks. Interactions of the complexants with actinides and strontium in those tanks resulted in these radionuclides becoming solubleâ€"moving from the sludge phase into the supernate. Consequently, a precipitation process will be used in the Waste Treatment and Immobilization Plant for the liquids in those two tanks to make them compatible with the pretreatment process described above. Some tanks contain low concentrations of cesium Low-Cesium Waste either because the cesium was removed or because the waste did not result from reprocessing. DOE developed a waste management plan and analysis Petersen, indicating that cesium ion exchange was not economically practical at cesium concentrations less than Page 59 Share Cite Suggested Citation: DOE is currently updating those analyses. For cesium waste feeds containing substantially less than 0. For feeds approaching 0. High-level waste vitrification is the immobilization method of choice nationally and internationally; it also produces a waste form that meets planned repository waste acceptance criteria. Unless additional low-activity waste processing capacity is provided, treatment operations could extend to approximately DOE, its regulators the Washington State Department of Ecology and the Environmental Protection Agency , and a group of internal and external experts participated in a study to determine the feasibility of supplemental treatment technologies to help meet the Tri-Party Agreement milestone for treatment without the high capital cost of a second facility. Three supplemental technologies were selected for lab tests with surrogate wastes: Cast stone was eliminated because of waste form performance i. DOE decided to conduct steam-reforming tests at Idaho on sodium-bearing waste and tank waste surrogates at Hanford. At Hanford, DOE is conducting full-scale bulk vitrification tests on surrogate wastes and actual tank wastes up to , gallons of waste from tank S, a low-cesium waste tank see Figure IV The committee toured the pilot-scale, nonradioactive, bulk vitrification facility at Hanford; heard presentations on this technology from DOE and contractors; and reviewed available literature. The committee observed that bulk vitrification is a much different approach to processing than the Savannah River Site saltstone. In particular, it is a high-temperature process greater than C , which will change the chemical nature of the waste e. Some fraction of the radionuclides cesium and technetium may migrate under the thermal gradient in FIGURE IV-7 Bulk vitrification processing is performed in a refractory-lined commercially available container. Page 60 Share Cite Suggested Citation: At this time there are no data to evaluate these possible effects. In addition, the Defense Nuclear Facilities Safety Board DNFSB has raised concerns about the proposed design of the full-scale test facility, which had no containment beyond the equipment itself. Although intended to process only low-curie feed, it is unusual to operate such a facility without successive barriers to confine radioactive materials. Waste Processing at the Idaho National Laboratory According to information available to the committee, the Idaho National Laboratory has no plan for on-site disposal of waste from reprocessing nuclear fuels that would fall within the scope of this study. Although final decisions have not been made, the current plan is for retrieved calcine to be sent to a repository without radionuclide or bulk-chemical separation after simple packaging or after being immobilized in an inert matrix. Sodium bearing waste is a highly acidic waste that contains trivial amounts of solids and no saltcake. It has been retrieved from some tanks, has been consolidated in a smaller number of tanks, and will be conditioned for disposal using steam reforming. Steam reforming is a commercially available technology that has been used for a variety of radioactive wastes including those from the nuclear power industry. They are one-of-a-kind facilities that present technical risks in their design, construction, and operation. Both the Savannah River and Hanford sites presented the committee with an enormous amount of waste characterization data based on actual sampling, process histories, and model calculations. For the purpose of waste processing and the design of processing facilities, DOE should continue to characterize its waste, but this should be done after waste retrieval and mixing, when truly representative samples can be taken. Even then, the contents and their concentrations need only be known sufficiently for reliable and efficient processing to take place and to provide the radionuclide inventory adequate for subsequent performance assessments. Some processing methodologies may have more stringent quality control requirements than others. In these cases the amount of characterization required may be increased or more adaptable processes could be sought. Each site is pursuing different technologies for immobilizing its processed non-high-level waste 10 â€" saltstone at the Savannah River Site, steam reforming at the Idaho National Laboratory, and vitrification at Hanford. The Hanford bulk vitrification process is less well developed technically than either the Savannah River Site saltstone or the Idaho National Laboratory steam reforming. Bulk vitrification operates at high temperatures, which may volatilize much of the waste and increase technical and safety risks. Before issuing a record of decision on supplemental treatment at Hanford, DOE should carefully and transparently review bulk vitrification versus the Savannah River Site saltstone and the Idaho National Laboratory steam reforming. This review should be conducted by a panel of technical experts independent of DOE. The Savannah River Site is facing serious challenges due to limited available tank space and the need for additional tank space to maintain operation of the Defense Waste Processing Facility and meet tank closure commitments. The Salt Waste Processing Facility relies on more efficient technologies to remove radionuclides from the Savannah River Site tanks than the deliquification, dissolution, and adjustment DDA process. Page 61 Share Cite Suggested Citation: The committee is concerned that the schedule for tank closure and the tank space crisis may increase the need to use DDA and possibly extend its operations, which could lead to disposal of additional radioactive material on-site in saltstone. To reduce the quantities of radionuclides to be disposed of on-site, DOE should develop alternates or enhancements to the deliquification, dissolution, and adjustment treatment process to solve its tank space problems. DOE and its regulators, with public stakeholder involvement, should objectively balance costs and risks near and long term of schedule delays in Savannah River Site salt processing against those of sending increased quantities of radionuclides to on-site disposal in order to preserve tank closure schedules. Page 51 Share Cite Suggested Citation: