LN TECHNOLOGIES CORPORATION 1501 KEY ROAD, COLUMBIA, S.C. 29201 (803) 256-4355

February 2, 1987
LN-87-0035-L18

Mr. Roy Person
Engineering Branch
Division of Waste Management
US Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Springs, MD 20910

Dear Mr. Person:

Enclosed is a draft of our responses to the NRC comments and questions regarding our topical report entitled, "Topical Report on 10 CFR 61 Qualified Radioactive Waste Forms." The responses are intended to answer questions which have been asked by the NRC and to conform the actions which LN must take in order to obtain approval of the report.

After you have had an opportunity to review our responses, Paul Denault, who is in charge of LN's chemistry group, and I would like to meet with you to discuss the responses and clarify any remaining areas in question. We will finalize our responses based upon the discussion at the meeting and formally transmit them to the NRC. The topical report will then be revised in order to address the changes presented in the NRC comments and our responses, and to include the additional testing data required.

I will contact you in the next several weeks in order to arrange a meeting at your convenience to discuss the responses.

Sincerely,

Steven B. McCoy

Steven B. McCoy
Director, Engineering Services

cc: P. Denault
R. Hemmings
R. Voit
SBM:dab

WM Record File
WM Project 20
Docket No.
PDR ✓
LPDR
Distribution:
*Literson W/encl T Johnson
(Return to WM, 623-SS)
Sac

8703020149 870202
PDR WASTE
WM-20 PDR

TECHNOLOGIES
CORPORATION

A Member of The SNC Group

RESPONSE TO USNRC COMMENTS ON THE LN TECHNOLOGIES 10 CFR 61 TOPICAL REPORT

1. Section IV.C.4

What is the basis for your statement that oils and organics in concentrations of less than one percent will not significantly affect solidification?

Answer

The statement was made on the basis of experience in solidifying actual wastes at power plants. Small amounts of oil and other organics in quantities of less than 1% are frequently observed in wastes to be solidified. Problems in obtaining solid products in such circumstances have not occurred. LN will initiate laboratory studies, however, to provide a more definitive basis for allowing oil and other organics up to 1%.

2. Section IV.D

It is not apparent that qualification tests were performed using the chemical additives discussed in this section. Therefore, if approval is requested for these additives, qualification test data needs to be provided.

Answer

Qualification tests using the trace additives, calcium chloride and silicon-based antifoam, have not been performed. Due to the small amounts used and the relatively infrequent use of these chemicals, it was not deemed

necessary to test samples with these additives. LN has discontinued the use of calcium chloride as an accelerator, and reference to it will be deleted from the topical report. LN will initiate testing, however, to verify that the antifoam does not have an adverse affect upon the solidified products. Due to the small amounts of antifoam actually used in solidifications (< 0.1% of waste volume), LN considers this work to be a refinement of the basic waste form qualification study, and approval of the topical report should not be contigent upon completing this additional work.

3. Section IV.E

The topical report states that not all the proposed waste streams are addressed in the process control program (PCP) provided. A PCP should be provided for the waste streams to be qualified. Note that the PCP in Appendix I does not address powdered resins and activated carbon.

The topical report also states that the quantities of solidification materials may be modified in accordance with a system operating procedure. A discussion of the possible modifications addressed in the system operating procedures should be provided for our review.

Answer

Data for the waste forms for which certification testing has been performed will be included in the topical report. Formulas for these waste forms need not be included in the PCP, however, unless it is intended to use the formula in current solidification operations. Sometimes, due to logistical or cost considerations, certified waste forms will not be used and, as a result, are not included in the PCP. It may be desirable at a later date, however, to use these waste forms and, at that time, the PCP will be revised to include that waste form.

The PCP (SS-001) has been revised to specifically address powdered resins (by defining filter sludges as powdered resins). Another PCP section will be added for activated carbon.

The test sheets in the appendices to the PCP procedure provide the calculations for scaling up the additive amounts used in the PCP to the amounts for solidifying one cubic foot of waste:

Solid Additives:

$$\frac{\text{lb Additive}}{\text{ft}^3 \text{ Waste}} = \frac{(\text{g Additive})\ (28{,}316\ \text{ml/ft}^3)}{(100\ \text{mls Waste})\ (454\ \text{g/lb})}$$

$$= (0.624)\ (\text{g Additive})$$

Liquid Additives:

$$\frac{\text{gal Additive}}{\text{ft}^3 \text{ Waste}} = \frac{(\text{ml Additive})\ 28{,}316\ \text{ml/ft}^3)}{(100\ \text{mls Waste})\ (3785\ \text{ml/gal})}$$

$$= (0.0748)\ (\text{ml Additive})$$

The system operating procedures specify that the total additive amounts be calculated by simply multiplying the amounts calculated on a cubic foot of waste basis by the number of cubic feet to be solidified.

In the actual solidification, the technician must transfer the calculated additive amounts within a 10% tolerance, which is allowed in order to compensate for differences between the PCP samples and the actual wastes. Significant differences rarely occur in solid wastes such as bead or powdered resins but can be a problem for evaporator concentrates. It is not uncommon, for example, for some additional concentration to occur during the 24-48 hours

required for PCP testing. Test data will be provided to ensure that the additive amounts used in actual solidifications are within the range of the qualified data.

4. Section V.A., last para., p.16

Results of scale-up tests should be presented and correlated with small-scale samples tested. In particular, the adequacy of using a Mixmaster to prepare small samples should be verified. Scale-up tests using 55-gallon drum size samples are inadequate. The largest liners should be used to verify that the large amount of heat produced by cement hydration does not adversely affect the final product.

Answer

Scale-up tests are being performed and the results correlated with small-scale test samples. As of the date of this response, liner size tests have been performed for the Resins (Formula I), Powdered Resins and Sodium Sulfate waste forms. Scale-up testing on other waste forms will be performed as a part of our certification program and the results submitted to the USNRC as additions to the topical report.

Scale-up tests with 55-gallon drum size samples are useful as a low cost intermediate step between laboratory and full-scale liners. We will continue to schedule full-scale tests, however, to ensure that acceptable products are produced.

5. Section V.B.1 and V.B.2

The discussion regarding the preliminary testing used to select the waste formulations for full qualification testing is confusing. We suggest that the discussions involving "preliminary acceptance" be deleted.

Answer

As suggested, the discussions regarding preliminary acceptance will be deleted.

6. Section V.C, 1st Para., p. 20

It is stated that difficulty was encountered in removing specimens from cardboard molds. A discussion of the removal effects on the waste samples prepared using the cardboard molds should be provided. We assume the samples used were 2" by 4" and 3" by 6" cylinders.

Answer

The waste form samples had a tendency to adhere to the cardboard molds which were apparently inadequately waxed. This made it difficult to remove all of the cardboard from the surface of the samples and some samples were broken in the process. Of the samples which survived the removal process and were subsequently used in the testing, there didn't appear to be any deterious affects to the samples or the test results.

This problem was solved by converting to plastic molds, 4.6 cm ID X 9.5 cm IH, for the remainder of the testing. The waste form samples do not adhere to the plastic which can be cut away and easily removed from the samples.

7. Section V.C., p. 20

In general, compressive strengths of forms used in immersion tests were higher than those used in other tests. In the report, it is indicated that samples were cured for 14 days before all tests except immersion/leaching, for which the samples were cured for seven days prior to testing. It is understood from the report that concrete increases in strength during the cure period but that an inadequate amount of water can result in a product of low or inadequate strength. Is it possible that a form immersed in water after seven days (and thus allowed to cure in an excess of water) may perform differently (better) than a form cured for 14 or 28 days (with only the water used in the formula) and then immersed in water? Since actual waste products will cure in closed containers with less than 0.5% free water, data should be presented indicating that forms tested after a seven-day cure period are no different than forms allowed to cure for a longer time.

Answer

Our experience with bead resins, has shown that development of strength in the waste form is critical to surviving the immersion test. A waste form which has not cured properly, due to the lack of water, will lack sufficient strength to withstand immersion irregardless of the length of the curing time.

We are aware that another vendor has had mixed resin waste forms with 7-day cure times survive immersion, while samples cured for 28 days have failed. We are not informed of the details of their sample preparation, thus we cannot comment on their results.

LN will perform additional tests, however, to determine the sensitivity of immersion test results to sample cure time. In addition, all future test samples will be cured for a minimum of 28 days prior to initiating the testing.

8. Section V.C., 2nd para., 1st sent., p. 20

Should 140°C be 140°F?

Answer

Yes, 140°F is the correct temperature.

9. Section V.D.1, V.D.3, V.D.4

The cure conditions as stated in these sections appear to contradict the cure conditions stated in Section V.C., 2nd para.

Answer

The cure times for the samples tested will be included in Appendix D. Actual cure times ranged between 7 and 14 days for test samples prepared earlier in the test program. Later test samples were cured longer, i.e. 17 to 36 days. The topical resport will be revised to correct the identified inconsistancies.

10. Section V.D.2

It is stated that immersion testing was performed for a minimum of fifteen days. A minimum immersion period of ninety days is needed for approval of your proposed waste streams per Technical Position on Waste Form for 10 CFR 61.

Answer

Immersion tests data, performed for the full 90 days specified in the Technical Position on Waste Form, will be provided for all waste forms presented in the topical report. The discussion in Section V.D.2 will be revised to delete reference to shorter testing periods.

11. Sections V.D.1, V.D.3, and V.D.4

Irradiation, biodegradation and thermal cycling for approval testing is needed for all proposed waste streams.

The results of the biodegradation tests, ASTM G21 and ASTM G22, were not presented in the report. Data should be presented which indicates whether or not the forms tested are resistant to biodegradation.

Answer

Irradiation, biodegradation and thermal cycling will be provided for all of the proposed waste forms presented in the topical report.

12. Section V.D.4

What was the size of the specimens which were thermal cycled? Were the specimens thermal cycled bare or in the mold? If the samples were thermal cycled while in the mold, a thermal analysis showing the center point temperature should be provided.

Answer

The samples which were thermal cycled were either 2" X 4" or 4.6 cm X 9.5cm in size. All samples were removed from the molds prior to testing.

13. Section V.D.5

Samples intended for qualification should be leach tested with both demineralized water and synthesized seawater.

Answer

Waste forms will be leach tested in both demineralized and synthesized seawater and the results submitted to the USNRC as additions to the topical report.

14. Section V.D.5, 1st para., last sent., p. 23

We suggest deleting this sentence as it is immaterial to the desired qualification testing.

Answer

As suggested, the sentence will be deleted.

15. Section V.D.5, 1st sent., p. 24

It is stated that the 2 liter leachant volume was reduced. What was this volume reduced to? For what samples is it applicable? What is the size of the "smaller plastic molds"? Are these sizes the same as the sizes given in Section V.C.?

Answer

The leachant volume was reduced to 1.6 liters for the samples prepared in the smaller plastic molds. The plastic molds are 4.6 cm ID X 9.5 cm IH for an internal volume of 158 mls.

16. Section V.D.5.C

An analysis should be provided to assess the effect of the nonuniform distributions observed.

Answer

LN does not presently have the resources to further investigate the distribution of tracers discussed in this paragraph. This discussion will be deleted from the report. It should be noted, however, that if the tracer concentration is higher at the surface as indicated by the data, then the resulting leach indices will be conservatively low.

17. Section V.D.5.d and Appendix G

Data are presented on the leaching of Ca, Na, SO_4 from a sodium sulfate waste specimen. Over ninety days, 0.3% w/o of the Ca was detected in the leachate. Based on this value it is stated that the solidified waste form will maintain its integrity.

It is unclear how this conclusion was reached without a fundamental understanding of the cement curing chemistry. Because the cement chemistry undergoes reactions at varying rates, some very slow, we do not understand how a ninety day leach test could be sufficient to base your conclusions. In fact, at the rate you project Ca to be released, it would be totally released in less than 100 years. This is less than the 300 hr stability goal stated in 10 CFR Part 61. Using as an analog traditional concrete construction and assuming a similar release mechanisms, at the Ca release stated we would also expect severe degradation of concrete structures. This severe degradation, however, is not observed. We, therefore, consider that the test method you have presented is insufficient on which to base the conclusions you have drawn from the data.

Answer

It is agreed that the test data on which these conclusions were based are limited. Since these data do not contribute to 10 CFR 61 certification of the waste forms, we will delete these sections from the topical report.

18. Section V.D.5.a, p. 24

Equation 2, given on page 24, for calculation of diffusivity (d) should include multiplication by f. Based on independent calculations using data presented in Appendix E, it is believed that the leach indexes were calculated correctly and thus all of the leach data were reviewed as though the values were correctly computed.

It should be stated whether or not the leach index values reported are the average values of all the leach indexes measured in a particular experiment.

Answer

Equation 2, given on page 24, for the diffusity D should have been multiplied by π :

$$D = \pi \left[\frac{An/Ao}{(\Delta t)_n} \right]^2 \left[\frac{V}{S} \right]^2 T$$

In checking the equation it was also noticed the cumulative fraction leached in the sentence preceding the equation was incorrectly stated. This quantity should be less than 20%:

$(An/Ao < 0.20)$

Despite the typographical errors on this page, a check of the calculations verified that the leach indices were calculated correctly.

The leach index values reported in Appendix D are average values for the ten intervals measured for the specific experiments.

19. Section V.D.5.b, p. 26

Although the leach indexes for Cs are comparable based on testing of a single formulation containing radioactive and nonradioactive tracers, no explanation is given as to why the fraction release of Cs-137 is in general about two-thirds the fraction release of nonradioactive Cs. Some explanation should be given regarding the consistently large differences in the fraction release data and why the trend observed (and not the reverse; where Cs-137 release is faster than Cs) would be expected.

A discussion should be given of the analytical methods used to measure non-radioactive Cs, Co and Sr in solution. There is no indication in the report of the limits for measuring these ions in solution or that the sensitivity of this experiment is comparable to that using radioactive tracers.

Note also that Appendix E contains only test data and does not have a discussion of leachability testing as indicated at the beginning of Section VI, page 32 of the Topical Report.

Answer

It is not understood why the fractional release of Cs-137 was less than for the nonradioactive tracers. Providing a definitive answer could require significantly more data comparing radioactive and nonradioactive tracer leach rates which is beyond the scope of our test program. There is no data, however, which indicates that radioactive tracers are more representative than nonradioactive tracers (or visa-versa) in simulating actual wastes. The reduction in testing cost and elimination of radwaste generation strongly argues for the use of nonradioactive tracers.

The last paragraph in Section V.D.5 on p. 24 states that Cs, Co and Sr content of rinse solutions and leachates is determined by flame emission spectrophotometry in accordance with the following standards:

Cobalt: EPA Methods Manual, Method 21.1

Strontium: "Standard Methods for Examination of Water and Waste Water", Part 326.B - Flame Emission Photometric Method

Cesium: "Analytical Methods for Atomic Absortion Spectrometry", Perkin Elmer Operations Manual, January 1982, Standard Flame Emission Conditions for Cesium.

The detection limits for the Cs, Co and Sr analyses were all 0.05 ppm. The accuracies for the analyses were $\pm$ 0.05 ppm.

When analysis results are below the limits of detection, the limits of detection are conservatively used in the leachability index calculations. For example, a value of <.05 mg/l is interpreted as 0.05 mg/l for the LI calculation.

As indicated, Appendix E contains only data without a discussion. The first paragraph of section VI (p. 31) will be revised.

20. Section V.D.5.e

Your conclusion that demineralized water is always the most restrictive is inconsistent with other data presented by P. Columbo and R. Neilsen of Brookhaven National Laboratory (NUREG/CR-0619) and in other topical reports. These data show that for testing wastes seawater will generally be the more restrictive leachate. This is due to the regeneration of the ion exchange media in the presence of a liquid containing high ionic concentrations. We, therefore, consider that performing leach testing on both demineralized water and seawater will sufficiently bound the leaching properties of solidified wastes in the actual burial environment.

Answer

LN will perform leach testing in seawater in addition to the demineralized water testing. The data will be submitted as soon as available as an addition to the topical report.

21. Section V.d.5.f.

The ninety-day leach test is being recommended because it will identify changes in the leaching mechanisms better than with a five day test. The ANS 16.1 procedure assumes a diffusion controlled release. However, this leaching mechanism could change with time. We, therefore, consider a longer test period essential in the evaluation of whether the diffusion controlled mechanism remains constant with time.

Answer

It is agreed that the leach tests should be run for the full 90 days. The full-term test data will be provided for each of the waste forms.

22. Section V.E

If 80 to 150 ft^3 waste forms are to be produced under this qualification program, full scale products of the maximum size should be tested. Testing should include compression and immersion tests.

Answer

Full-scale products will be produced for each of the waste forms to be certified. The results of full scale tests will be submitted to the USNRC as additions to the topical report. LN does not believe, however, that waste form approval should be delayed until full-scale tests are completed. These tests must be performed with new, noncontaminated equipment and such equipment is not always readily available.

23. Section VI, General

For all waste stream formulations proposed to be qualified, a complete set of test data is needed. Test data presented on other formulations is insufficient to use as a basis for elimination of the recommended tests.

Observations of physical changes to the specimens after testing should also be discussed. For example, did surface sloughing, swelling, or dimensional changes occur after the testing?

What was the reason for the relatively low compression strength (370 psi) of the immersion test specimen? Note also that for formula 1 the cesium leach index is less than six. This represents an unacceptable result.

Answer

A complete set of data will be provided for all waste forms to be certified.

Observations of physical changes to the test samples after testing will be provided. Reporting these observations, however, is not an acceptance criterion requested in the Technical Position.

As stated in section VI.A, the 370 psi compressive strength is "unexpectedly low and inconsistent with the other measurements". It is not known why this measurement was so low but it should be noted that it is well above the minimum acceptable level of 50 psi. The immersion/compression test will be re-performed, however, to check the reported data. The boric acid (formula 1) waste form will be deleted due to the cesium leach index of <6.

24. Section VI,C, 1st-3rd lines, p. 34

The leach indices for the Formula 1 bead resin samples were from 5.9 to 6.0 for the demineralized water case. These represent unacceptable results for qualification of this waste system. For a waste stream to be qualified, acceptable leach rates should be obtained for all leach indices.

Answer

The leach test will be re-performed and if the resulting leach indices are less than 6, the boric acid (formula 1) waste form will be deleted or reformulated.

25. Section VI,D, p. 35

It is indicated in the report that mechanical properties of solidified waste forms are enhanced by increasing the cement-to-water (C:W) ratios. However, the compression test data listed in Table D.4a show that for the set of forms prepared for each resin type, the composites having lowest C:W have the highest compressive strengths. Is there an explanation for this apparent contradiction?

Answer

Cement-to-water ratios cannot be calculated from the amount of "additional water" which is the volume of water added above the surface of saturated resin.

For the purposes of this report, saturated resin is defined as resin saturated with water to equilibrium with all observable free-standing water decanted from above the settled resin surface. The total water can be calculated by adding the water content of saturated resin to the "additional water". Saturated powdered resin contains approximately 70% water. Using this value to calculate the total water for the powdered resins in Table D.4.a, the compression values are shown to increase with increasing C:W ratios:

Powdex PCH

- Water Content (ml) -

Saturated Resin	Add'n Water	Total Water	Cement (g)	CW Ratio	Irradiation Compress. Str. (psi)
70	2.5	72.5	45.0	.62	680
70	5.0	75.0	50.0	.66	700
70	7.5	77.5	57.5	.74	880
70	10.0	80.0	65.0	.81	1060

The reason for this method of water measurement is to simulate the way that resins are transferred and processed at power plants. Resins are transferred in a slurry to the solidification liner (container), allowed to settle, then dewatered down to the top surface of the resin. Additional water is then added back followed by the various dry additives. This eliminates the need to determine total water in the liner which would be difficult to determine due to technical and radiological reasons.

26. Section VI,F, 1st sent., p. 36

It is stated that any cement formula qualified to 10 CFR Part 61 could be used for filter encapsulation. The tensile strength of any waste formulation proposed for encapsulation should be determined.

Answer

The stress calculations in Appendix H are based upon the modulus of rupture, which is a tensile property obtained in a bending test and not a uni-axial test. This more closely models the stresses imposed by burial as the flat heads of the container are subject to bending rather than uni-axial loads. LN will ensure that the tensile properties of the encapsulation material meet the minimum values specified in Appendix H.

27. Appendix D

There do not appear to be initial compression test data for any of the waste streams. These data need to be provided to determine if testing (e.g., irradiation, immersion, etc.) affected the strength of the formulation.

Answer

LN will provide initial compression data for all waste forms.

28. Appendix D

All leach testing data for all the proposed waste streams should be provided for our review. In addition, actual test reports should be provided for other testing performed.

Answer

As requested, all leach testing data for the proposed waste forms will be provided. In addition, the test reports will be provided for the other testing performed.

29. Appendix F.

It is unclear how the control samples were taken and what the analytical data for them represent. In addition, statistical error bars should be presented for the data in Table F.1.

Answer

Refer to the answer given to question #16.

30. Appendix H

In C.5 of the Technical Position on Waste Form (TP), it is stated that for filter cartridge wastes, the waste generator should demonstrate that the selected approach for providing stability will meet the requirements of 10 CFR Part 61. A structurally stable waste, according to 10 CFR 61.56 "will generally maintain its physical dimensions and form under the expected disposal conditions such as the weight of overburden." Encapsulation of the filter cartridge in a solidification binder, mentioned in the TP as one option for providing stability, has been selected by NUS. Cement grout has been selected as the binder material. NUS presents calculations (in Appendix H of the topical report) of the thickness of the cement encapsulation required to withstand a specified overburden load (45 ft of material of 120 lb/ft^3 density). These thicknesses are calculated as a fraction of the compressive strength of the cement. In addition, NUS assumed in these calculations for the sake of conservatism that during encapsulation none of the cement grout flows into the metal cage containing the filter cartridges. NUS maintains that, in actuality, significant volumes of grout will flow into the interior of the metal cage, and thereby, furnish additional structural support to the encapsulated

product. The unquantified additional structural support from cement in the interior of the metal cage is used to justify a safety factor of 1.5 used in calculating the thickness of cement in the top, bottom, and side-wall between the metal cage and the external container.

It is further assumed in making these calculations that the mechanical properties of grout "in tension and flexure" may be "estimated as a ratio for the compressive strength." The ratios used for grout are taken to be the same as those "typically estimated" for concrete. No values for these ratios are cited except $ST/S_c=0.15$ in connection with failure of container end by shear (in Figure 5 of Appendix H of the Topical Report). It is not clear how this ratio between the tensile and compressive strength is used in the consideration of failure of the container ends by bending as presented in Appendix H (e.g., top drawing in Figure 4). The staff concludes that NUS has not adequately demonstrated that an unreinforced grout shell can support the weight of the overburden. It may prove necessary to incorporate reinforcing structures into the grout material. The staff further concludes that NUS has failed to demonstrate that sufficient additional structural support will be provided by "significant" amounts of grout which will flow into the metal cage containing the filter cartridges. Furthermore, since the cement ends and sidewall are not internally reinforced, NUS should indicate how it will determine, either on a case-by-case basis for each filter encapsulation liner or on a generic basis, that sufficient grout has flowed into the interior of the metal cage to justify use of the 1.5 safety factor. Such a justification should take into account that no credit for structural strength may be taken by the filter cartridges since these may be subject to degradation processes after encapsulation.

Since the grout used for encapsulation is poured onto a bottom slab which is already solidified and set and, in addition, may not necessarily have the same composition as the grout, inadequate bonding between the grout and the bottom slab at the seam separating them may compromise the integrity of the encapsulation. The calculations in Appendix H of the topical report do not take account of the seam between the grout and the bottom of the slab. In addition, the seam may provide a pathway for leaching of radionuclides from the filter cartridges. NUS should demonstrate that the seam will neither compromise the ability of the filter encapsulation liner to withstand the weight of overburden nor provide a pathway for the release of radionuclides.

Since NUS proposes to use "any cement formula (waste form) qualified to 10 CFR Part 61 requirements" as grout in encapsulating the filter cartridges, a process control program should be presented which will provide reasonable assurance that encapsulation with such a grout will result in a waste form which will comply with the stability guidance for processed waste presented in the TP.

A detailed description should be given of the method for preparing a liner for encapsulating filter cartridges. The type of materials that would be processed by encapsulation should be listed. The description of the encapsulation method should at least include an explanation of how the liner (with the cement slab) will be prepared.

Note also that the Hanford disposal site has increased the effective disposal depth to 55 ft. The structural calculations, therefore, should be revised for this burial depth.

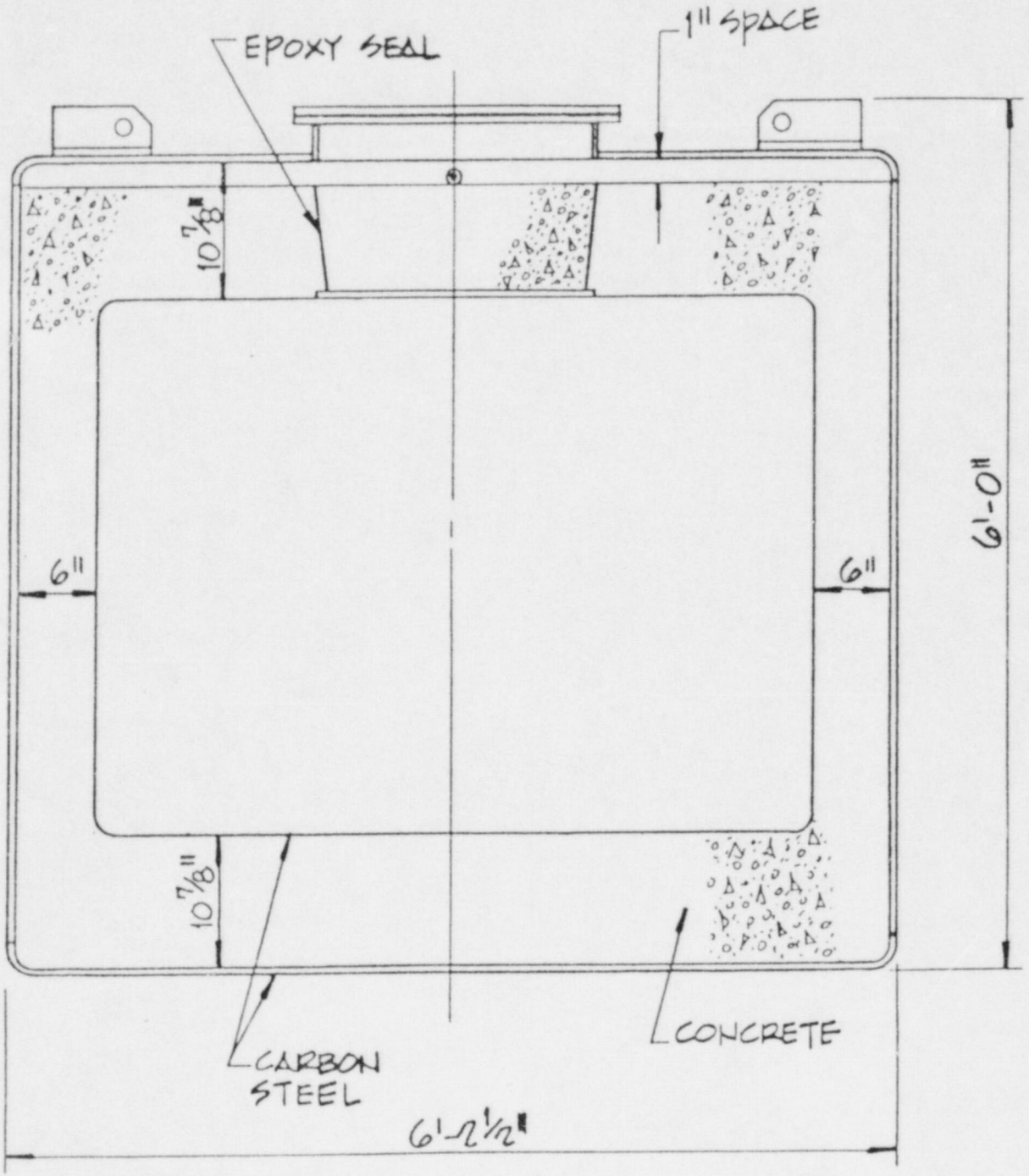
Answer

In order to increase the strength of the filter encapsulation liner, eliminate concerns regarding the seam between the grout and bottom of the slab and to make the container easier and less expensive to use, LN has redesigned the FE liner. Section VI.F and the analysis in Appendix H, which will reflect the new burial depth of 55 feet at Hanford, will be revised.

The new filter encapsulation liner design, shown in the following figure, requires that the container concrete be poured during fabrication at one time, thereby eliminating the seam at the bottom of the liner. A plug is poured separately and placed in the liner opening after the filters are loaded into the liner. An epoxy sealant, commonly used for nuclear applications, is then pumped into the gap between the plug and the concrete of the liner head. The resulting bond is stronger than the base concrete which it seals. The new design is much easier for the utility customer to use as the concrete container is poured during fabrication under controlled conditions rather than after loading with radioactive wastes. In addition, there is no need to mix and transfer the concrete grout at the site, with the potential problem of premature set of the grout if problems occur. The FE liner will be more fully described in the revised section of the topical report.

LN-182 FE

FILTER ENCAPSULATION LINER



31. Appendix I

A description should be given of the probable ranges of waste properties that are expected for actual wastes that can be successfully solidified using the formulas given in the Topical Report. Parameters such as acceptable waste pH values, percent oil, percent total solids, mixing times or the ratio of anion exchangers to cation exchangers in mixed bed resin wastes (solidified with formula 1) should be included.

The testing procedures for each waste type refers the Solidification Technician to the Project Manager for alternate formulas in the event that a solidification test is not successful. How do the alternate formulas differ from the formulas used to prepare samples included in the test program intended to demonstrate that the solidified products meet the stability criteria of 10 CFR Part 61?

Each procedure should require an evaluation of the waste analysis to determine if, in fact, the properties of the waste are within acceptable ranges for the solidification formulations.

The percent oil content is to be recorded on the PCP Test Sheet for each of the six procedures given. Does the +1% designated in the PCP Test Sheets for Resins Formula I, Filter Sludges, and Resins Formula II indicate an acceptable limit for the amount of oil in the wastes? Why is the 1% designation not included in the PCP Test Sheets for Boric Acid Concentrates and Sodium Sulfate Concentrates?

It appears that there are two criteria for an acceptable PCP specimen (no free liquid and free standing monolith). However, there are references to "three criteria" in Sections 9.3.16, 9.4.17, 9.5.13, 9.6.16 and 9.7.13. These apparent contradictions should be resolved in order to avoid potential confusion in carrying out the solidification tests.

Answer

The range of waste characteristics varies widely between different plants and even within plants between different batches. For example, the floor drain wastes at a seawater plant may contain high concentrations of seawater when service water leakage occurs. Floor drain wastes can contain virtually any chemicals, solids, wastes, etc., which can flow down a drain. In addition, the characteristics of waste ion exchange resins, i.e. cation-to-anion ratios, % exhaustion, ionic form, % fines, etc., would be extremely difficult to determine.

Fortunately cement is a fairly flexible binding agent and it is possible to obtain acceptable products despite the wide variations in waste characteristics. In addition, LN restricts various parameters in accordance with regulatory and cement chemistry requirements. The amount of oil in the waste to be solidified is restricted <1% as required by the Barnwell disposal site criteria. Variations in pH are controlled by treatment with lime to an alkaline pH suitable for the cement to set. The PCP also provides added confidence that a solidified product will be acceptable, although it is acknowledged that a set (solid) product is not necessarily a "stable" product as defined by the Technical Position. In summary, it is believed that the controls already imposed by LN in the PCP are sufficient and

trying to further restrict wastes to be solidified on the basis of detailed chemical and physical analyses is needlessly expensive and somewhat impractical. LN would like to discuss this topic in more detail with the NRC.

When the solidification PCP tests are unsuccessful, the technician is directed to call the LN Project Manager for instructions. The Project Manager has access to other formulations, acceptable in stabilizing wastes, which are not presented in the PCP procedure. In addition, the technician may be experiencing problems related to technique which can be resolved by the Project Manager. The Project Manager will not deviate from "stabile" waste forms unless the waste to be solidified is classified as Class A Unstable. All deviations from the PCP procedure are documented by the technician in the PCP records and by the Project Manager in the project file.

The PCP procedure requires that the waste parameters considered necessary to produce an adequate product are measured and recorded.

The percent oil content of 1% is the maximum amount allowed by the Barnwell disposal site, and cannot be exceeded in solidifying wastes for disposal at that site. The PCP has been revised to more clearly specify that the maximum 1% oil content applies to all waste forms and to all wastes to be disposed of at Barnwell.

As mentioned previously in the response to the first question, LN will perform testing to verify that the range of oil allowed by the PCP will not adversely affect the stability of the waste form.

There are two criteria for an acceptable PCP specimen and the PCP has been revised to resolve the contradictions in sections 9.3.16, 9.4.17, 9.5.13, 9.6.16 and 9.7.13.

32. Appendix I, Section 3, p. 4 of 43

The PCP defines sodium sulfate concentrates as "sodium sulfate (Na_2SO_4) solutions in the range of 0% to 25% sodium sulfate." If it is anticipated that up to 25% sodium sulfate in solution will be solidified then test data should be included in the topical report to demonstrate that such solutions can be solidified and the resulting product meets the stability criteria of 10 CFR Part 61. If additional data are not presented, then the PCP should be changed such that the percentage stated in the PCP is consistent with that used in the test programs for qualifying waste forms.

The PCP defines filter sludges as "powdered ion-exchange resins, diatomaceous earth and other filter pre-coat materials." The PCP should list the types of filter sludges that can be solidified and should not refer to "other materials". A solidification test program should be given in the PCP for each filter sludge type/cement formulation. The test data necessary to demonstrate that solidified products from each waste/cement formulation meets the stability criteria of 10 CFR Part 61 should be included in the Topical Report.

The PCP defines boric acid concentrates as boric acid solutions up to 20 w/o boric acid. Test data presented for boric acid formulas 1, 2 and 3 are inconsistent with this definition.

What is the basis for the 10 ml free liquid acceptance criteria? This value will result in substantially exceeding the 0.5 percent disposal site free liquid requirement for solidified wastes. It should be understood that the free liquid requirement was written to allow for condensation of air within the container. In a PCP the free liquid criteria should be zero.

Answer

The PCP has been changed to specify an acceptable range of 13-20% which is consistent with the data in Table D.2a.

The term "filter sludges" has been redefined in the PCP as "powdered resins". This will prevent other filter aids from being solidified unless the waste forms have been specifically tested and certified.

The range of boric acid solutions of 0-20% by weight is consistent with formula 4. The PCP has been revised such that formulas 1 and 2 are consistent with the test data.

All PCP samples are capped to contain moisture evaporated from the sample. In actual solidifications, a large volume of water may be boiled off the billet then condensed to form "free water" layer of 4-5 inches (approx. 10%) on top of the billet. This water is generally reabsorbed by the billet in the cement hydration process over the next several days. In PCP testing, however, results are required in 24-48 hours and sufficient time has not been provided for the water to reabsorb, hence the relatively large volume of "free water" is allowed in the PCP sample. Data will be provided which shows that free water is reabsorbed.

33. Appendix I, PCP Data Sheets, p. 29 of 43

It appears that the PCP formula is based on a 15 w/o sodium sulfate solution. If a 20 w/o solution was to be solidified, why is the 20 w/o formulation in Table D2a of Appendix D to the topical used as the basis for the PCP recipe.

Answer

The PCP formula B was specified as an intermediate value between 13% and 20% Na_2SO_4. The PCP formulas will be adjusted to reflect an exact average of the formulations presented in Table D.2c.

34. Appendix I, Section 6.0, 1st para., p. 5 of 43

Note that insufficient data has been submitted by Nuclear Technology Corporation (Ref. 4.4 of the topical report) to qualify the oil solidification formulation. This reference is, therefore, inappropriate for assuming that the NTEC product meets the stability requirements in 10 CFR Part 61.

Answer

It is our understanding that Nuclear Technology Corporation (Nutec) has received and is responding to questions from the USNRC regarding their topical report. Nutec has indicated to us that they intend to respond to these questions in order to obtain Commission approval of their topical report. If Nutec does not actively pursue NRC approval of their topical report, LN will discontinue use of their process and delete the instructions for the Nutec process in our PCP.

35. Appendix I, Section 9, pp. 7-23 of 43

What is the basis for using the oven cure times given in the PCP procedure for ensuring the actual wastes will meet the stability requirements of 10 CFR Part 61?

Answer

The PCP samples are placed in the oven to expose the samples to elevated temperatures such as those which occur in the neutralization and cement hydration processes. This accelerates the set of the PCP samples which otherwise would require much longer set times. According to Mindess and Young, curing the samples for 24 hours of 60°C (1440 °C - hours) is equivalent to a 28-day cure for normally cured concrete.*

36. Appendix I, PCP Test Sheets, pp. 26 of 43

Comparing the PCP calculation sheet for the boric acid formulations proposed for qualification on Tables D.1a through D.1.d. of the appendix D to the main report, it is unclear if the PCP addresses the proposed formulations. For example, the lime contents cited in Appendix D cannot be calculated by the formula presented in the data sheets and there is no correlation between the cement, TCB and accelerator weights. What are TCB and the accelerator? What is the difference between the value (c) for lime weight and (k) for lime weight?

* Concrete, S. Mindess, J. F. Young, Prent-Hall, Inc., Chapter 11, p. 312.

Answer

The PCP calculation sheet reflects the data presented in Table D.1.d. of the topical report. The lime weight (c) in the PCP Test Sheet is the starting point for the technician in titrating with lime. The total lime weight (k) resulting from the titration is the value used in the formula calculations. The amount of lime will necessarily vary between waste batches depending upon the concentration of boric acid and other components of the waste.

TCB is the identification used in the PCP for clinotilolite. The weights specified in the PCP and the topical report are the same - 5 grams. By inputting the lime and the boric acid values in Table D.1.d., the Formula C calculations will result in cement weights approximately the same as those in the table.

Example: 10% H_3BO_3

Cement (d) = 130 - 10 - 17.8 = 102.2g

The calculations in the PCP use a slightly different method of calculating the cement weight by equating % H_3BO_3 to the grams of H_3BO_3 in a 100 ml sample. For example, a 100 ml sample of 10% H_3BO_3 contains slightly more than 10 grams of H_3BO_3, but this simplification results in a slight deviation from the cement values actually used in the testing (Table D.1.d.).

The test formulas are presented as Formula C rather than the median values of Formula B, since these are the upper limits of mixability in full-scale liners. Additional data will be obtained to support the Formula A and B values.

37. Appendix I, PCP Data Sheets, p. 29 of 43

It is assumed that TCA on the data sheet represents fly ash, although there is no statement in the PCP which clarifies that. How would the operator know this?

The testing procedure (Section 9.3) allows for additional lime to be added for pH adjustment. If pH adjustment is required, how is it determined that the final recipe is consistent with the formulations proposed for qualification in Table D.2a?

Answer

TCA is the identification for flyash. The operator is instructed during training as to the identification of the various solidification additives. If he forgets the additive identification, he can refer to his training manual or, alternatively, contact his supervisor.

Waste pH will depend upon the chemical composition of the waste, the % of remaining capacity (resins), resin type, etc. The amount of lime used to adjust the pH will vary depending on the specific waste conditions and it is not necessary (nor likely) that the lime content be identical to that used in the waste form testing.

38. Appendix I, PCP Data Sheets, p. 32 of 43

The procedure outlined for Resins Formula I is based on Formula 1 used to solidify mixed bed resins as described in Section VI.C and Appendix D of the report.

Since waste forms prepared using this formula do not satisfy the stability criteria, the inclusion of the testing procedure in the PCP is confusing and not necessary. If Formula 1 is to be used only for Class A mixed bed resin wastes, it should be stated in the PCP. Further, the testing procedure should direct the Project Manager or Solidification Technician to verify the waste class before proceeding.

Answer

As stated in the answer to question #24, the leach test for Bead Resin (formula I) will be repeated. If the resulting leach indices are less than 6, the waste form will be deleted from the topical report and the PCP. In addition, the PCP has been revised to direct the solidification technician to verify and record the waste class before proceeding.

39. Appendix I, PCP Data Sheets, pp. 32 and 35 of 43

How is the resin content in the sample measured? The amount of resin and sludge in a 100 ml sample could vary significantly with the amount of water used for slurrying. If the sample contains an excess of water, how is the sample decanted and what are the decanting criteria?

Answer

Bead and powdered resins are allowed to settle and excess water poured off or otherwise decanted before the sample volume is measured. Bead resins settle immediately but powdered resins require longer settling times of approximately 10 minutes. The water is decanted from the sample down to the top surface of the resin.

40. Appendix I, PCP Data Sheets, p. 32 of 43

It is assumed that TCA is flyash.

It appears that the formulation proposed for qualification in Table D.3a of the Appendix of the main report is more representative of Formula C in the PCP. Why is the qualification recipe the high cement rather than the middle cement formulation? Note also that the PCP adds an accelerator which does not appear to be included in the qualification formulation.

Answer

TCA is the identification for flyash.

The qualification formula in Table D.3a was assigned as the high cement formula in the PCP since it is the near to the limit of mixability. LN will generate additional data to qualify the formulas (A & B) which used less cement. In addition, any accelerators will be tested and certified for use in the solidification formulations.

41. Appendix I, PCP Data Sheets, p. 35 of 43

Note that no qualification data is provided for the filter sludge waste stream.

Answer

The PCP has been revised to define "filter sludge" wastes as powdered resins.

42. Appendix I, PCP Data Sheets, p. 41 of 43

The qualificaton formulations in Table D.3b of Appendix D to the main report cannot be correlated with the PCP data sheets for resin Formula 2. The PCP data sheets should be modified as required.

Answer

The range of cement weights specified in the PCP were selected to be representative of the formulas tested for the various types of resins. LN will expand the test data, however, to cover the 70-90 gram range of cement for each type of resin.

43. Appendix I

Note that activated carbon and powdered resins are being proposed for qualification. However, no PCP information is provided. The PCP should be updated accordingly.

Answer

The PCP will be revised to include instructions for both activated carbon in addition to those provided for powdered resins.