Mendiola, Doris

Subject: FW: Docket ID NRC 2011-0022 Comments from the Electric Power Research Institute (EPRI)
Attachments: EPRI May 2012 BTP Comments.pdf

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~~77 FR 34411~~

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From: Bladey, Cindy
Sent: Friday, October 05, 2012 8:08 PM
To: Mendiola, Doris; Gallagher, Carol
Subject: Fw: Docket ID NRC 2011-0022 Comments from the Electric Power Research Institute (EPRI)

From: Cox, Billy <bcox@epri.com>
To: Bladey, Cindy
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Sent: Fri Oct 05 15:42:44 2012
Subject: Docket ID NRC 2011-0022 Comments from the Electric Power Research Institute (EPRI)

Dear Ms. Bladey:

Attached please find a scanned version of comments from EPRI for Docket ID NRC 2011-0022 on a revision the USNRC Branch Technical Position on Concentration Averaging and Encapsulation.

The original has been sent to your attention for delivery on Monday October 8th.

Kind Regards,
Billy Cox

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Template = ADM-013

E-RIDS = ADM-03
Add = J. Kennedy (JEK1)

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10/5/2012

Cindy Bladey
Chief Rules, Announcements, and Directions Branch
Office of Administration
Mail Stop: TWB-05B01M
US NRC
Washington D.C. 20555-0001

Subject: Docket ID NRC 2011-0022 Revised Branch Technical Position on Concentration Averaging and Encapsulation of Low-Level Radioactive Waste.

Dear Ms. Bladey,

The Electric Power Research Institute (EPRI) is an independent non-profit organization that conducts scientific research and development relating to the generation, delivery and use of electricity for the benefit of the public. Please accept these formal comments from EPRI on a revision to the *Branch Technical Position (BTP) on Concentration Averaging and Encapsulation of Low-Level Radioactive Waste.*

The purpose of this letter is summarize some of the technical conclusions from EPRI low-level waste (LLW) research and to identify areas for improvements in the May 2012 draft revision of the BTP (U.S. Nuclear Regulatory Commission, 2012).

With the May 2012 draft revision of the BTP, the NRC made significant progress in developing guidance to address stakeholder concerns. There remain areas where additional changes will simplify the BTP, balance the risks and benefits of LLW disposal against the potential hazard to an inadvertent intruder following disposal site closure, reduce actual collective radiation dose to workers, minimize the need for on-site waste storage, and minimize the creation of orphaned wastes.

EPRI LLW research has identified areas for improvements that remain in the May 2012 draft revision of the BTP. The current draft BTP introduces what EPRI considers:

- a conservative domestic well drilling scenario that amplifies the importance of homogeneity,
- the exclusion of cartridge filters from "homogeneous wastes,"
- an absence of specificity in an acceptable minimum waste to binder ratio for encapsulation and solidification and,
- an unsubstantiated concern on the long term gamma hazards from discrete pieces of activated metal.
- unbalanced risk factors in the assumed equivalence of Nb-94 in activated metals with Co-60 and Cs-137 in other less stable waste forms in setting averaging constraints.

Discussion

Each of these technical issues arise from the NRC's concerns over inadvertent intrusion into discrete "hot spots" in waste after closure of a disposal site via well drilling. The well drilling concerns focus either on unlikely "hot spots" in waste already pre-defined as homogeneous or from the unearthing of discrete gamma sources. The gamma source concern is in response to historical sealed source accidents that were caused by loss of licensee control of sealed sources and not from intrusion into an LLW disposal site.

A clear distinction exists between the long-term gamma dose hazards presented by a sealed source and the long-term gamma hazard from LLW present in the disposal site as either discrete pieces of activated metal or as cartridge filters. Sealed sources typically contain only one radionuclide (the most common of long-term concern is Cs-137/Ba-137m), whereas activated metal and cartridge filter wastes consist of known mixes of fission and activation products. It is unrealistic to consider that these waste items consist of anything other than the mix of radionuclides (EPRI, 2010). The gamma hazards from these non-sealed source wastes are dominated by short-lived isotopes of cobalt that do not present a long-term gamma risk.

The multiple intruder exposure carry-away scenarios presented in Appendix B of the May 2012 draft revision of the BTP differ somewhat in geometries, exposure times, and assumptions. EPRI has not duplicated the scenarios in their entirety in the waste and source comparison that follows; however, our analysis demonstrates that there is little long-term intrusion hazard from either discrete pieces of activated metal (those <0.01 ft^3) or from stainless steel encased filter cartridges in Class A, B or C waste.

In Section 4.3.2 Table A of the May 2012 draft of the BTP three primary gamma emitters (Co-60, Nb-94 and Cs-137/Ba-137m) are identified with activity values for each of these nuclides by waste class. The values in Table A indicate thresholds where discrete items should be treated separately because they "...are similar to sealed sources." The values in Table A also represent the sealed source limits that can be disposed of in each waste class.

Using the historical LLW radionuclide mix, two models were developed for: a) activated metal, which is almost entirely activated stainless steel (where Nb-93 impurities are greatest and activate to Nb-94); and b) cartridge filters that contain very little Cs-137 in comparison to other gamma emitters because of the soluble nature of cesium. The cartridge filters contain even less Nb-94, which is present almost exclusively in only activated metal.

The first model is of an activated metal cube with a volume of 0.01 ft^3 consisting of a piece of stainless steel (SS) using the fractional mix in historical activated metal waste. This mix is increased in concentration until it is ten times the Class C sum of the fractions (SOF). In this instance the classification is driven by Table 1 radionuclides with the Table 2 nuclides being about eight times the Class C SOF.

The second model is a typical 6" diameter by 30" long cartridge filter (FLT) using the fractional mix in historical filter waste (PWRs and BWRs are evaluated separately). This mix is increased in concentration until it is ten times the Class C sum of the fractions from Table 1 (again the waste class driving table). For this filter model at ten times the Table 1 SOF, the Table 2 SOF for Class C is approximately 0.18 for PWR filters and 0.13 for BWR filters.

In charts 1 and 2 below, the dose rate from these items at 3 cm and 2 m (similar distances as used in the draft BTP Appendix B scenarios) is calculated using the software program MicroShield. These models are decayed to 100, 300 and 500 years and the dose rates are plotted against the decay of a 1 cm diameter by 2 cm long 130 Ci Cs-137 source.

Chart 1

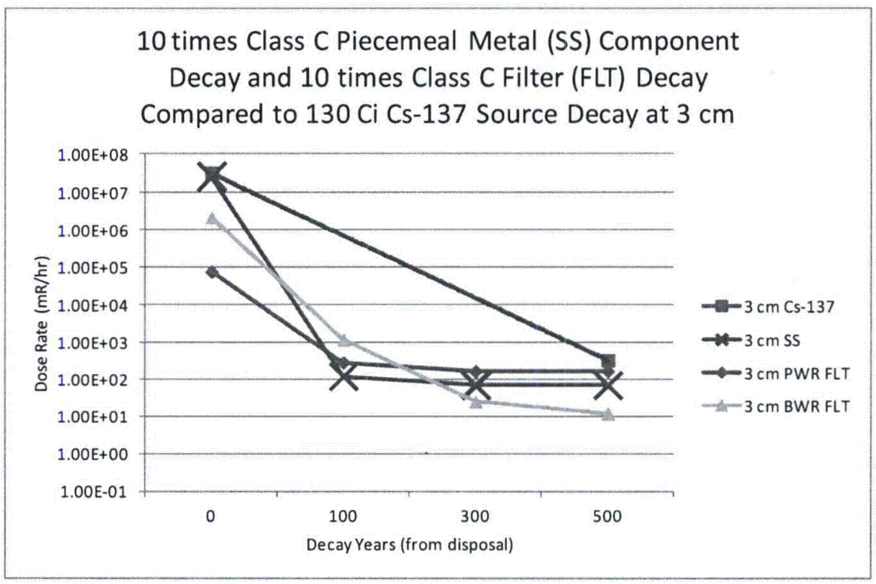

Chart 1 demonstrates that cartridge filters and discrete pieces of activated metal which were ten times Class C when disposed would exhibit 3 cm dose rates lower than a 130 Ci Cs-137 source at 500 years.

Chart 2

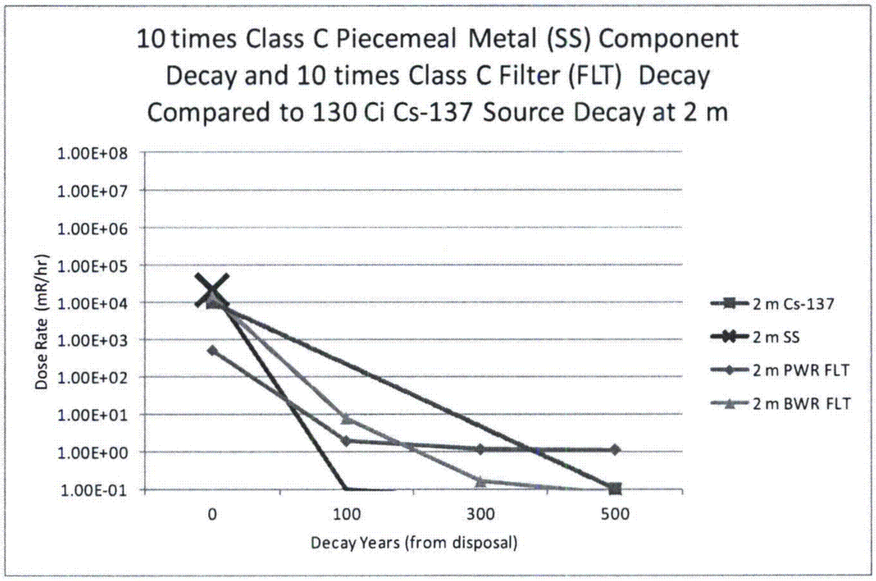

Chart 2 demonstrates that cartridge filters and discrete pieces of activated metal which were ten times Class C limit when disposed would exhibit 2 m dose rates of 1 mR/hr or less at 500 years, which is essentially equivalent to the risk of a 130 Ci Cs-137 source at 500 years given all the other uncertainties in the intrusion scenario.

Together, these examples demonstrate that the nature of the radionuclide mixes in LLW and the blending constraints alone (two and ten times the waste class) limit the gamma hazard from the radionuclide mixes in piecemeal activated metal and cartridge filters and further considerations for gamma hazards is not warranted.

An important observation in the activated metal model is that even at the maximum averaging constraint of ten times Class C, the model contains about 0.5 mCi of Nb-94 which is 50% of the piecemeal consideration from Table A for primary gamma emitters in the May 2012 draft revision of the BTP. Therefore, it would require a 0.01 ft^3 piece of activated stainless steel approximately 20 times Class C limit before it would qualify for piecemeal consideration (>1mCi of Nb-94), further rendering the concept of piecemeal consideration for activated metal moot.

While the models in Charts 1 and 2 were run at ten times the class C limit, the slopes for the dose rate decays would be similar in a Class A SOF model except that the waste decay slopes would appear even steeper because of the greater restriction on Cs-137 in Class A waste. This means that while the actual predicted dose rates would be different, the 100 year dose rate deltas between the Cs-137 source values and the various waste type models are representative for comparison purposes. In 100 years, for example, the multiple order of magnitude dose rate differences between a Cs-137 source and these discrete waste types would exist for Class A waste as well (dose rates approximately 1,000 times lower for discrete waste items as compared to a Cs-137 source).

This analysis demonstrates that discrete pieces of activated metal and cartridge filters do not pose a carry-away intrusion hazard like mono-isotopic sealed sources do and therefore a distinction between waste and sealed sources should be made in the BTP.

To address these issues, the following improvements to the draft BTP could be made:

1. An alternative drilling scenario eliminates the need for further tests of homogeneity in wastes that are already considered (pre-defined) homogeneous. EPRI previously submitted research on common drilling methods and the regulatory environment within which well drilling must be conducted (EPRI, 2012). The research concludes that the drilling method, disposition of drill cuttings and information management (i.e. knowledge of local geology, records of historical land use, records of previous borings) are subject to strict regulatory requirements and technical analysis such that many of the assumptions included in the BTP scenario would either be precluded or have an extremely low probability of occurrence. EPRI's well drilling scenario used methods determined most probable from such an intrusion based on an extensive review of the industry and actual well driller interviews. The EPRI scenario used the same methodology selected by the staff in NUREG-1538 for the most probable drilling method at Yucca Mountain (USNRC, 2001). The data submitted by EPRI could be used to develop probability distributions that would permit a more risk-based, probabilistic assessment rather than the current set of deterministic assumptions.

   The NRC scenario in the May 2012 draft BTP pre-supposes the existence of 'pockets' of higher activity waste in homogeneous waste forms that persist hundreds of years into the future. EPRI disagrees with this assumption as a basis for an intruder scenario. Our research indicates that homogeneity in the package should be the normal expectation for mixable waste and cartridge filters in the context of the disposal environment and any intruder scenario. Physical and chemical diffusion of energy, atoms and chemical concentrations are well documented and the principle is basic to science consistent with the second law of thermodynamics (Callister, 2004) (Perry & Green, 1984).

2. Clarify the meaning of the phrase used to describe homogeneous wastes in part as "...mixed as part of the design of a nuclear power plant." To avoid confusion or misinterpretation during the course of inspection activities or other evaluations of homogeneous waste, use of this phrase in Sections 2, 4.1, 4.2.1, Appendix A and Appendix B should be clarified.

   It is not a given that all nuclear power plants are designed with systems that promote the mixing of various waste streams. It is necessary to accept that plant-specific equipment and design will dictate if ion exchange resins (both powdered and bead), filter media and charcoal are loaded into the same vessel or separate vessels or are collected separately or together into tanks. Furthermore, waste may even have to be placed directly into disposal liners for various reasons including, design, operational efficiency, ALARA or some other necessity or restriction.

   To ensure that decisions made by plant operators to mix the types of waste streams as described in Section 4.2.1 are included in the definition of "...mixed as part of the design of a nuclear power plant"; the wording should be changed to state, "waste shipped from nuclear power plants that is predefined as homogeneous need not be further evaluated for homogeneity." Section 4.2.2 should be annotated as not applicable to nuclear power plant generators and should be clarified as only applicable to blending of wastes by waste processors.

3. Reconsider the blanket treatment of all cartridge filters as discrete items. EPRI's research indicates that it is not necessary to maintain the classification of any cartridge filters as discrete items. The NRC has provided an exception where some filters may be treated as homogenous (Section 4.3.4); however, this Section is not referred to in all prior references to cartridge filters and homogeneous waste within the BTP. Section 4.3.4 also places the burden on each licensee to develop a technical basis that is subject to inspection defining why their cartridge filers are homogenous. EPRI research clearly indicates that cartridge filters in any form do not constitute the same risk or hazard as sealed sources and should not be treated as such for classification and disposal.

   Treating all filters the same is supported by the prior data provided by EPRI and the new dose rate comparisons shown in Charts 1 and 2 of this letter to eliminate cartridge filters from consideration as discrete items in the BTP. EPRI has demonstrated that cartridge filters do not contain any significant quantities of long lived gamma emitters (EPRI, 2012). Inclusion of cartridge filters in the definition of a homogeneous waste type could be worded as follows: "...cartridge filters that can be demonstrated through process knowledge not to contain primary gamma emitters in excess of the values in Table A and..." Similarly, Section 4.3 could then be revised to include only cartridge filters containing primary gamma emitters in excess of the values in Table A.

Alternately, Table C in Section 4.6 should include a paragraph under the column titled "Allowable Classification Mass or Volume" to be consistent with Section 4.3.4.

4. Update Table C. Volumes and Mass Determination of Concentration to include 'Mixable' waste with solidified ion-exchange resins. This would be consistent with the discussion in Section 4.2.1 and avoid confusion or misinterpretation during the course of inspection activities or other evaluations of waste processing.

5. Provide separate guidance for encapsulation of waste and encapsulation of sealed sources in Section 4.5. Separate guidance for waste and sources is warranted because the waste items of concern (discrete activated metal items and cartridge filters) do not pose the long-term gamma risk that sealed sources do.

   Encapsulation of waste and encapsulation of sealed sources have different design functions. Sealed sources are encapsulated primarily for gamma dose concerns and for intruder isolation (sealed sources are typically of a special form design and not readily dispersible). A secondary function of sealed source encapsulation is concentration averaging to facilitate disposal and reduce the risk of source accidents from orphaned sources.

   Waste is encapsulated primarily to mitigate dispersion and because of this additional safety feature, the NRC allowed for averaging over the volume of the encapsulation matrix instead of just the volume of the un-encapsulated waste. A secondary role of the encapsulation matrix may be to provide stability.

   Section 4.5 should be revised to reflect this difference by inserting a sub-Section 4.5.1 for source encapsulation after the second sentence in section 4.5 and deleting the fourth bullet. Then add a sub-Section 4.5.2 as follows:

   4.5.2. Encapsulation of Contaminated Materials and Cartridge Filters

   Concentration averaging of cartridge filters and objects over the mass and volume of the encapsulation agent is permitted so long as the waste to binder ratio exceeds 14% and the binder meets the NRC stability criteria cited in the BTP on Waste Form.

   - *The factor of 2 and 10 constraints for mixtures still apply, but the mass and volume of the encapsulation binder and the waste may be credited in determination of the waste classification.*
   - *If an unstable binder is used or the waste to binder ratio is less than or equal to 14%, the mass and volume of the binder cannot be credited in determination of the waste classification.*

The use of a waste loading to binder ratio is not intended to be used as a method to avoid other averaging constraints. It is expected that encapsulated waste (i.e. not sealed sources) would still be subject to the averaging constraints discussed in Section 4.3.2 for gamma emitters and 4.3.3 for non-gamma emitters.

A minimum acceptable (>14%) waste loading to binder ratio should be specified for encapsulation of waste that is independent of the container size. The >14% waste to binder ratio value is based on the 55 gallon drum example in Appendix C of the existing BTP on Concentration Averaging and Encapsulation. This waste to binder ratio for container sizes larger than a 55 gallon drum has already been approved via the last NRC Topical Report on Waste Form (DT-VERI-11NP/P-A, Rev 1, Addendum 1) issued in 1999. The basis of this topical report and the 55 gallon drum example from Appendix C of the existing BTP should not be considered exceptions. Rather the >14% waste to binder ratio used in these examples was not considered an extreme dilution measure by the NRC and should generically apply to any other stable waste binder. Two other binders have been approved as stable since 1999 by the Council of Radiation Control Program Directors E-5 Committee after testing to the NRC Stability criteria by DOE-Idaho. These binders and any future waste binders that can be tested and approved to meet the NRC Stability criteria should allow concentration averaging through generic >14% waste to binder ratio guidance.

It is likely that endorsement of a generic waste to binder ratio will prompt a question if this could be extended to large components such as reactor vessels. While EPRI research indicates that intact disposal of reactor vessels with all internal components averaged results in significantly less occupational radiation risk and less public radiation risk, a more immediate need is facilitating the disposal of operational waste. Since the disposal of waste is preferable to storage, a reasonable container size limitation could be placed on the application of a >14% generic waste to binder ratio. A reasonable maximum container size to consider is 331 ft^3 for this application, as this includes the current maximum sized commercially available disposal liner that could be used for this purpose and for which a shielded shipping cask (DOT 7A Type A, IP-1, and IP-2) exists.

6. The BTP could be significantly simplified if the piecemeal evaluation for items <0.01 ft^3 was removed from the flow charts and text. EPRI has shown that the concern for discrete items in carry-away scenarios is limited to the only long-term gamma hazard remaining at 100 and 500 years, which are sealed sources with values given in Table A of the May

2012 draft of the BTP. Given the historical radionuclide mix of activated metal, the concentration averaging constraints alone (factors of 2 and 10) limit the only long lived gamma emitter (Nb-94) in activated metal to a value far less than the Nb-94 value given in Table A of the May 2012 draft of the BTP. The current piecemeal restriction may result in activated hardware segmentation campaigns to purposely avoid the creation of discrete sizes because of the additional survey requirements and as a result contributes additional dose to workers and adversely impact packaging efficiency.

The limits set in 10 CFR §61.55 Table 1 apply to long-term exposures rather than acute exposures that might be attributed to sources and other discrete items. It would be more appropriate in this case to allow averaging of Nb-94, on the basis of a factor of 10, to be consistent with other long-term exposures. Based on the discrete item scenario, an item excavated at any time after closure would be less than 1 mrem/yr at Class A limits. In the short-term scenarios where Co-60 and Cs-137 are considered present, Nb-94 may be present at its Class C limit and not generally regarded as contributing significantly to the scenario. A bounding calculation assuming a discrete item with Nb-94 at a factor of 10 above the Class C limit confirms that exposures estimated at ~70 mrem/yr are consistent with the general objective to protect the intruder without restrictive averaging.

The results of EPRI research related to this topic have been published in several publicly available technical reports:

- *An Evaluation of Alternative Classification Methods for Routine Low Level Waste from the Nuclear Power Industry.* EPRI, Palo Alto, CA; 2007, 1016120
- *Proposed Modifications to the NRC Branch Technical Position on Concentration Averaging and Encapsulation (BTP): Technical Bases and Consequence Analysis.* EPRI, Palo Alto, CA; 2008, 1016761
- *Options for Improved Low Level Waste Disposal Using 10 CFR 61.58.* EPRI, Palo Alto, CA; 2010. 1021098.
- *Additional Research Supporting Changes to the Branch Technical Position on Concentration Averaging and Waste Form Summary of EPRI Input to the Process.* EPRI, Palo Alto, CA; 2012. 1025302.

EPRI appreciates the inclusion of comments and Staff's response in appendices to the BTP. These responses provide important insight to Staff's thinking and reasoning that helps to explain and clarify the language and intent of the BTP.

Thank you for consideration of this letter in the BTP Revision expected to be published in early 2013.

Best Regards,
Lisa Edwards

LMEdwards

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Works Cited

Callister, W. D. (2004). Fundamentals of Materials Science and Engineering. Wiley.
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