



## Sandy Joosten

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**From:** Gayle Brown [Gayle.Brown@Studsvik.com]  
**Sent:** Thursday, June 10, 2010 4:03 PM  
**To:** CHAIRMAN Resource  
**Subject:** Letter - Policy Issue Vote Paper and memo  
**Attachments:** Letter\_Policy Issue Vote Paper.pdf; Commission Cover Letter 6.10.2010.pdf; Memo-IER Segregation-Classification.pdf

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June 10, 2010

Rochelle Bavol  
Sandy Joosten  
Office of the Secretary  
Nuclear Regulatory Commission  
Mail Stop O-16G4  
Washington, DC 20555-0001

Re: Submission of Material for Commission Meeting on June 17, 2010:  
Issues with Blending of Different Types of Ion Exchange Resin

Dear Ms. Bavol and Joosten:

Studsvik hereby submits the enclosed written material for review by the Commission in advance of the June 17<sup>th</sup> public Commission meeting on blending of low level radioactive waste.

Thank you for the opportunity to provide this material. Feel free to contact me at 312-343-7808 or at [joseph.dicamillo@studsvik.com](mailto:joseph.dicamillo@studsvik.com) should the Commission have any questions or should it require any additional information.

Sincerely,



Joseph DiCamillo  
General Counsel

JGD:geb

Enclosure

cc: Via Electronic Mail  
Commissioner Kristine L. Svinicki  
Commissioner George Apostolakis  
Commissioner William D. Magwood, IV  
Commissioner William C. Ostendorff  
Chairman Jaczko

# Studsvik

Via Electronic Mail

June 10, 2010

Honorable Gregory B. Jaczko  
Chairman  
Nuclear Regulatory Commission  
Mail Stop O-16G4  
Washington, DC 20555-0001

Re: Comments to Policy Issue Vote Paper on Blending of Low Level Radioactive Waste and Accompanying Analysis Issued April 7, 2010 (SECY 10-0043)

Dear Mr. Chairman:

Studsvik, Inc. ("Studsvik") submits the following comments on the Policy Issue Vote Paper on Blending of Low Level Radioactive Waste ("Vote Paper") and the Accompanying Analysis issued by Commission staff on April 7, 2010. These comments are for the Commission to consider as it reviews the staff's recommendations.

Studsvik recommends to the Commission that it not adopt Option 2 which allows large scale blending of low level radioactive waste ("LLRW"). As discussed below, there are significant drawbacks to that option: the Class B/C LLRW that would be downblended with Class A LLRW is *not homogenous*; large scale blending would *reduce safety and environmental safeguards*, and significant volumes of *Class B/C LLRW would continue to be stranded*. When these facts are taken into consideration the proposal does not meet the Commission's standards for a risk-informed, performance-based approach to environmental and safety regulations for radioactive waste.

## Homogeneity

The different types of waste that are being considered for large scale blending – Class A LLRW and Classes B/C LLRW – are **not** homogeneous. According to NRC's guidance (Savannah River Site High Level Waste Tank Closure: Classification of Residual Waste as Incidental, 1999, p. 20), homogeneous wastes are defined as:

"A homogeneous waste type is one in which the radionuclide concentrations are likely to approach uniformity in the context of the intruder scenarios used to establish the values included in Tables 1 and 2 of 10 CFR 61.55."

A separate technical analysis sent by Studsvik to the Commission today examines attempts to blend different types of ion exchange resins and concludes:

"Blending is not an appropriate technique for the disposal of ion exchange resins that have widely different activity levels and different particle sizes or densities, as the heavier bead resins with one level of activity will mostly settle to the bottom of the disposal container while the lighter bead resins or much smaller powdered resins will mostly accumulate near the top of the disposal container producing a final dewatered disposal container that is highly segregated by resin type, density, particle size and/or by relative activity."

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(Studsvik Memo, "Issues with Blending of Different Types of Ion Exchange Resin," June 10, 2010, p. 9)

That analysis also determines that it may not be possible to achieve radiological homogeneity in blended waste.

Given the results of this analysis, Option 2 would allow large scale blending of non-homogeneous forms of waste – ions that can be differentiated in nature.

Homogeneity is a key component of and will affect the intruder site assessment to be addressed in the rulemaking on unique waste streams. As noted above, there are questions about the technical feasibility of blending to create homogenous wastes that the Commission should carefully examine. Therefore, regardless of which option the Commission selects, any issues relating to homogeneity should be addressed only in a regulation, not in guidance as recommended in the Vote Paper.

## Reduction of Intruder Safety and Environmental Safeguards

Large scale blending will result in lowering the environmental and safety requirements for the disposal of Class B/C LLRW and will erode the public's confidence in the safety of LLRW disposal. WCS submitted a study to the Commission showing that large scale blending results in waste that is 450 times higher than the NRC standard for A level waste 100 years after disposal (WCS January 29 letter). The Vote Paper also acknowledges that blended waste poses an unresolved safety question with respect to the inadvertent intruder. Specifically, the Accompanying Analysis to the Vote Paper determined that:

"The specific concern with proposals for large-scale blending is that significant fractions of waste in one area in a disposal facility, corresponding to a large shipment of blended waste, could have radionuclides at or just below the Class A disposal limits. This configuration would pose a greater risk to an inadvertent intruder than smaller batches of waste with the same radionuclide concentrations because the intruder would be more likely to exhume a significant volume of waste near the Class A limit unmixed with lower concentration waste."

(Section 3.2.2)

In response to safety concerns, the owner of the Clive, Utah disposal site has asserted to the Commission that blended waste will be disposed of with more safeguards than are required for Class A waste. This belies the fact that the industry recognizes that blended waste is more hazardous than Class A waste. In addition, without a regulation requiring explicit safeguards, there is no guarantee that these extra disposal measures promised by the Clive facility operator will be maintained in the future. The public expects the Commission as the responsible regulator to promulgate enforceable regulatory safeguards and not to rely upon merely voluntary practices to protect public safety and the environment.

The Vote Paper recommends that a "risk-informed, performance-based" approach justifies reducing the current regulatory safeguards. However, this kind of approach risks reinforcing the public perception that environmental and safety requirements for disposal are being compromised or circumvented through a practice that undermines the current classification system.

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## Stranded Waste

The Vote Paper and Accompanying Analysis give inadequate attention to the problem of stranded waste. According to the Electric Power Research Institute ("EPRI"), at least 5,000 cubic feet of Class B/C resin cannot be addressed by large scale blending, at least in part because there is an insufficient amount of Class A resin to successfully blend all Class B/C resin into Class A. The Vote Paper merely reports EPRI's findings without analyzing the true extent of the stranded waste, or the consequences stranded waste will have for the long-term stability of LLRW disposal options.

As a starting matter, EPRI's analysis does not account for non-resin Class B/C waste. Large scale blending does not address various other types of Class B/C LLRW such as irradiated hardware, sealed sources, filters, medical and scientific research waste. These wastes, by their nature, simply cannot be "blended" together with Class A waste. As such, unless a Class B/C disposal site opens to the 36 states left without a disposal path since the Barnwell site closed to them, 5,000 cubic feet of resin waste and all the non-resin Class B/C LLRW describe above will be stranded.

Medical research and treatment would bear a disproportionate share of the negative impact because Class B/C medical waste would continue to be stranded. Increasing storage costs for these wastes would only multiply the difficulties for medical researchers.

The Commission must carefully examine the possible consequences large scale blending will have for stranded waste and the long-term stability of LLRW disposal options before it makes any changes to its policy on blending.

## Alternatives to Staff Recommendation

For all the reasons stated above, Studsvik recommends that the NRC adopt Option 4 in the Vote Paper and modify 10 CFR Part 61 to prohibit large scale blending by waste processors because it is tantamount to intentional mixing to lower the waste classification. Further we recommend that 10CFR Part 20, Appendix G be modified to explicitly codify the long-standing industry practice – that waste be classified at the time it is prepared for shipment from a generator's facility, i.e., before being sent to an intermediate processor prior to disposal:

This approach also reflects the position that the nuclear waste regulatory authority in Utah, the only state with a disposal site that can accept blended waste, has taken on blending. The Utah Radiation Control Board recently passed a Position Statement on Down-Blending Radioactive Waste and a Policy Maintaining Waste Classification System Integrity that express the Board's opposition to waste blending when the intent is to alter the waste classification for the purposes of disposal site access and call for maintenance of the current radioactive waste classification system.

As outlined above, there are clear safety benefits for choosing Option 4. When coupled with volume reduction by processors, Option 4 would decrease LLRW volumes. As the Vote Paper recognizes, this option addresses stakeholder concerns that environmental and safety requirements for disposal are not being compromised or circumvented through a practice that undermines the current classification system. Under Option 4 generators would continue to have flexibility under the Branch Technical Position on Concentration Averaging and Encapsulation ("BTP") to mix waste when, for example, it results in operational efficiency or reduced worker exposure.

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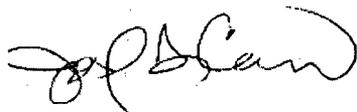
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Should the Commission choose to adopt the staff's recommended Option 2 in the Vote Paper, the Commission should use formal rule-making processes, including notice and comment, to make any changes in policy which would allow large scale blending. In addition, the Commission should direct that the environmental impacts of the proposed new regulation be fully assessed under the National Environmental Policy Act. Specifically, criteria for homogeneity and sampling should be implemented through rulemaking. Implementation of these criteria through guidance as recommended under Option 2 risks engendering the same uncertainty and varying interpretations among industry that exists now with blending. Homogeneity is a key component of and will affect the intruder site assessment to be addressed in the rulemaking on unique waste streams, making it vital that its requirements and standards be set by rule.

Regardless of which option the Commission selects, it should state publicly that no large scale blending will be allowed under current NRC guidance while the Commission formally adopts new regulations and/or guidance setting forth the standards under which blending would be permitted.

This public clarification is necessary to remove confusion that arises from several statements in the Accompanying Analysis to the Vote Paper. The Analysis states that until the Commission's decision is fully implemented the staff would be authorized to respond to individual stakeholder requests to allow large scale blending using current guidance in the BTP. When coupled with a series of letters sent last year from the NRC staff to various stakeholders which have been interpreted by some in the industry to allow large scale blending under the BTP, these statements in the Analysis effectively could establish large scale blending as accepted industry practice prior to implementation of the Commission's decision.

Sincerely,



Joseph DiCamillo  
General Counsel

cc: Via Electronic Mail  
Commissioner Kristine L. Svinicki  
Commissioner George Apostolakis  
Commissioner William D. Magwood, IV  
Commissioner William C. Ostendorff  
Rochelle Baval  
Sandy Joosten

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# Studsvik

June 10, 2010

## MEMORANDUM

**FROM:** Brad Mason, Chief Engineer, and Corey Myers, Engineer I

**TO:** Joseph DiCamillo, General Counsel

**RE: ISSUES WITH BLENDING OF DIFFERENT TYPES OF ION EXCHANGE RESIN**

### INTRODUCTION

This document summarizes the results of testing that demonstrates that it is not technically feasible to blend certain types of ion exchange resins due to substantial particle size and density differences that result in rapid segregation of resin types in the disposal container.

Ion exchange resins are used in the cleaning of water in nuclear power plants. Depleted resins are produced in a wide variety of forms that vary in size, shape, density, and chemical composition. These variations significantly impact the settling time and resultant segregation of different resin types when otherwise well-mixed resins are transferred to the disposal container for final dewatering. When well-mixed resins are transferred into a large disposal container, the filling and dewatering operations occur over at least several hours to as much as several days to fully fill and dewater a large disposal container with resins. Table 1 in the Addenda provides a few examples of the different types of ion exchange resin and their general characteristics. Partially or fully depleted resins will have further density and particle size differences from the resin data provided in Table 1.

### BLENDING, RESIN MIXING, AND SEGREGATION

Blending of resins is based upon the mathematical averaging of small amounts of high activity Class B and/or C wastes with a large amount of lower activity Class A waste in such a way that the overall waste class of the combined mixture is still considered Class A. In order for blending to be viable, a relatively homogenous mix of high activity and low activity waste must be achieved. Otherwise, blending is nothing more than placing high activity waste next to low activity waste and calling both wastes low activity.

For resins, blending requires that two or more batches of resin be thoroughly mixed in an appropriate vessel and the resultant well-mixed resins be transferred to a disposal container for dewatering and ultimate shipment to a licensed disposal facility. It is not possible to mix the resins in the disposal container due to the presence of large banks, sheets and/or racks of dewatering filtration media that make it impossible to mix resins in the disposal container.

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As is seen in nuclear power plants, the mixing and movement of resins requires copious amounts of water. However, testing has shown that as the water content of a resin slurry increases, the segregation of different resin types becomes faster and more distinct, see Addenda - Table 2, resin settling test data. As shown in Table 2, in all cases, the initially well-mixed resins segregate much more quickly than the 'mixture' can ever be dewatered, with substantial to complete segregation occurring in less than one minute. Consequently, the final product in the high activity waste can separate from the low activity waste producing a non-homogeneous final waste in the disposal container.

Resins segregate in a process called segregation or 'classification' based primarily on two factors: 1) particle size and 2) particle density. Classification is well-documented phenomenon, as described by the Department of Energy Handbook on Water Treatment Processes [1]:

*'Because of the different densities of anion and cation resins...lighter anion resin would gradually rise to the top by a process called classification, resulting in a layer of anion resin on top of the cation resin'*

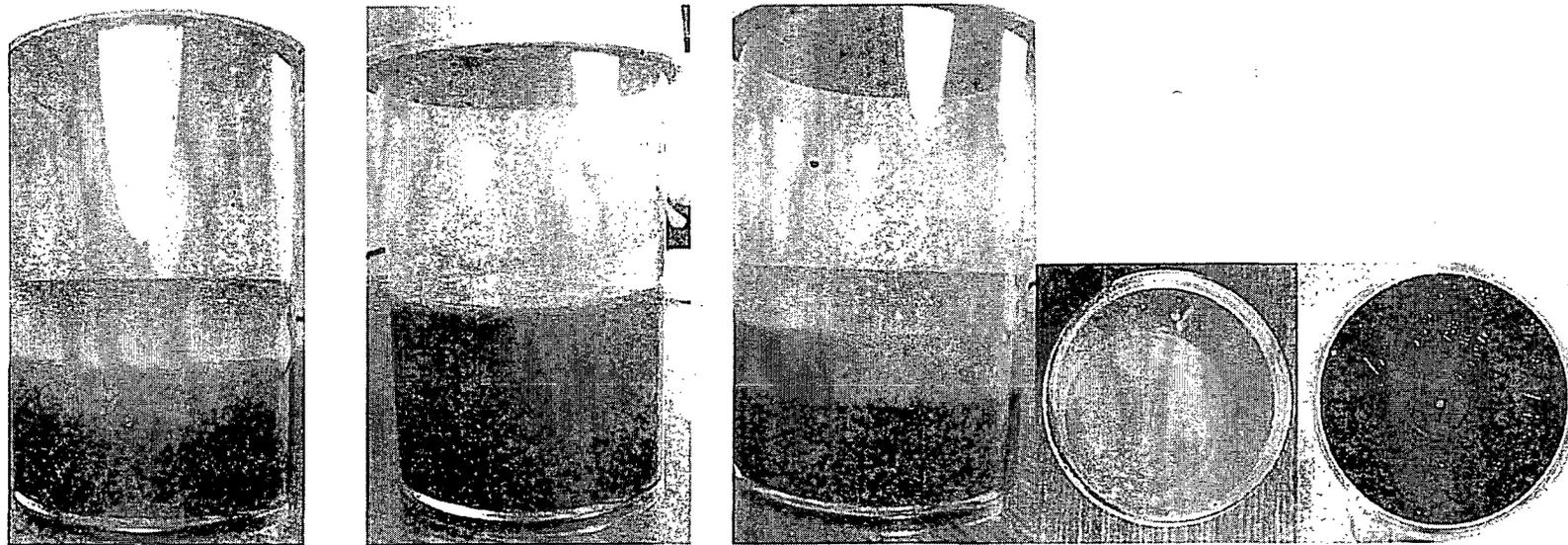
The denser, larger cation resin beads settle quickly to the bottom of a container, while smaller and lighter bead resins, such as anion resins, are carried upward by rising water turbulence and eventually settle on top of the denser, larger cation beads. In the event that powdered resins are mixed with bead resins, the segregation phenomenon is significantly aggravated as the very fine powdered resins can remain fluidized until the last of the initially well-mixed powdered-bead resin mixture is added to the disposal container. This results in the bead resins being largely settled in the bottom of the disposal container while the powdered resins are still fluidized or only partially settling at best. While it is obvious that a homogeneous physical mixture cannot be achieved, the same concepts apply to radioactivity. The theoretical possibility of achieving homogeneity of radioactivity exists; the physical and technological challenges of achieving radiological homogeneity make such a goal virtually impossible to meet.

Six sets of photos are provided below that show the classification/segregation of different resin mixes at various water concentrations. Table 2 provides a discussion of the parameters for each test run with information on the resin mix ratios and the water content of the initially well-mixed resin/water slurries. In the photographs the settled resins segregate rapidly, in less than one minute, as recorded in Table 2.

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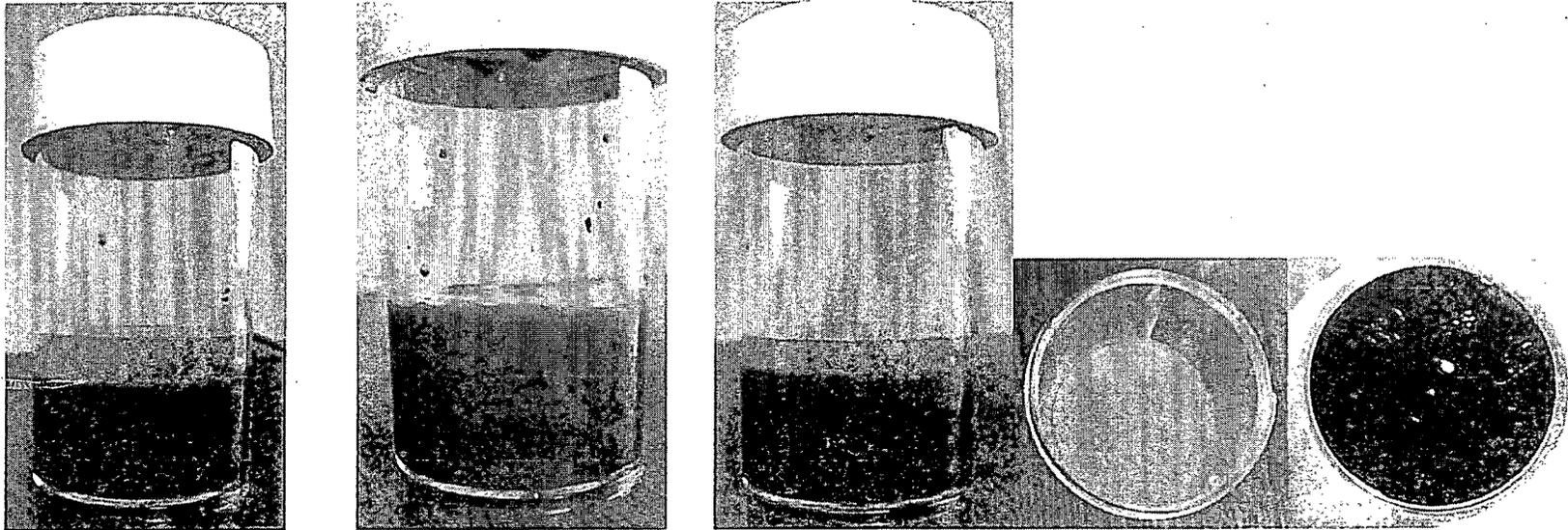
### TEST NO. 6: 86% BEAD RESIN, 14% POWDERED RESIN, 2:1 RESIN TO WATER RATIO

The bead resin used in this test comprises mixed resins with part anion (clear) and part cation (black). The powdered resin is tan or beige in color. As is evident in the first photo, the anion/cation beads will segregate with the lighter anion beads settling on top of the cation beads and the much smaller powdered resins mostly separated and settled on top of the clear anion resins. The lighter clear anion resins appear to have the same color as the powdered resins that have settled on top of the anion resins. There is some minor mixing of the powdered resins into the bottom cation layer and the middle anion layer. The second picture was taken immediately following the vigorous mixing and pouring of the combined resins from another container into the container shown in the second and subsequent photos. At this very early stage, second photo, resin classification is already occurring. In less than 15 seconds, the resin has re-segregated as shown in photos 3, 4 and 5, with cation beads on the bottom, anion beads in the middle, and powdered resin on top. Examination from above and below shows no beads are at the top of the 'mixture', and no powder is at the bottom; therefore, this cannot be called a homogeneous mixture, but shows strong segregation of each resin type.



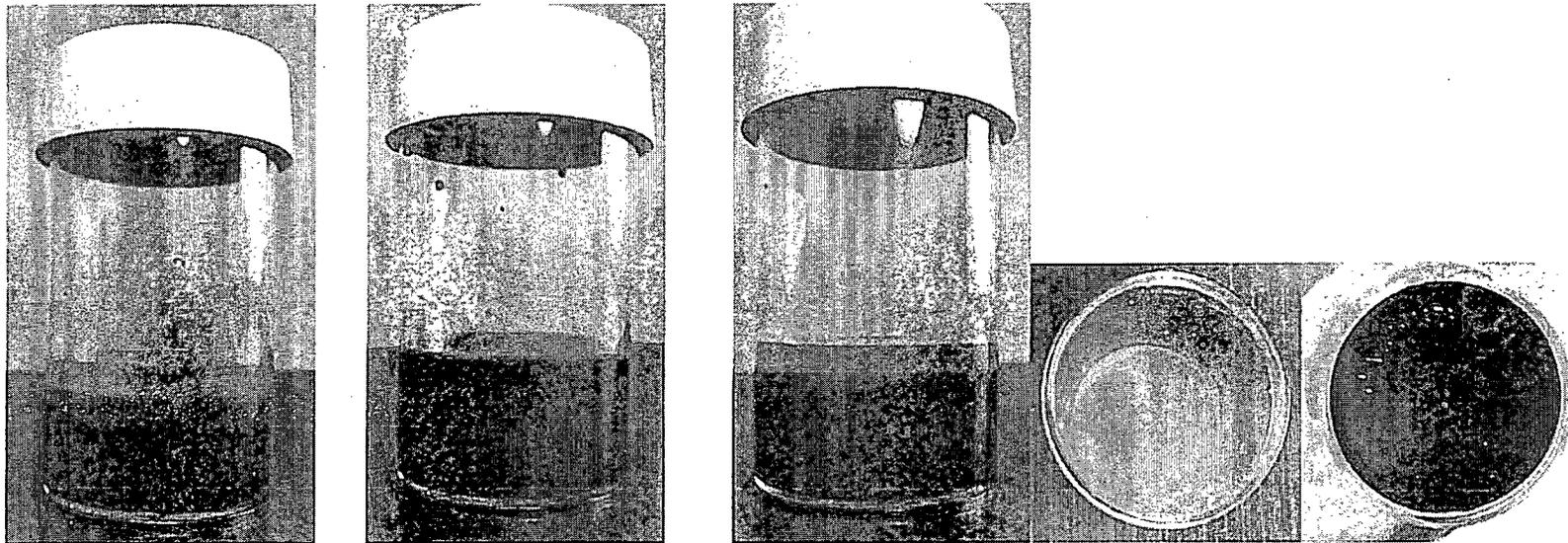
**TEST NO. 3: 86% BEAD RESIN, 14% POWDERED RESIN, 3:1 RESIN TO WATER RATIO**

The same resins used in Test No. 6 were used in Test No. 3, but less water was used for Test No. 3. Classification again occurred in less than 15 seconds and significant segregation of the resins occurred. Again, this cannot be called a homogeneous mixture, but shows strong segregation of each resin type.



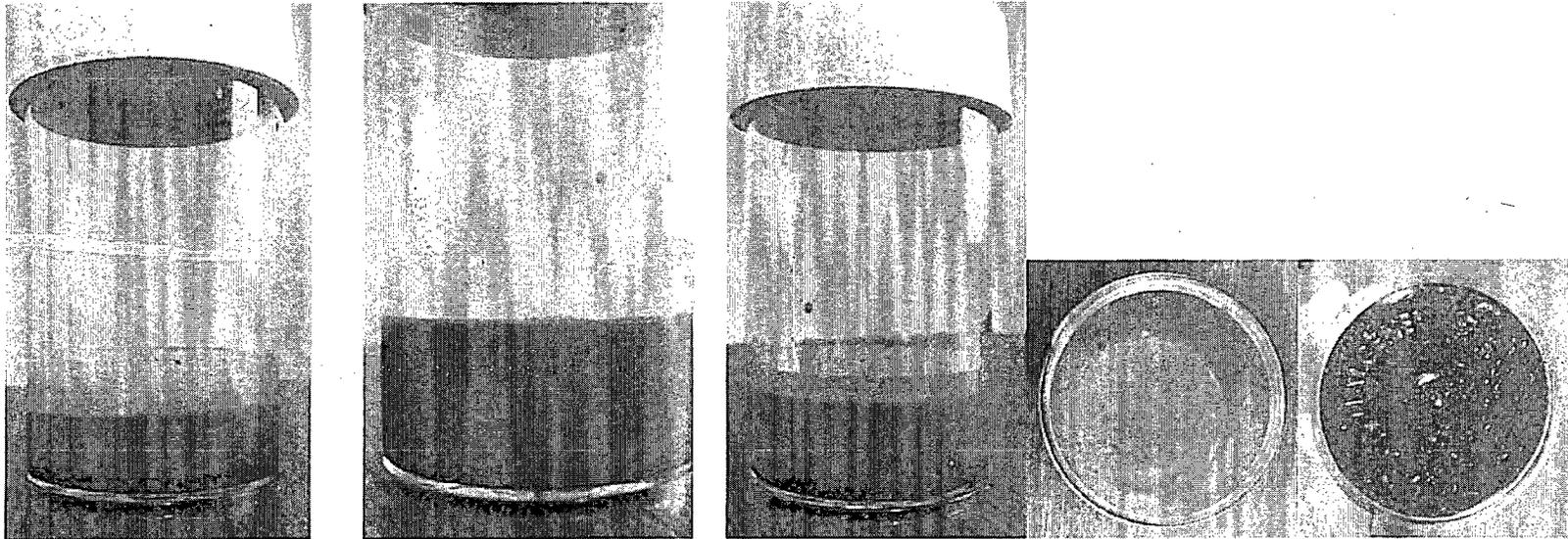
### TEST NO. 1: 86% BEAD RESIN, 14% POWDERED RESIN, 4.5:1 RESIN TO WATER RATIO

The same resins used in Test No. 3 were used in Test No. 1, but less water was used for Test No. 1. The first photo illustrates the very small amount of excess water used in this test. Again, picture 2 represents the slurry immediately after mixing. The third picture was taken approximately 1 minute after mixing was stopped. It shows that the anion and cation beads are not substantially segregated. However, the powdered resins have largely segregated to the top of the bead mixture. Since the powdered resin is only 14% of the total resin volume it shows that most of the powdered resins have fully segregated from the bead resins. Examination of above and below shows the top is entirely powdered resin and the bottom has only cation beads with some anion beads. Classification occurred in approximately 30 seconds. Again, this does not represent a homogenous mixture, as the powdered resins show strong segregation from the bead resins.



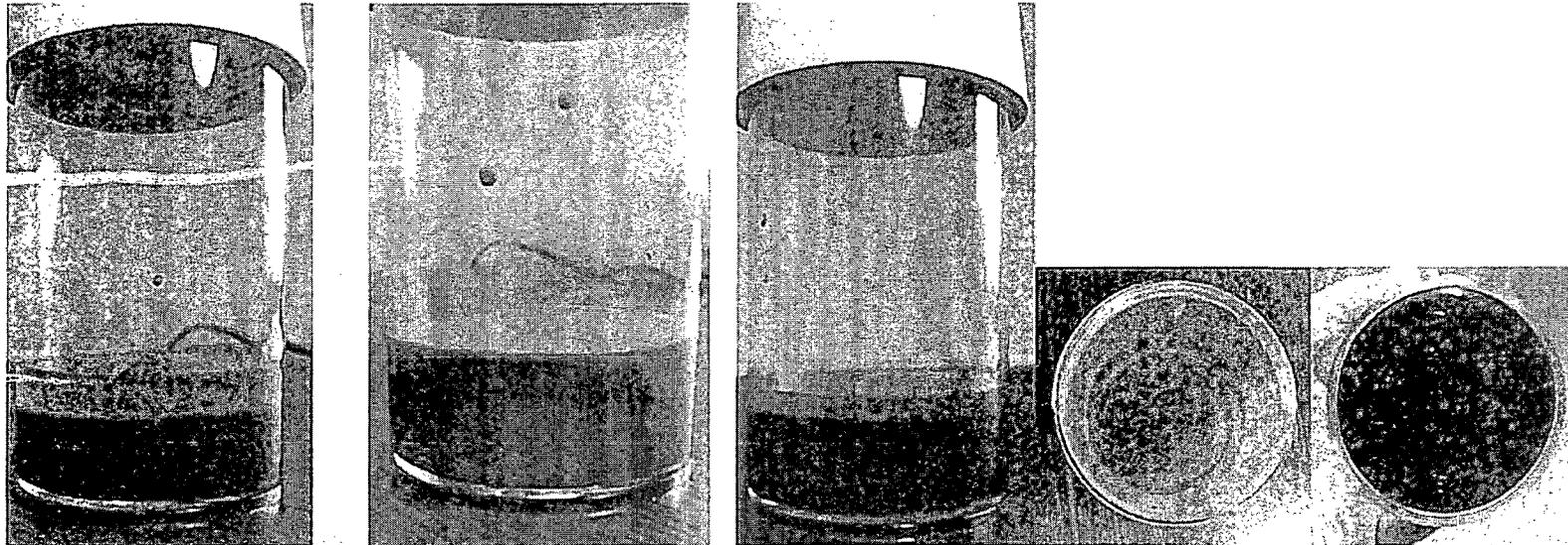
**TEST NO. 12: 14% BEAD RESIN, 86% POWDERED RESIN, 2:1 RESIN TO WATER RATIO**

The bead resin used in this test comprises mixed resins with part anion (clear) and part cation (black). The powdered resin is tan or beige in color. Due to the small volume of the mixed bead resins, the composition of the bead portions of the resin mix appears to be relatively homogenous. However, the bead resins are clearly segregated from the much smaller sized powdered resins that form a separate layer on top of the bead resins. The second picture was taken immediately following the vigorous mixing and pouring of resins from another container into the pictured container. At this very early stage, resin classification is already occurring with the much larger bead resins rapidly settling to the bottom of the container. In less than 15 seconds, the resin has re-segregated, with beads on the bottom and powdered resin on top. Examination from above and below shows no beads are at the top of the 'mixture', and no powder is at the bottom; therefore, this cannot be called a homogeneous mixture, but shows strong segregation of each resin by size.



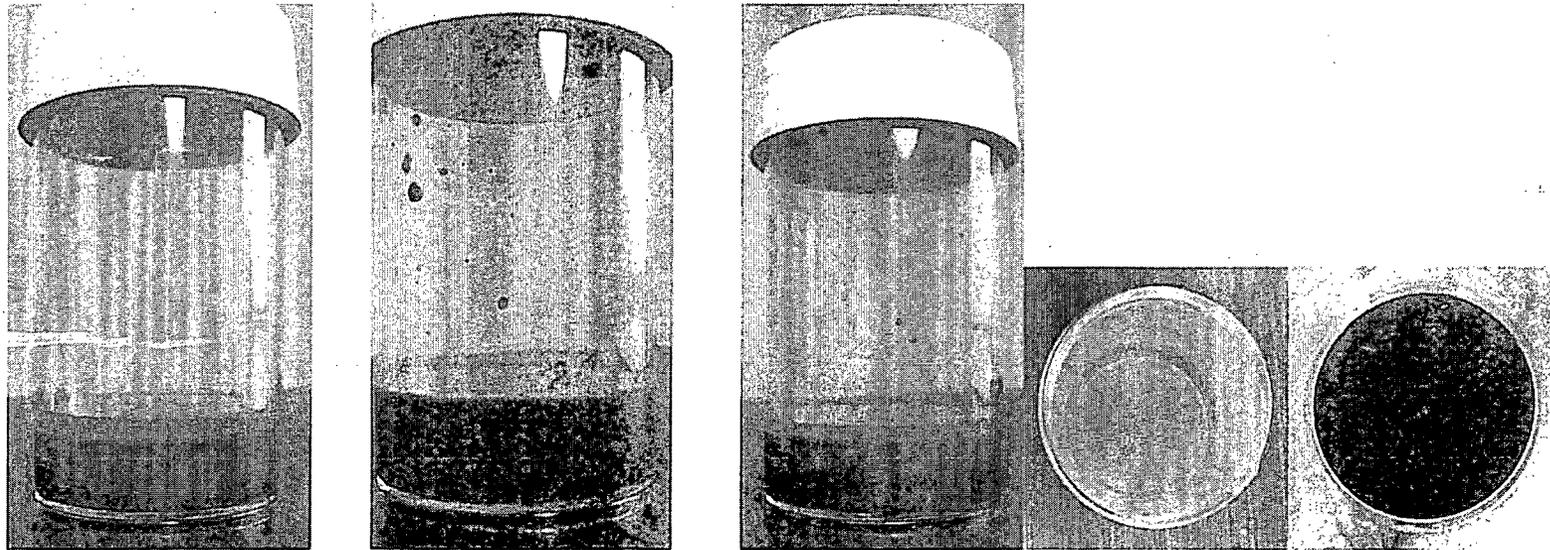
**TEST NO. 9: 14% BEAD RESIN, 86% POWDERED RESIN, 3:1 RESIN TO WATER RATIO**

The same resins used in Test No. 12 were used in Test No. 9, but less water was used for Test No. 9. Classification of the bead resins from the powdered resins occurred in approximately 30 seconds. The third picture shows a solid layer of bead resins on the bottom, a secondary layer of low bead resin concentration in the middle, and an entirely powdered resin layer on top. This cannot be called a homogeneous mixture, but shows strong segregation of each resin by size.



### TEST NO. 7: 14% BEAD RESIN, 86% POWDERED RESIN, 4.5:1 RESIN TO WATER RATIO

The same resins used in Test No. 9 were used in Test No. 7, but less water was used for Test No. 7. The first photo demonstrates the very small amount of excess water used in this test. Picture 2 represents the slurry immediately after mixing. The third picture was taken approximately 1 minute after mixing. It shows a completely segregated layer of powdered resins on top of a variable layer of bead and powdered resins in a non-uniform mixture. However, the side view misrepresents the location of most of the bead resins. This occurs because the walls of the container increase the drag force on the bead resin, slowing their descent. This becomes evident when the beaker is examined from below. The bottom of the beaker shows uniform bead content of a higher concentration than is seen from the side of the container. Examination from above confirms the top layer is entirely powdered resin. Classification occurred in less than one minute. Again, this does not represent a homogeneous mixture, but shows strong segregation of each resin by size.



## **VIDEO**

A video recording of the testing was taken to demonstrate the classification of resins in real time.

Video available upon request.

## **SUMMARY**

Blending is not an appropriate technique for the disposal of ion exchange resins that have widely different activity levels and different particle sizes or densities, as the heavier bead resins with one level of activity will mostly settle to the bottom of the disposal container, while the lighter bead resins or much smaller powdered resins will mostly accumulate near the top of the disposal container, producing a final dewatered disposal container that is highly segregated by resin type, density, particle size and/or by relative activity.

If resin blending is to be authorized, only resins of similar particle size and density should be mixed together to prevent substantial segregation in the disposal container, as it is not technically feasible to provide mixing in the disposal container where there are numerous banks or racks of dewatering filter media. Of special concern is that powdered resins of one Class should not be mixed with bead resins of a different Class, or large variations in activity will certainly result as demonstrated by the testing document in this paper.

## ADDENDA

TABLE 1: EXAMPLES OF UNSPENT RESIN CHARACTERISTICS

Brand - Model	Size (microns)	Shape	Bulk Density	Moisture Retention	Type
Purolite – NRW 5010	650 – 950	Spherical Beads	36.9 lb/ft <sup>3</sup>	80-90%	Strong Base Anion
Rohm Haas – IRN99	300 – 850	Spherical Beads	52.4 lb/ft <sup>3</sup>	37-43%	Strong Acid Cation
DOW – DOWEX SBR-C	350 – 1200	Bead	42 lb/ft <sup>3</sup>	43-48%	Strong Base Anion
Graver – POWDEX PAO	<200	Powder	44 lb/ft <sup>3</sup>	50-60%	Strong Base Anion
Graver – POWDEX PCN	<200	Powder	45 lb/ft <sup>3</sup>	40-60%	Strong Acid Cation

TABLE 2: RESULTS OF BLENDING OF POWDERED RESINS WITH ANION AND CATION BEAD RESINS – SEGREGATION

Test No.	Bead : Powder	Resin : Water	Degree of Classification / Segregation	Settling Time (sec)
1	6 : 1	4.5 : 1	Powder/Bead Classification Present	27
2	6 : 1	3.6 : 1	Complete Powder/Bead Classification	24
3	6 : 1	3.0 : 1	Anion/Cation Bead Classification	13
4	6 : 1	2.6 : 1	Rapid Classification	9
5	6 : 1	2.25 : 1	Immediate Classification	7
6	6 : 1	2.0 : 1	Tightly Packed Classification	7
7	1 : 6	4.5 : 1	Concentration Gradient with all Powder on top	41
8	1 : 6	3.6 : 1	Powder/Bead Classification Present	33
9	1 : 6	3.0 : 1	Powder/Bead Classification	32
10	1 : 6	2.6 : 1	Complete Classification	16
11	1 : 6	2.25 : 1	Rapid Classification	8
12	1 : 6	2.0 : 1	Tightly Packed Classification	4

## REFERENCES

[1] U.S. Department of Energy. DOE Fundamentals Handbook, Chemistry. DOE-HDBK-1015/2-93. Vol. 2. Washington, 1993.

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X-SBRS: None

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2010 16:02:49 -0400

From: Gayle Brown <Gayle.Brown@Studsvik.com>

To: "chairman@nrc.gov" <chairman@nrc.gov>

Date: Thu, 10 Jun 2010 16:02:46 -0400

Subject: Letter - Policy Issue Vote Paper and memo

Thread-Topic: Letter - Policy Issue Vote Paper and memo

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