

**Department of Energy**  
Savannah River Operations Office  
P.O. Box A  
Aiken, South Carolina 29802

**SEP 23 2010**

**Mr. Manuel Bettencourt, Chairperson**  
**Savannah River Citizens Advisory Board**

**Dear Mr. Bettencourt:**

**SUBJECT: Dr. John Pickett's Public Comment on the Department of Energy's (DOE) Defense Waste Processing Facility (DWPF) Melter Bubblers**

The DOE-SR Citizens Advisory Board (CAB) Waste Management Committee (WMC) requested on August 24, 2010, that DOE provide a formal response to the questions posed by Dr. John Pickett in his July 2010 public comments concerning the DWPF melter bubblers.

Enclosed is the response by Savannah River Remediation, LLC, (SRR) to Dr. Pickett's specific questions. DOE's Assistant Manager for Waste Disposition staff reviewed SRR's response and found it to be supported by reports issued by Energy Solutions in conjunction with research performed by the Vitreous State Laboratory.

Mr. Karthik Subramanian presented a synopsis of SRR's response to the WMC on August 24, 2010, and will re-present it to the CAB on September 28, 2010.

If you have any further questions, please contact me or Ms. Jean M. Ridley of my staff at (803) 208-6075.

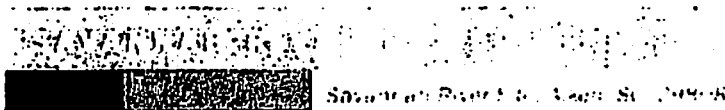
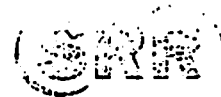
Sincerely,

  
Jack R. Craig  
Acting Manager

**WDPD-10-87**

**Enclosure:**  
**Response to Public Comment from:**  
**Dr. John Pickett's to: SRS**  
**Citizens Advisory Board (CAB) and**  
**DOE-SR (SRR-2010-00024)**

**cc w/Enclosure:**  
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SRR-2010-00024  
RSM Track #: 10667

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**RESPONSE TO PUBLIC COMMENT FROM: DR. JOHN PICKETT'S TO: SRS CITIZENS ADVISORY BOARD (CAB) AND DOE-SR\***

**Introduction**

The Defense Waste Processing Facility (DWPF) has produced an average of approximately 215 canisters/year over the last 10 years with approximately 4,000 lbs of glass per canister. Tank farm sludge waste feed preparation and DWPF feed support a canister production capability of 250 and 325 canisters/year respectively, while all other DWPF plant systems support the designed production capability of more than 400 canisters/year. As such, tank farm sludge waste feed preparation and melter improvements are planned to maximize production capability. The improvements to the melter, the primary limiting factor in canister production, will be achieved through the installation of bubbler systems that nominally double the average production capacity of the melter.

The installation and operation of the bubbler systems to be retrofitted within the current DWPF melter will follow a systematic and controlled approach. A testing program is being completed to determine any safety and operational impacts to the system. These data will be used to continue to operate DWPF within a safe operational envelope while meeting the goals of the liquid waste system plan. The start-up strategy of the bubblers is currently being developed and will follow

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\* The information presented herein was developed by a team led by Mr. Karthik Subramanian, SRR Chief Technology Officer. The team included DWPF Engineering, EnergySolutions, and the Vitreous State Laboratory.

the same detailed controlled startup and learning process as with all enhancements/modifications to existing facilities. The same glass quality requirements are to be met while enhancing the production capacity to accelerate the sludge disposition rate.

A recent presentation to the Citizens Advisory Board revealed many of the same questions that the DOE-SR and SRR engineering and operations team have been addressing to support proper installation and operation of the melter bubblers. In addition to these questions, the team has addressed the typical issues in system modifications, such as sludge batch planning, transfer control, and safety analyses. The questions were summarized in a public comment by Dr. John Pickett. Specific responses to each of the questions are given below.

### Responses

Many of the CAB questions are premised on the absence of a cold cap in the melter under operation of the bubblers. In the absence of the cold cap, a variety of species can be carried over into the off-gas system thereby producing some of the results that are discussed by the CAB questions. The critical nature of the cold cap and the chemistry therein is recognized by the team. As such, bubbled, joule heated ceramic melters of the type fielded and tested by EnergySolutions and the Vitreous State Laboratory are operated under near complete cold cap coverage. The melter bubblers in DWPF will be operated within a regime to maintain the necessary cold-cap coverage to nominally prevent the accelerated carryover of species. Additionally, knowledge of test programs, and previous melters operated under similar conditions, were used to develop the strategy for implementation at DWPF and response to the specific questions.

The cold-cap coverage in the melter is a complex function of the chemistry and heat flow. The general cold-cap coverage can be estimated via monitoring of the plenum temperature and the power input to the dome heaters. These parameters will be monitored to ensure that cold-cap coverage is consistent with known parameters from previous sludge batches.

**Question:** Based on the "post-mortem" inspection carried out by GTS Duratek on the 2nd M-Area melter, how long will the K-3 refractory in the DWPF melter last?

**Response:** In the mid-1990s, GTS Duratek (now EnergySolutions) was awarded a contract to treat 660,000 gallons of hazardous and radioactive (mixed) waste that was stored in M-Area. GTS Duratek designed, constructed and operated the largest radioactive waste processing melter in the United States. This melter, the DM5000A, had a glass pool surface area of 5 square meters (twice as large as the DWPF melter) and had ten bubblers installed to increase the waste production rate of the melter. The DM5000A melter operated for approximately one year and processed over two million pounds of glass prior to shutdown. After waste processing was completed, the molten glass remaining in the melter was removed by drilling a hole through the refractory floor (from the bottom up) and allowing the molten glass to gravity drain into a series of staged drums

beneath the melter. Once the glass was drained and the melter cooled to room temperature, the lid of the melter was removed and the interior of the melter was inspected by GTS Duratek personnel.

Inspection of the interior refractory condition revealed little to no evidence of refractory wear above the glass melt line. The area at the melt line (the interface region of the glass surface and the melter plenum) revealed the most corrosion/refractory loss. In melters, wear in this region is typically significantly higher than anywhere else in the melter. The DM5000A melter had a four inch wide band that had a maximum loss of two inches with the average being approximately one inch of loss. The refractory below the melt line was in excellent condition. Visible block edges were sharp (as opposed to rounded from wear) and block faces were nearly flat. The two discharge orifices were visible and were sharp with no signs of wear. The refractory closest to the bubblers (the closest bubbler was approximately four inches from the wall) did not show any signs of wear. GTS Duratek estimated that the melter had another four to seven years of operational life. Westinghouse Savannah River (WSRC) performed an independent review of the melter refractory (BNF-003-98-0136, Inspection of M-Area, GTS Duratek, Melter Refractories, Ray Schumacher, 9/27/99) and concluded that "...after reviewing the refractory observations from this study, there does not appear to be any new information which would dispute GTS Duratek's previous estimate on an extended campaign life of four to seven years of similar operation."

EnergySolutions also designed, built and operated the Low Activity Waste (LAW) pilot melter facility (located in Columbia, MD) for the Waste Treatment Plant (WTP) at the DOE Hanford site. The LAW pilot melter (DM3300) had a glass pool surface area of 3.3 square meters and operated for 4.8 years, producing 7.7 million pounds of glass before being decommissioned. The DM3300 was inspected in a similar manner to the DM5000A. Inspections of the DM3300 melter revealed that the average wall loss of 2 - 3 inches was observed for all glass contact refractory. Refractory loss at the location of the melt line was higher. Loss on the floor refractory was approximately one inch. The refractory loss is primarily related to general corrosion of the refractory. There was no indication of excessive wear at the location of the bubblers where the closes bubblers were approximately two inches from the walls.

For the DWPF melter, EnergySolutions is designing four bubbler assemblies which will be deployed in existing ports on the DWPF melter. SRR has identified that bubbler assemblies can be installed in DWPF melter nozzles B1, B2, C2, and C4. Two of the nozzles (C2 and C4) are currently being used for glass pool temperature and glass level indication. Therefore, for these nozzles, the bubbler assemblies are designed with these capabilities in addition to bubbling. Two of these nozzles (C2 and C4) are located near the refractory wall (closest is ~5 inches from the refractory wall). To minimize refractory wear near the location of the bubblers, ES oriented the bubblers such that the injection orifice pointed away from the refractory wall. Table 1 provides a summary comparison of the melters, including the DWPF.

Table 1: Summary Comparison of Melters and Bubblers

Parameter	DWPF	DM5000A	DM3300
Geometry	Cylinder	Rectangular	Rectangular
Melt surface area, m <sup>2</sup>	2.6	5.0	3.3
Glass contact refractory type	K3	K3	K3
Glass contact refractory thickness, in	12	10	12
Number of bubblers	4 assemblies	10 assemblies	8 assemblies
Closest distance from bubbler injection point to refractory wall, in	~5	~4	~2
Closest distance from the bubbler injection point to floor refractory, in	>2	2	2
Total glass produced, lb	2,963,000*	2,175,000	7,762,000

\*Estimated value for first DWPF melter at 6.3 years of operation.

Based on the above information and the fact that the bubbler injection points for the DWPF bubblers are further from the refractory wall than the DM3300 and the DM5000A, EnergySolutions does not anticipate that the bubblers will cause a significant loss of the wall refractory due to erosion in the DWPF melter. Little to no erosion will occur on the floor refractory since the bubblers are at least as far from the floor as the DM3300 and the DM5000A.

**Question:** How will the redox be controlled in the DWPF with a bubbler system? Would various types of gases be used?

**Response:** Redox control in the DWPF melter equipped with bubblers will be controlled using the same methodology currently used at the DWPF. Formic acid/nitric acid will be used to control the redox of the glass melt while processing. Although EnergySolutions has previously used air as the bubbling gas, the bubblers are being designed to operate using argon. This will reduce the tendency of the glass to become oxidized when air is used as the bubbling gas. Melter testing using argon as the bubbling gas has been shown to slightly reduce the glass melt as compared to air. Therefore, there is no anticipated difference in redox control for the DWPF melter.

During processing, the melter is operated with a near 100% cold cap coverage. EnergySolutions does not recommend operating the melter with an open cold cap as this can lead to excessive particulate carryover from the melter and can lead to off-gas line plugging. Methods for facility startup have been developed which will minimize particulate carryover. Near complete cold cap coverage was used during the operation of the DM5000A as well as the DM3300. Typical plenum temperatures during melter feeding were maintained at 350 - 450°C. Cold cap coverage will

similar to that current maintained by the DWPF melter during operation. The only difference is that the waste throughput rate will be twice as high as the rate currently achieved by the DWPF.

Near complete cold cap coverage is also needed to minimize carryover of volatile constituents in the DWPF feed, such as Ru, Tc, Cs, Sr, and halides. EnergySolutions has provided operational protocols to minimize carryover of volatile constituents in the DWPF feed, such as Ru, Tc, Cs, Sr, and halides. During feeding operations, EnergySolutions recommends operating the DWPF melter with a near 100% cold cap. During idling, when bubbling can strip volatile constituents directly from the glass, EnergySolutions recommends reducing or securing the argon flow to the bubblers. The bubblers are designed to allow the gas flow to be completely secured and that they will not plug when argon flow is restored. Carryover from a properly bubbled melter is not significantly different from a non-bubbled melter when normalized to the mass of feed fed to the melter.

**Question: How frequently will the final glass product be measured to insure that the radioactive constituents are sequestered in the glass and that the durability limit is met?**

**Response:** The current accepted sampling frequency of one sample per macrobatch will be maintained.

**Question: Can the expected lifetime of the DWPF off-gas film cooler brush be estimated, and how long (how much downtime) would be required to replace it?**

**Response:** The film cooler brush has never been installed during radioactive operation. Other methods have been used to (infrequently) remove minor deposits. Based on ES/VSL operating experience we don't anticipate a need for significantly increased cleaning. Excessive carryover is not expected due to proper installation and deployment of the bubblers.

**Question: Has the level of Tc retention been determined in simulant runs?**

**Response:** EnergySolutions-VSL has measured technetium retention in bubbled melters of various scales with a wide variety of feed simulants, primarily for the Hanford Waste Treatment Plant (WTP). Typical retentions are in the range of 30 – 60%, which is comparable to that observed in other vitrification facilities around the world that typically have not employed bubbling. At the relatively low bubbling levels required to achieve the target glass production rate increases planned for the DWPF, the effect on increased technetium carryover should be modest. Furthermore, since the vast majority of the technetium in the SRS flow-sheet reports to Saltstone (not DWPF), modest changes in the retention in glass are not likely to have any significant impact to the overall system.

**Question: What would be the effect of additional Tc on the saltstone feed, Saltstone Waste Water treatment permit, and Saltstone Performance Assessment?**

Response: The Tc retention in the glass is expected to remain similar to the current retention given that the cold cap will be maintained. In addition, the broad majority of the Tc is held in the salt waste as determined through testing at the SRNL. As such, modest changes in the Tc retention in glass are not expected to have any significant impact on the overall system.

Question: What is the rate of additional acidic gas carryover to the off-gas system, and can the effect on the Hastalloy be estimated?

Response: On a per unit feed basis, the proportion of nitrogen oxides generated will be very similar; however, the mass flow rates will be proportionately higher due to the higher processing rate. Based on test results with bubbled melters and the relatively low bubbling rates that will be required at DWPF, it is expected that 75-95% of the sulfur and 30-60% of the halides will be retained in the glass. The large-scale melter testing described above (M-Area, LAW Pilot melter, DM1200 Pilot melter), which employed much higher bubbling rates, showed no significant issues with off-gas corrosion resulting from increased carryover.

Offgas flow (a function of feed/production rate) should not exceed our DWPF design basis. Bubblers do not affect feed composition, but rather increase the production rate which, at best, will equal our original design basis.

Question: How long (how many months, or years) would be required to replace the DWPF off-gas system, if and when the Hastalloy is corroded?

Response: Accelerated corrosion of the Hastalloy is not expected since the primary corrosive species, sulfur and halides, are expected to be retained in the glass consistent with current retention.

Question: How much additional Cs and Sr would be carried back to the tank farm and how much would it cost to retreat the Cs/Sr to return it to the DWPF (note, at least 4-5 iterations should be used)?

Response: Based on test results with bubbled melters and the relatively low bubbling rates that will be required at DWPF, it is expected that over 99% of the cesium will be retained in the HLW glass, while strontium retention would be even greater (probably over 99.8%).

Question: Based on simulant studies, how much additional silicon and/or borates would be carried over to the tank farm evaporator and would this affect the evaporator pluggage rate?

Response: Based on test results with bubbled melters and the relatively low bubbling rates that will be required at DWPF, it is expected that boron retention will be over 99% in the glass, while silicon retention would be even greater (probably over 99.8%). These rates of retention indicate that no impact to the evaporator.

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Conclusion

Bubbled, joule heated ceramic melters have experienced a 15 year technology maturation, testing and evaluation program, largely focused on their deployment at the Hanford site's Waste Treatment and Immobilization Plant, and beginning with the SRS M Area project. Over 11,000,000 lbs of glass have been produced with this melter technology, with a broad spectrum of HLW and LAW simulants and wastes. From this experience, we understand that feed chemistry, feed type, and melter operating parameters can vary system performance. The data from these projects were used to formulate the controlled strategy that will be used to install and operated bubblers at the DWPF facility. It is recognized that, as with any modification, there is a start-up phase and continuous improvement that will take place as the bubblers are operated and more knowledge is gained. The liquid waste system continues to be modified as technologies mature and avail opportunities to accelerate the overall waste disposition program at SRS.

Sincerely,



James W. French,  
President and Project Manager

KS:df

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