U.S. Department of Energy
Office of River Protection
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

11-NSD-056

AUG 0 2 2011

Mr. Frank M. Russo, Project Director
Bechtel National, Inc.
2435 Stevens Center Place
Richland, Washington 99354

Dear Mr. Russo:

CONTRACT NO. DE-AC27-01RV145136 – REVIEW COMMENT RECORD (RCR) FOR INSTALLATION OF VESSEL TOP HEADS FOR THE FIVE NON-NEWTONIAN VESSELS, UFP-VSL-0002A/B, HLP-VSL-00027A/B, AND HLP-VSL-00028

Reference: BNI letter from R.W. Bradford to D. E. Knutson, DOE-WTP, "Recommendation for Installation of Vessel Top Heads for the Five Non-Newtonian Vessels, UFP-VSL-0002A/B, HLP-VSL-00027A/B, AND HLP-VSL-00028," CCN: 226344, dated July 7, 2011.

This letter provides the U.S. Department of Energy, Waste Treatment and Immobilization Plant (DOE-WTP) RCR comments (attached) on the Justification for Continued Design, Procurement, and Installation (JCDPI) and technical support documentation to support the recommendation for installation of vessel top heads for the five Non-Newtonian vessels, UFP-VSL-0002A/B, HLP-VSL-00027A/B, AND HLP-VSL-00028, contained in the above Reference.

DOE has evaluated the JCDPI including the referenced technical support documents and determined that there is insufficient information for demonstrating the Non-Newtonian vessels will meet their credited safety functions. The JCDPI (24590-WTP-JCDPI-ENS-11-0001) presents a request to move forward with the scheduled vessel head weld closure for the five Non-Newtonian vessels. This review reflects a judgment by DOE that the decision to proceed with vessel head placement, in itself, is not a nuclear safety issue, but instead, resides as a Project risk-based decision.

However, the DOE review team agreed that the design mixing capability from testing and evaluations of the five non-Newtonian vessels (UFP-VSL-00002A/B, HLP-VSL-00027A/B and HLP-VSL-00028) has not demonstrated compliance with the Authorization Basis. The supporting document, *Risk Evaluation for Installation of Heads on the Five Non-Newtonian Vessels* (24590-WTP-RPT-ENG-11-147, Rev. 1), is similarly judged to be incomplete, in that it makes assertions that are not supported based on testing and evaluations to date. Further, the review team evaluated the document's conclusions on the adequacy of Non-Newtonian vessel design and performance and determined that they reside within design and engineering.

Attachment 4
(See RCR attachment for position of staff)

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At this point, DOE will take no further action in BNI's request to approve the above Reference. However, DOE has prepared comments related to the JCDPI that illustrates the issues raised by the review team (e.g., item 7 of the JCPI and the referenced technical support documents) that should be considered as a part of the basis in the DOE's decision. Resolution of the underlying issues identified in the attached comments is required prior to Non-Newtonian vessel installation.

If you have any questions, please contact me, or your staff may contact Paul G. Harrington, Assistant Manager, Engineering and Nuclear Safety at (509) 376-5700.

Sincerely

Dale E. Knutson, Federal Project Director
Waste Treatment and Immobilization Plant

Stacy Charboneau, Deputy Manager
Office of River Protection

NSD:DHA

Attachment

cc w/attach:
D.M. Busche, BNI
R. B. Daniel, BNI
W. M. Linzau, DNFSB
BNI Correspondence

Attachment
to
11-NSD-056

RCR Comments

(total # of pages, 8, excluding cover sheet)

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5. Document Number(s)/Title(s)	6. Program/Project/Building Number	7. Review Team Members	8. Organization/Group	9. Location/Phone
JCDPI 24590-WTP-SE-ENS-11-0008, Rev. 0, Non-Newtonian Vessel Head Placement	WTP	Don Alexander, Ko Chen, Langdon Holton, Steve Additon, Contributors: Albert Hu, Tom Nirider	ORP, Nuclear Safety Division	372-2453

17. Comment Submittal Approval:	10. Agreement with indicated comment disposition(s)	11. CLOSED
Organization Manager (Optional)	Reviewer/Point of Contract	Reviewer/Point of Contact
	Date	Date
	Author/Originator	Author/Originator

The JCDPI is not accepted for review. DOE agrees that the design mixing capability of the five non-Newtonian vessels (UFP-VSL-00002A/B, HLP-VSL-00027A/B and HLP-VSL-00028) has not been shown to be able to comply with the Authorization Basis based on testing and evaluations to date.

The JCDPI (24590-WTP-JCDPI-ENS-11-0001) presents a request to move forward with the scheduled head weld closure for the five non-Newtonian vessels. This reflects a judgment that maintaining the vessel fabricator's schedule with modification of the vessels as required following vessel head placement is prudent even though the design is not demonstrated. The JCDPI request does not provide sufficient justification for review of this proposed action against the JCDPI criteria established in DOE Guide 421.1-2 (Section 4.1.1.4) and the implementing ORP procedure. The supporting *Risk Evaluation for Installation of Heads on the Five Non-Newtonian Vessels* (24590-WTP-RPT-ENG-11-147, Rev 1) is similarly judged to be incomplete, in that it makes assertions that are not supported based on testing and evaluations to date.

Responses to the comments will provide an understanding of the basis of the current vessel design and requirements for future testing. DOE requests one or more briefings to discuss proposed responses in support of resolving the underlying issues associated with the vessel design.

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1	Describe deviations from the current safety basis for the five non-Newtonian vessels (NNVs) that must be evaluated for approval; include clarification of how the anticipated design and operation of the vessels conflicts with the requirements identified in the PDSA and its Addendum including Section 2.7.6 of the Addendum, which discusses mixing uncertainty and the resulting potential impacts on criticality safety, poorly mixed regions, and the accumulation of solids in vessels. Specifically describe: 1) any potential change in the means of providing a required safety function, at the level of detail in which the design is described in the PDSA/PDSA Addendum (e.g., might the NNVs require mixing by means other than PJMs or sparging, such as recirculation pumps? might a TSR be needed for minimum mixing intervals to ensure waste rheology is bounded by test data?); 2) any factors that increase the probability that the as-built design will prove to be incapable of providing a required safety function relative to the uncertainty already described in Section 2.7.6;	Yes		

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	3) any factors that extend the schedule for assured resolution of the identified mixing uncertainties and the current estimated resolution schedules for the potential strategies/outcomes identified; 4) the estimated probability of a decision to replace the PJM chandelier arrangements and available evidence that the Project is committed to the described contingency of vessel redesign, testing, re-fabrication and replacement as identified in the JCDPI; and 5) potential impacts on the required vessel operational support systems such as PJV/PVV and their exhaust filtration systems for normal and abnormal events that could challenge the reference design concept and prove difficult to resolve (e.g., might there be impacts on the operating pressure or capacity of the compressed gas systems for sparging and NNV PJM operation and required ventilation systems?).			
2	Provide an estimated schedule for resolution of this JCDPI with an ABAR to the PDSA for the various possible outcomes identified. Describe how near term 42 inch PJM platform Informational Testing, Large Scale Integrated Testing (LSIT) and analyses are factored into this schedule. Describe how this schedule is integrated with the previously required updates to the PDSA and Preliminary CSER. If resolution could take more than one year for any of the documents to be revised, explain how the JCDPI is suitable for such a long delay.	Yes		
3	JCDPI evaluation requires a determination that delay in the proposed activities would have a significant (adverse) effect on DOE interests. To support such a determination, clarify how a delay in welding the heads would create a significant impact at the vendor's facilities and how it was determined that there were no other more practical means of obviating such an impact (e.g., provide temporary vessel closure and an alternate storage location). 1) Explain why vessel HLP-VSL-00022, which is on the WTP's critical path, cannot be fabricated prior to fabrication completion of the five non-Newtonian vessels. Describe other sequencing options. 2) Identify any other schedule precursors on the fabrication schedule from Informational Testing, Large Scale Integrated Testing and other major required actions.	Yes		
4	The JCDPI asserts that the PJM chandelier arrangement could not be modified in the existing vessels even if the heads had not been welded on, concluding that new vessels would be needed and thus that welding has no impact on this possible redress strategy. Describe how BNI determined that there were no possible effective modifications that could be made to the PJM configuration without vessel replacement, including options if the heads were not welded at this time.	Yes		
5	DOE concludes that vessel erosion could be more severe than previously predicted from the M2 EFRT erosion wear testing because the NNV fluid properties have a denser solids fraction, particularly post wash-leach solids compositions and concentrations (24590-WTP-RPT-PET-10-014) compared to the M2 test simulant. Should there be increased erosion, premature vessel penetration and loss of vessel contents to the black cell could result. Provide BNI's evaluation of the potential need for a change in wear plate design and the basis for concluding that head welding would not impact redress should such a change be needed for any of the five NNVs. Discuss the potential impact of resolution of the DNSFB staff comments on erosion wear on this conclusion.	Yes		
6	Describe how monitoring from outside the vessel wall will ensure quantification of local accumulation of fissile material (JCPDI, item 7). Describe the proposed control strategy to monitor the potential for fissile material accumulation and respond in time to ensure prevention of a nuclear criticality. Specifically state whether neutrons would be relied upon for detection and specify proposed control actions. Provide BNI's basis for concluding that design changes to the non-Newtonian vessels will not be needed to prevent criticality or that the implementation of	Yes		

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	any required design changes would not be impeded by welding the heads.			
7	Describe how the response to comment 1 impacts the CSER's underlying assumption that criticality is incredible. [Section 7 of the JCDPI discusses inadvertent criticality as one of the two primary hazards that could impact the decision to weld the vessel heads in place.]	Yes		
8	Section 3.8.2. of the Risk Evaluation (24590-WTP-RPT-ENG-11-147) proposes a conservative new model for potential hydrogen gas content equal to the volume of maximum credible solids buildup layer. Please explain: 1) The decision to permit 100% of the remaining margin to 4% hydrogen to be used as an acceptance criterion for solids layer buildup size (i.e., why zero remaining margin is viewed as acceptable). 2) The basis for concluding UFP-VSL-00002A/B cannot accumulate 102 liters or more of solids (i.e., how it was determined not to pose the limiting case since it has the least margin). 3) The basis for concluding HLP-VSL-00027A/B cannot accumulate 1972 liters or more of solids. 4) The potential impact of material retained on the tops of the chandeliers on the total quantity of built up solids. 5) The potential impact of built up solids during off-normal operating conditions for the NNVs. 6) The separate impacts of PJM operating and sparging uncertainties on the estimated solids buildup potential and location. 7) On what basis BNI would recommend welding the vessel heads even if DOE concludes that the buildup of the solids layer volume has yet to be bounded at a volume within the current margin.	Yes		
9.	Discuss the implications of possible solids buildup (including on the vessel bottom, on support structures and/or on top of the chandelier) on the NNV Unit Liter Doses as modeled in the accident analyses or HPAV design if the effect of mixing deficiencies is either to enrich the retained solids in radiological content within an NNV or to transfer an enriched stream to the next vessel or HLW. Provide the basis for concluding that these Unit Liter Dose impacts can be resolved even with the heads welded.	Yes		
10	Describe the impact of Figure 1 in the Risk Assessment which appears to show a diminishing benefit from heel removal over multiple batches (diminishing returns at 3 or 4) on the potential use of this strategy to address NNV mixing limitations or criticality concerns (the JCDPI describes heel removal as part of the current criticality prevention strategy).	Yes		
11	Discuss the potential need to modify other vessel design features to address NNV mixing deficiencies including; 1) PJM nozzle modifications for improved mixing performance or mitigation of solids accumulation, 2) Air sparger modification to remove solids accumulated on the tops of the chandeliers or to limit other in-vessel accumulations, 3) Addition of vessel sample locations to improve the ability to characterize vessel contents to confirm safe operating conditions, and 4) Addition of vessel monitoring capability for criticality, either inside or outside of the vessel. Discuss the impact of proposed head welding on redress involving these potential vessel modifications should any of them be needed.	Yes		
12	Discuss the potential for plugging of PJM nozzles, air spargers, steam rings (for UFP-VSL-00002A/2B), and pneumatic dip tubes. If plugging occurs, would it impact the vessel control strategies and estimates of the mass of non-Newtonian solids accumulated and estimates of the volume of hydrogen gas retained? Could such impacts affect the decision to weld the heads?	Yes		

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	Describe how abnormal operation of vessel design features (e.g., PJMs, air spargers, steam rings, and pneumatic dip tubes) will impact the estimates of the mass of solids accumulated in NNVs and estimates of the volume of hydrogen gas retained. Identify and describe the minimum operating conditions for these design features, both singly and in combination, to ensure vessel operational safety.			
13	To reach the required conclusion regarding the risk that the proposed activity will cause a significant adverse impact on the environment, mission, or safety, additional assurance that planned future activities will suffice to ensure safety is required. Specifically, describe: 1) How the LSIT will be used to close the issues on solids accumulation and criticality control identified in this JCDPI and support the revision to the Authorization Basis; 2) Any additional features in the LSIT plan that address a potential failure of the NNVs to achieve their mixing requirements; and 3) The criteria to be used to support a decision on the acceptability of the PJM chandelier arrangement to meet the mixing requirements identified in the PDSA to prevent a nuclear criticality and release hydrogen gas.	Yes		
14	The JCDPI limits the proposed activity to delivery of the vessels to the site, but does not allow installation. Explain how the vessels can be safely stored in the interim and explain how BNI determined that installation would not be necessary under the JCDPI.	Yes		
15	The Risk Evaluation appears to be based on the assumption that Pu exists as an oxide with a particle size of ~10 micron. The Preliminary CSER is based on tank farm information and indicates that Pu will be held in agglomerates and large flocculants of 0.1 to 1 millimeter diameter (Reference: PNNL-11304, "Potential for Criticality in Hanford Tanks resulting from Retrieval of Tank Waste"). Describe how larger particle sizes impact the described criticality issue resolution strategies?	Yes		
16	Discuss how criticality safety limits are effectively controlled by reliance on the waste acceptance criteria (WAC) on the received tank farm waste considering both the identified potential for solids buildup and the physical/chemical transformations of the waste that will occur during PJM Mixing, solids concentration, solids washing, and solids leaching (including oxidative leaching).	Yes		
17	Describe and provide the technical basis for the increase in solids and liquid phase shear for: 1) During normal operations between PJM drive cycles and at sparger operating modes (idle flow and full flow) 2) Post DBE operating conditions. Describe how this increase in the solids and liquid shear strength will impact the vessel welding recommendation considering solids suspension, solids bottom clearing and gas release.			

The following additional comments pertain to the ongoing design process and their impact to the current vessel design and subsequent vessel installation.

Comment #	Comment	Reviewer Concurrence Required	Disposition (Provide justification if NOT accepted.)	Status
a	The documentation provided to support the JCDPI (e.g., Risk Evaluation, LOAM Report) does not appear to provide a complete assessment of the vessel design requirements, vessel operating modes or a complete assessment of the			

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	safety functions. New testing information is provided in the LOAM Report (24590-WTP-RPT-ENG-11-013), for example. Each of the five NNVs have different design requirements, fluid conditions (ranging from Newtonian to non-Newtonian), and mixing requirements. These differences require separate and complete analysis to determine if the vessels comply with their safety functions. For example, the UFP-VSL-00002A/B vessels are uniquely different with respect to geometry, fluid properties, operating conditions, Newtonian and non-Newtonian chemistries) when compared to the HLP vessels. The UFP vessels have several operating modes including: solids concentration, solids caustic leaching, and solids oxidative leaching. During these different operations modes the mixing performance is different depending upon the operation of the ultra-filter feed pumps, whether the PJMs are operated with gravity refill (as required at temperatures above 139°F) or suction refill. In all of these operating modes the safety functions must be met. Provide references (and reference content locations) that clearly, completely and accurately identify the following information. 1) Operating conditions of each of the five NNVs (UFP-VSL-00002A/B, HLP-VSL-00027A/B and HLP-VSL-00028) vessels including their abnormal operating conditions and accident conditions based on testing information and analysis. This description should present information on PJM operating modes and conditions, recirculation pump operating conditions, and air sparger operating requirements dependent on vessel fill level. 2) Abnormal operating conditions and accident conditions based on testing information and analysis for each of the five NNVs (UFP-VSL-00002A/B, HLP-VSL-00027A/B and HLP-VSL-00028). 3) Safety related vessel mixing requirements and their basis for each vessel. 4) Any additional analysis completed that evaluates the safety functions for each of the five NNV vessels. 5) Historical testing conditions of the five NNVs. Alternative control strategy(ies) to support compliance with the safety related mixing requirements based on the recent testing information and analyses.			
b	Identify required inputs to support a decision on the acceptability of the PJM chandelier arrangement to meet the mixing requirements identified in the PDSA to prevent a nuclear criticality and release hydrogen gas and when the decision is to be made. Provide a unique assessment for each of the five vessels.	Yes		
c	Please provide the test plan for Informational Testing and Large Scale Integrated Testing.	Yes		
Specific Questions on Nuclear Criticality Safety				
1-CSER	Describe how the recent LOAM benchmark testing information affects the CSER contingency 7.11.11 Gravity Segregation section which concludes that mixing will limit the potential for selective settling and dismisses gravity segregation as an incredible scenario.	Yes		
2-CSER	Describe the calculations that will be performed, and contingency analyses conducted, to establish the safety margin associated with any plutonium oxide accumulations in vessels and piping.	Yes		

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3-CSER	Describe how a system designed to measure the location of fissile material in WTP vessels would be integrated into the control strategy for criticality safety. Describe how the proposed control strategy for waste feed (a TSR-level control on waste feed parameters) can be robust enough to protect the assumption of sub-criticality in the five NNVs given the potential for solids accumulation and unknown factors in processes such as wash/leach and cesium ion-exchange.	Yes		
4-CSER	Describe how the results of recent LOAM benchmark testing, and other recent analyses, that demonstrate separation of solids phases affect the assumption that all plutonium oxides will remain with credited metal absorbers (Fe, Ni). [The CSER does not contain a limit addressing the presence of discrete plutonium particles not chemically bonded with absorber metals (PuO_2).]	Yes		
5-CSER	Describe the analysis completed to support a determination that fissile material does present a safety issue with the five NNVs considering the following: 1) CSER contingency 7.11.4 identifies restrictions (controls) on the use of acid to dissolve sludge. 2) CSER Open Action Item A.1.7 indicates that procedural controls on the use of nitric are not sufficiently developed to conclude that criticality is incredible in the event that nitric acid is used for tank cleaning or solids removal. 3) The CSER presently prohibits the use of nitric for heel dilution and cleanout. 24590-WTP-PL-ENS-11-0005, CSER Update Plan does not include planning to address this issue.	Yes		
Specific Questions on Hydrogen Retention and Release				
1-HGR	Provide an assessment of the following operational and design mitigation measures identified in the JCPDI which may suffice to prevent nuclear criticality and ensure required management of hydrogen retention and release (especially Mixing Requirement 10 on solids accumulation); describe the recommended controls for each option: • Particle size limits on the WTP feed stream, • PJM firing sequences, utilization of Heel Removal capabilities, and • re-location of the vessel pump suction line.	Yes		
2-HGR	The JCDPI identified the potential for solid accumulation in the NNVs during multi-batch operations. 1) Describe how non-Newtonian solids accumulation will impact the temperature profile in the vessels and its impact on the hydrogen generation rate. 2) Describe any changes to the vessel purge rates and impacts to the PVV system operations. 3) Describe why non-Newtonian solids accumulation will not result in an episodic release of hydrogen. [Current hydrogen generation rate (HGR) calculations for the five vessels assume a well mixed, homogenous slurry as documented in the latest WTP HGR report, "Revised HGR Calculation of HGR and Time LFL for WTP", 24590-WTP-M4C-V11T-000011, Rev C. The accumulated solid will have much higher temperature due to concentration of heat emitting isotopes such as Sr-90. The thermolysis and radiolysis rate of TOC is temperature dependent. The latest WTP HGR calculation develops an HGR Layer Model to calculate the HGRs of accumulated solid layer for few Newtonian vessels. It demonstrates higher HGRs with this solid layer compared with the previous calculation using a homogenous HGR model.]	Yes		
3-HGR	Explain the basis for the earlier decision for removing the fluid recirculation systems used to ensure solids mixing to support hydrogen gas release, from the designs for HLP-VSL-00027A/27B and HLP-VSL-00028. Could design	Yes		

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	changes such as the addition of recirculation lines be incorporated into to the 3 vessels following vessel head placement. Recirculation pumping allows for continuous bottom clearing during the ultrafiltration process in UFP-VSL-0002A/B. [In 2004 the recommended configuration for the vessels was to include an all-in hybrid including PJMs, spargers, and recirculation pumps. This is documented in 24590-WTP-3TD-50-00003, Rev A. "System Description for the Pulse Jet Mixers and Supplemental Mixing Systems".]			
4-HGR	The Risk Evaluation (24590-WTP-ENG-11-147) indicated that particles greater than "~210 to 300 micron" would accumulate. LOAM benchmark Testing (24590-WTP-ENG-11-013) tested a particle size distribution up to ~770 micron. A recent BODCN (24590-WTP-BODCN-ENG-10-0003) provided two conditions for the waste feeds to the five NNVs. These are: • *"For vessels, UFP-VSL-00002A/B, HLP-VSL-00027A/B, and HLP-VSL-00028, the WTP will use process control to condition the slurry viscosity and shear strength for leached, washed, and concentrated waste to be within the range of 6cP and 6 Pa to 30 cP and 30 Pa as the lower and upper bounds respectively. The post leaching, washing, and concentration non-Newtonian slurry solids are ≤300 micron and ≤3.8 g/ml bulk average density, and a maximum plutonium oxide particle of 10 micron."* *And for as-received waste that is concentrated.* • *"The bulk maximum of the average solids density distribution (mass averaged density) expected for mixing of the tank farm as-received HLW feed is 2.9 g/ml. The maximum for the particle size distribution expected for tank farm transfers to WTP is 700 micron, and a maximum plutonium oxide particle in tank farm transfers is expected to be 10 micron."* Please explain how the conclusions on gas release and no-solids accumulation would change based on a more comprehensive evaluation of the NNV vessel fluid questions and explain how this would be taken into account for the decision to weld the NNV vessel heads.	Yes		
5-HGR	The Risk Evaluation (24590-WTP-ENG-11-147) provides estimates of the PJM effective clearing radius for the five NNVs on page 8. These estimates are used to support a conclusion that the PJMs can clear the bottom of the vessels and comply with the PDSA hydrogen gas release requirement to suspend solids. A recent assessment completed by BNI (CCN: 204844) determined that the difference between the predicted effective clearing radius (as used in LOAM and the Risk Evaluation) and the clearing radius measured in the LOAM benchmark testing (24590-WTP-RPT-ENG-11-013) is overstated by 37 - 43% for Test 6. Test 6 is was a complex simulant with an 8 cP viscosity fluid and is a representation of design basis conditions. Based on these results the bottom area cleared based on the Risk Evaluation results is overstated by a factor of ~3. Given these results, what confidence exists to support a determination that the PDSA gas release requirements are met?	Yes		
Please Provide the Following Information Identified during the TCDP1 Review:				
1	Provide interim Hazards Assessment information (scheduled for completion by Fall 2011) that documents a systematic identification and evaluation of the hazards associated with the proposed change(s) to the Authorization	Yes		

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	Basis. Given solids accumulation, many of the existing controls for nuclear criticality as currently specified in the CSER and the controls specified in the PDSA Addendum for hydrogen generation and release will be impacted. Therefore the extent of impact of the reference design on the environment, mission, and safety must to be evaluated and new controls should be specified.			
2	Describe how the results from the *Evaluation of Batch to Batch Pumpout* (24590-WTP-RPT-ENG-11-146) that show that heel removal is not effective and that solids accumulate to large quantities batch to batch are to be verified. Solids accumulation can lead to nuclear criticality and to hydrogen retention and release. Provide the plans to support this verification.	Yes		
3	The JCDPI describes that there is a potential for solid accumulation in the NNVs during multi-batch operations. Describe how solids accumulation will impact the temperature profile in the NNVs and if the potential for a steam bump is increased. Describe how the steam bump would impact the operation of the vessel and PJM ventilation systems. [The steam bump is defined as a phenomenon where the trapped water moisture inside the accumulated solid layer is heated to finally become buoyant to cause a roll-over of whole contents of the vessel. This will result in violent release of the waste in the vessel.]	Yes		