McNulty, Richard R

From: Alexander, Donald H
Sent: Thursday, August 04, 2011 10:33 AM
To: Lagdon, Richard H; Branch, Stanley; Knutson, Dale E; Samuelson, Scott L; 'Charboneau, Stacy'; Poneman, Daniel B; 'david.huizenga@nnsa.doe.gov'
Cc: Brunson, Gary E; Callahan, Victor L; Harrington, Paul G; Wicks, James H; McNulty, Richard R
Subject: Tests Verify Faulty NNV Decision will increase EAC $$$$
Attachments: Info Tests July August 2011.pptx

Dear Mr. Lagdon:

Unfortunately the Decision to Weld the Non-Newtonian Vessels was made a day too soon. Based on the testing yesterday evening and the recent testing results it is clear that the Decision to Weld will require rework and place unacceptable liability upon the government. It is too bad that the DPO Process was not fairly brought to closure prior to this decision. The following provides a technical basis for my statement:

The most important test for determining the fate of the Non-Newtonian Vessels was completed yesterday August 3rd, 2011 at the Mid-Columbia Engineering Small Scale Test Stand. The test results came in on the afternoon of August 3rd, 2011 only hours after the DOE Federal Project Director sent his "risked based" letter to the Contractor lifting the hold point on vessel welding. One wonders why the decision letter wasn't held until the results of the test were available? After all, the tests were sponsored by WTP. Once Again, I was the only scientist present to observe these tests. I guess the project doesn't really care about the test results.

Testing over the last two weeks demonstrates that we are now at the point where a very expensive contingency option will have to be exercised. This involves either the implementation of design and fabrication of a new vessel or significant modification of the existing vessel. Either option will be extremely costly because the interfacing systems, such as the PVV system, vessel piping arrangements, and other systems will all require redesign and this will be exceedingly costly. This could have been avoided if the DOE technical staff recommendations and those of the DNFSB (among numerous others) had been fairly considered. Since DOE management has accepted the risk and assumed the liability (11-WTP-274; Russo email), the action will require a substantial increase to the EAC of up to several billion dollars. The risk decision was made with full knowledge that the current design is outside the Authorization Basis (11-NSD-056), is not compliant with the Contractor's processes and procedures (11-WTP-221 and 11-WTP-266), and is based on flawed bases documents (11-NSD-056). In spite of the inability of the current design to avoid solids accumulation and concentration; erosion will likely be the Achilles Heel.

Test 4 completed as a part of the LSIT and earlier tests demonstrate that the proposed mitigation actions are not viable and that the more expensive "Contingency Option" of redesign, testing and fabrication will be required.

In Chapter 5 of the BNI "Risk Evaluation for Installation of Heads on the Five Non-Newtonian Vessels" (24590-WTP-RPT-ENG-11-147, Rev 1) provided several ideas for the mitigation of accumulation; Primary among these recommended actions are:

- Alternate PJM operation –sequential or alternating firing modes
- Alternate PJM operation – turning off the center PJM to allow outer PJMs to drive solids to the center in an up-well zone
- Alternate Pump Suction Location
- Limit particle sizes

Attachment 8

As discussed below, all of these mitigating have failed to resolve the accumulation and concentration issue. As the BNI Risk paper notes under section 5.2.5 "Contingency Evaluation":

In the event that the mitigation options discussed above in section 5.2.2 through 5.2.4 are not successful and the mitigation option to limit particle sizes (Section 5.2.1) is not implemented a modification to the NNV PJM arrangement would be required. This would require development of a new array, testing of a new vessel geometry, and refabrication of the vessels. If this worst case scenario is realized, the head would need to be removed, the vessel internals (PJM chandelier arrangement, spargers, suction line, etc. would need to be removed, the new vessel internals would be installed and the vessel shell would have to be requalified. The optimum implementation of this alternative would be design and fabrication of a new vessel and internal PJM arrangement instead of modification of the existing vessel.

Testing over the last two weeks demonstrates that we are now at the point where the contingency option will have to be exercised. This will mean the implementation of design and fabrication of a new vessel or substantial modification of the existing vessel. This option will be extremely costly because the interfacing systems, such as the PVV system, vessel piping arrangements, and other systems will all require redesign and this will be exceedingly costly.

INFORMATION TEST 4 RESULTS and OBSERVATIONS:

TEST 4: Test 4 was run with a 4 part simulant (aluminum hydroxide, ground silica, bismuth oxide, and glass beads) in an 8Cp solution of glycerin and water. The test was run during pump-down with the central jet off and with the outer perimeter jets firing. Earlier tests with 2 part simulant (aluminum hydroxide and glass beads) indicated that this configuration should provide a high yield of glass beads. The test completed yesterday afternoon shows that the configuration will not work as follows:

1. Apparently the admixture of the 4 particles in glycerin behaves as a cohesive mixture. As such, the spherical beads which heretofore made it to the central suction line (2 particle simulant) were hung up around the perimeter of the vessel floor.
2. The solids driven to the center PJM caused plugging of the suction line.
3. The recovery of ~1575 ml of glass beads from the heel means that this mitigation option is ineffective because the bead concentration is **enriched by more than 300 wt%.**

The attached photos (1 and 2) show the recovery of the black beads by sieving and the total quantity of beads recovered (~1575 ml) and measured in graduated cylinders.

LIMIT PARTICLE SIZES

Numerous photos of the accumulation within dune formations on the floor of the vessel demonstrate that **fine particles will also accumulate**. Previous photos (3) attached above show the inter-layering of the fast settling ~700 micron beads with aluminum hydroxide (~140 microns). Even the ~10 micron solids are accumulating in the heel and on the head of the chandelier.

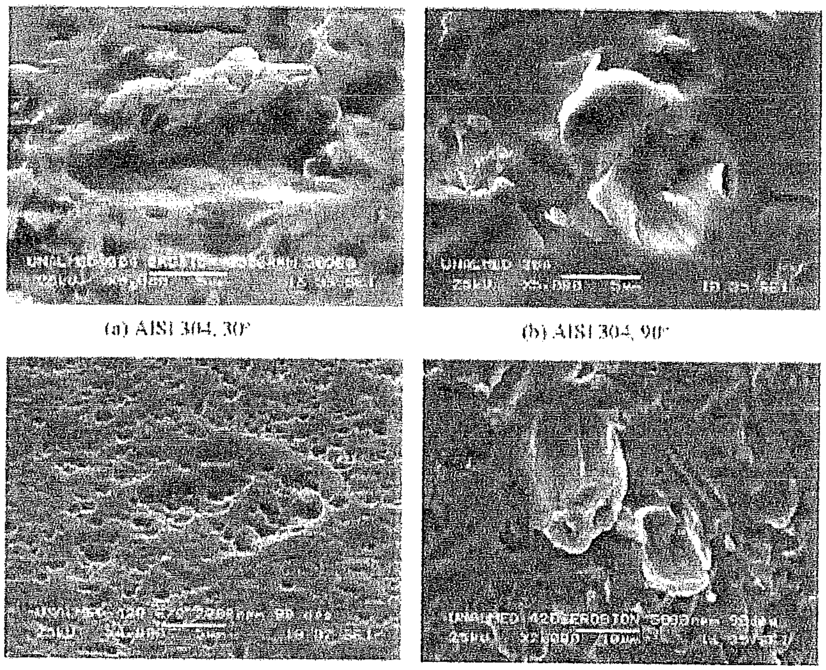
ALTERNATE SUCTION LINE LOCATION:

Four alternate suction line locations (photo 4 attached) were evaluated to determine if the accumulation problem could be resolved. The optimal location was determined to be at position 3 in the attached photo. When testing was conducted with the same 4 part simulant approximately 650 ml of beads remained in the heel representing about 150% enrichment (photo 5 attached). The significant problem with this approach is the the location of the up-well will change as a function of fluid and slurry characteristics change. Even so 150% enrichment is unacceptable.

EROSION: THE NNV DESIGNS ACHILLES HEEL:

As shown in the photo 6 above, the center PJM causes compression of the stainless steel wear plate but shows minor erosion. By contrast, substantial erosion occurs on the 7 perimeter wear plates (photo 7). As explained in DPO document 11-NSD-40, Adverse Issue 5, Erosion: angled jet impingement causes far more severe and accelerated erosion than normal jet impingement.

Studies of stainless steel erosion/corrosion using quartz sand[1] ranging in size from 200 to 300 microns typical of Non-Newtonian simulants shows that "*the most severe condition was obtained for grazing incidence and high impact velocity.*" Tests were run at 4.5 and 8.5 meters/second. According to the study, "*oblique impacts cause formation of grooves and prows, while normal incidence of the particles leads to craters and indentation like marks.*" The erosion effects from Lopez et al, 2005 can be seen in the photomicrographs below.



(a) AISI 304, 30° (b) AISI 304, 90° (c) AISI 420, 30° (d) AISI 420, 90°

Fig. 4 Typical erosion marks in AISI 304 and AISI 420 steels surfaces for (a and c) grazing and (b and d) normal impact

WTP will experience much more severe abrasion since the jets are operated at 12 meters/second (as compared to 4.5 and 8.5 meters/second in the tests by Lopez et al. 2005). Erosion will place a limit on jet velocity at least for vessels (both Newtonian and Non-Newtonian) that manage high solids. The Newtonian and Non-Newtonian vessels of concern will have a full scale velocity of about 12 meters/second. The materials carried by the jet will include large amounts of abrasive material as compared to the simulant used in M2 testing. These fragments will accelerate erosion. Some minerals will become rounded. Others will cleave and retain sharp edges.

CONCLUSION

The risk based decision was a day too soon. LSIT testing underway at MCE demonstrates that the proposed mitigative actions in the "Risk Evaluation for Installation of Heads on the Five Non-Newtonian Vessels" (24590-WTP-RPT-ENG-11-147, Rev 1) cannot be met by the current design.

Welding the vessels will take away a degree of flexibility as stated in the Risk Report: *If this worst case scenario is realized, the head would need to be removed, the vessel internals (PJM chandelier arrangement, spargers, suction line, etc. would need to be removed, the new vessel internals would be installed and the vessel shell would have to be* *requalified. The optimum implementation of this alternative would be design and fabrication of a new vessel and internal PJM arrangement instead of modification of the existing vessel.*

What this means is that, the Contractor believes that if the mitigative options are ineffective, then the vessel should be scrapped. Testing shows that none of the mitigative options are sufficient to mitigate the accumulation and concentration issues. Perhaps of equal importance, given the fact that the NNV arrangements have steeply angled nozzles not found in the NN vessels it has been demonstrated by testing that they will experience severe erosion.

Therefore, because the most current data was not considered, the decision to weld was premature. More importantly, the Department in an unprecedented action assumed the liability for the decision. **This translates to a sizeable increase in the EAC (based on my prior experience in Project Controls) resulting from project delay due to vessel redesign, testing, and plant redesign due to schedule impact. This substantial risk could have been largely mitigated had the project included a fall-back alternative like that recommended by the DOE Engineering staff (April 21, 2010).**

[1] Lopez, D., J.P. Congote, J.R. Cano, A. Toro, and A.P. Tschiptschin. Effect of particle velocity and impact angle on the corrosion-erosion of AISI 304 and AISI 420 stainless steels. Elsevier. February 2, 2005.