U-603798
ATTACHMENT 2

Engineering Change Evaluation 363975 Revision 0

EC Number 363975
An Evaluation of the RCIC Tank Vortex Test Results with Respect to the Clinton High Pressure Core Spray Suction Line During High Flow Accident Conditions

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1.0 REASON FOR EVALUATION / SCOPE

The purpose of this EC is to document the evaluations performed using a RELAP5 model to simulate the introduction and transport of air in the HPCS suction piping. This analysis bases entrainment behavior on the recently performed prototypical vortex testing completed at Alden Laboratories. The primary focus of this evaluation is on the time when the automatic realignment of the HPCS pump suction to the suppression pool is in progress. This evaluation demonstrates that potential air entrainment due to fluid vortexing in the storage tank has had no impact on the past functionality of the HPCS pump. This evaluation is not intended to form a new licensing basis for the HPCS system nor is it intended to support plant setpoint modification.

Based on recently completed subscale testing (Reference 1) the previously existing level limits on the RCIC/HPCS storage tank had the potential to introduce significant quantities of air to the HPCS suction piping prior to suppression pool transfer. The level at which the suction switchover from the RCIC/HPCS storage tank to the suppression pool initiates has been historically set at a point relatively close to the top of the storage tank outlet pipe. Recent subscale tests demonstrate that air entrainment is expected prior to reaching the low level switchover level in the tank for high flow rate conditions (5500gpm). The subscale tests further suggest that the suction transfer setpoint will be reached prior to initiation of air entrainment for the 3000 gpm condition. The length of the suction piping (approximately 300 ft) coupled with a flow velocity at 5500 gpm of approximately 9.67 feet/sec implies a significant time is needed to transport any air ingested due to vortexing to reach the HPCS pump. A RELAP5 Mod 3.3 model of the suction piping had been previously prepared (Reference 2). This model has been updated to reflect the data collected in the recent testing and has been exercised to provide a better understanding of high flow rate void transients on the HPCS suction piping.

2.0 DETAILED EVALUATION Inputs

2.1 Description of the System

The HPCS suction line consists of 16 and 20 inch standard pipe configured to allow suction to be taken from either the RCIC/HPCS storage tank or the suppression pool (References 13, 14 & 21). This corresponds to an area of 1.2684 ft^2 for 16" pipe, and 2.0142 ft^2 for 20" pipe.

The path from the suppression pool has a horizontal run of 20 inch piping with a normally closed isolation valve at the suppression pool outlet. It also has a 13.25 foot drop from the suppression pool to the horizontal run per Reference 12. Use of 10 foot drop in RELAP5 input is conservative.

The suppression pool isolation valve will open when the level in the RCIC/HPCS tank reaches the low level setpoint, currently set at a level of 740 feet, or about 3.8 inches (Ref. 22, Table 3.3.5.1-1, Item 3.d and B.3.3.5.1, SR 3.d) above the top of the tank exit pipe (Ref. 3 &4).

The 16 inch piping is a run of approximately 285 feet that connects the RCIC/HPCS tank to the 20 inch header in a tee outboard of the suppression pool isolation valve. See References 9-12)

There is an isolation valve and a check valve in the 16 inch header near the tee to the 20 inch header per Ref. 9, Plan "G".

The RCIC/HPCS tank isolation valve will close sequentially after the suppression pool isolation valve is fully open per Reference 22, section B 3.3.5.1, Background section.

The HPCS pump is a vertical well pump, with a nominal flow of 5010 gpm at 200 psig vessel pressure and a plant tested runout flow rate of 5500 gpm at 0 psig vessel pressure. This analysis is based on the tested flow rate of 5500 gpm that was tested during a surveillance Ref. 5.

The RCIC/HPCS storage tank has an ID of 29'-11.25" (Ref. 6) for a volume per foot of level of 5265 gallons, or 438.8 gallons per inch.

The 16 inch HPCS suction pipe connects horizontally and flush to the storage tank at an elevation centered at 739.25 feet per Ref. 9, Plan "F".

2.2 Subscale Testing Input Data Description

The 3 tests at flow rates of 3000 and 3 tests at flows of 5500 gpm were conducted in Reference 1. A key feature of the testing was that no circulatory vortex formation was observed, and no air entrainment was seen until the level dropped low enough that Bernoulli breakthrough occurred. The following table provides the prototypical tank levels observed in the testing.

Alden Test Results –Measured breakthrough level Reference 1

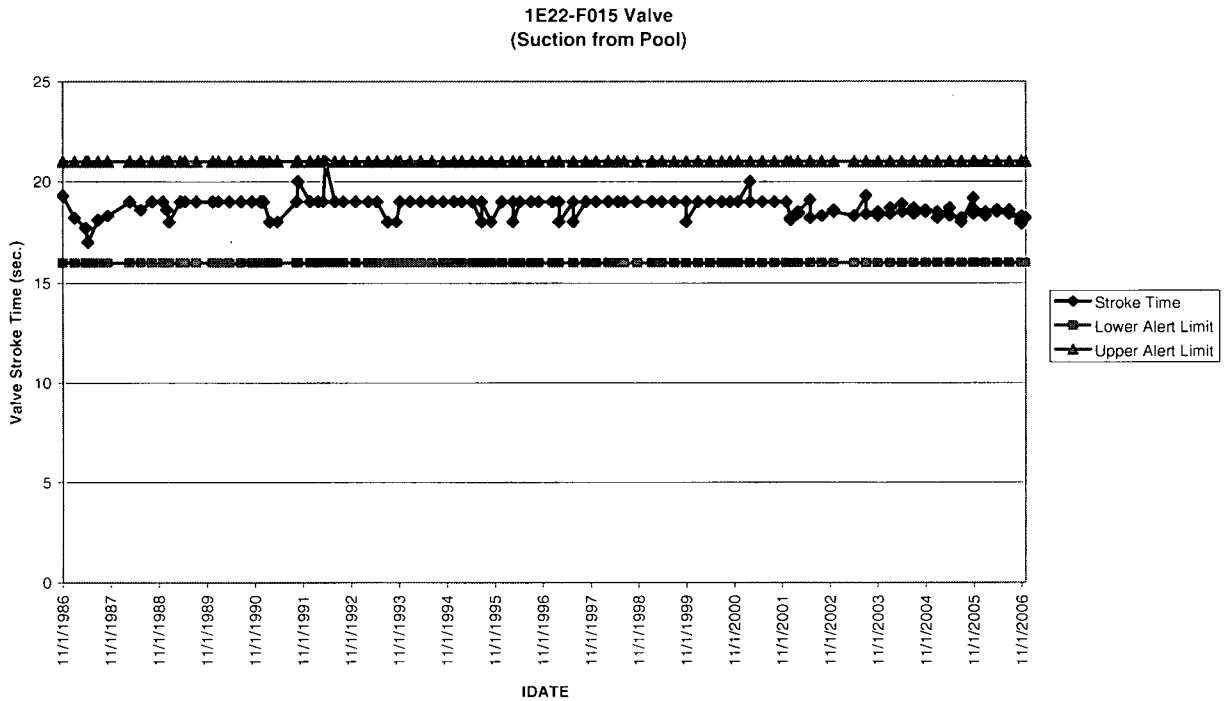
	3000 gpm testing	5500 gpm testing
Test Number	Breakthrough level in.	Breakthrough level in.
1	2.6	4.65
2	2.56	4.17
3	2.75	4.80

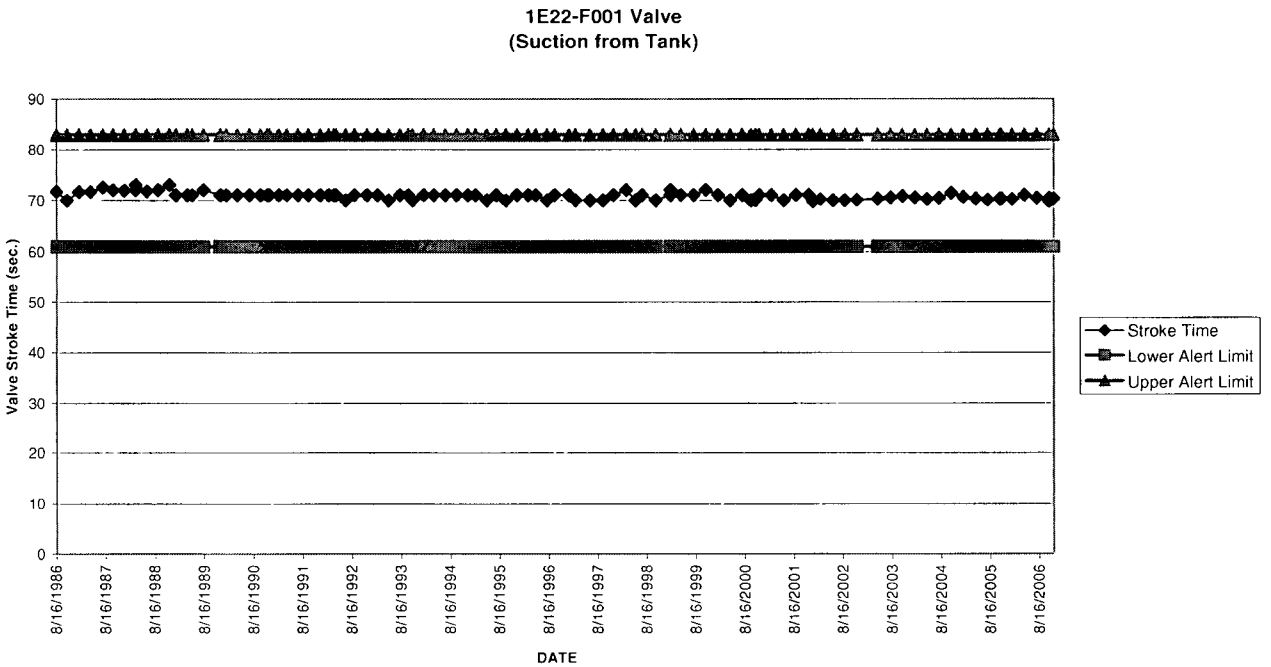
2.3 Input Data for Statistical Uncertainty

The flow measurement accuracy is 2% from Reference 1.

The level measurement accuracy was 0.25% of scale (72 inches) in the test measurement device from Reference 1.

2.4 Input Data for Valve Stroke Times from Ref. 15





Description of Cases are based on the Suppression Pool Isolation valve stroke time:

Two key inputs define the cases analyzed with the RELAP5 model of the HPCS suction piping. The only difference between the cases is in the suppression pool isolation valve stroke time. The two cases are:

Case 1 (Design valve timing case)- This case uses a valve stroke time of 28 seconds.
Case 2 (Actual valve timing case)- This case uses a valve stroke time of 21 seconds. This value was selected based on enveloping actual historical plant stroke time measurements, and represents the longest stroke time recorded as part of the surveillance testing over the life of the plant.

2.5 Input Data for RELAP5 Piping

The piping connections were laid out from P&ID References 8 & 13. Lengths, elevations and locations of elbows and Tees were taken from References 9-12.

Loss coefficients were taken from Crane Technical Paper #410, Reference 16, pages A-26 through A-29.

Loss Coefficient piping:

K=f(L/D) Reference 16, Page 2-8, equation 2-4
Where:
f=friction factor, assuming a diameter Commercial Steel from Reference 16, page A-23
ε = 0.00015 feet Absolute Roughness from Reference 16, page A-23

Diameter	16"	20"
friction factor f	0.0123	0.0118

for 90 degree Standard elbows assume L/D=12 from Reference 16, page A-29
for 90 degree Short Radius elbows assume L/D=20 from Reference 16, page A-29
for Tee flow through run assume L/D=20 from Reference 16, page A-29
for Tee flow through branch assume L/D=60 from Reference 16, page A-29

Valve Loss Coefficients:
K=f*(8) for 16" to 20" Gate Valve Reference 16, Page A-27
K=f*(50) for 16" to 20" Swing Check Valve Reference 16, Page A-27
For sudden sharp edged contractions of area, Kentry = 0.5 Reference 16, Page A-29
For sudden sharp edged expansions of area, Kexit = 1.0 Reference 16, Page A-29

Fitting or Valve	16" Dia	20" Dia
90° Standard K	0.148	0.142
90° Short RadiusK	0.246	0.236
Tee thru run K	0.246	0.236
Tee thru branch K	0.738	0.708
Gate Valve	0.098	0.094
Swing Check Valve	0.615	0.590

Junction 10301 Loss Coefficients:

The K junction for the 16" Tee through the branch is 0.738

Junction 15001 Loss Coefficients:

The entire equivalent K junction for exit of RCIC storage tank

K150f= K exit
K150f=1.00

K150r= K inlet
K150r=0.5

Junction 15101 Loss Coefficients:

The entire equivalent K junction for exit of suppression pool through isolation valves 1E22F314 and 1E22F015 and suction strainer

Strainer was 2.8 ft head loss=h_L at 70 F at 6400 GPM from calc 01HP13

That makes K= h_L *2*g/v^2
That makes K= (2.8 *2*32.2)/$(7.85)^2$ = 2.926

Where:
h_L=2.8 feet
g= 32.2 feet/sec2
area: ID=20"-7/8" –7/8" = 18.25" or 1.521 ft , area (Pi/4)(1.521)^2 = 1.817 ft2
v=6400 GPM*(0.1337 ft3/gal)*(1 min/60 sec)*(1/1.817 ft2) =7.85 ft/sec

Line 1HP05-16" piping for Volume #100, RCIC Storage Tank suction:

Hydrodynamic Component Number	Length (ft)	Angle from Horiz (degrees)	Junction Component	Loss Coeff Forward	Loss Coeff Reverse	Reference & Comments
100-01	4.4124	0°	16" Gate Vlv 1E22F318	0.098	0.098	Ref. 10, plan K. Elevation 739'-3", includes valve 1E22F318
100-02	4.4124	0°				Total Length is 32-13.438+3.5
100-03	4.4124	0°				22.062
100-04	4.4124	0°				divide by 5 volumes
100-05	4.4124	0°	90° elbow	0.148	0.148	4.4124
100-06	5.2500	-90°		0	0	Ref.12, sect 19-19 down to Elevation 723'-6"
100-07	5.2500	-90°		0	0	Height is 739.25-723.5 = 15.75 feet, divided by 3 volumes
100-08	5.2500	-90°	90° elbow	0.148	0.148	5.2500
100-09	10.55	0°				Ref. 10, plan J. Elevation 723'-6" Length is 26.5' -3.5' +28.5'+30= 81.5 feet
100-10	10.55	0°		0	0	Ref. 9, plan H. Elevation 723'-6" Length 22' - 2' = 24 feet to elbow
100-11	10.55	0°		0	0	Total length 81.5+ 24 = 105.5 feet
100-12	10.55	0°		0	0	divide by 10 volumes
100-13	10.55	0°		0	0	10.55
100-14	10.55	0°		0	0	
100-15	10.55	0°		0	0	
100-16	10.55	0°		0	0	
100-17	10.55	0°		0	0	
100-18	10.55	0°	90° elbow	0.148	0.148	
100-19	8.5	0°				Ref. 9, plan H. Elevation 723'-6" Length 26.5' - 4.5'-5' = 17 feet to elbow, divide by 2 vol

100-20	8.5	0°	90° elbow	0.148	0.148	8.5
100-21	10.75	0°				Ref. 9, plan H. Elevation 723'-6" Length 20' -2' +3.5 = 21.5 feet to elbow, divide by 2 vol
100-22	10.75	0°	90° elbow	0.148	0.148	10.75
100-23	11.15	0°				Ref. 9, plan H. Elevation 723'-6" Length 5' +24.25' = 29.25 feet
100-24	11.15	0°				Ref. 9, plan G. Elevation 723'-6" Length 22.5' +4' = 26.5 feet
100-25	11.15	0°				Total Length is 29.25+26.5=55.75 feet to elbow
100-26	11.15	0°				divide by 5 volumes
100-27	11.15	0°	90° elbow	0.148	0.148	11.15
100-28	12.000	0°				Ref. 9, plan G. Elevation 723'-6" Length 20' -3.5' +7.5 = 24 feet to elbow, divide by 2 vol
100-29	12.000	0°	90° elbow	0.148	0.148	12.00
100-30	5.166	-90°		0	0	Ref. 12, sect 18-18. Elev 723'-6" down to 713'-2" Length 10.33 feet to elbow, divide by 2 vol
100-31	5.166	-90°	90° elbow	0.148	0.148	5.166
100-32	6.125	0°		0	0	Ref. 9, plan G. Elevation 713'-2" Length 12.25 feet to elbow, divide by 2 vol
100-33	6.125	0°	90° elbow	0.861	0.861	Include elbow+gate valve + check valve loss coeff
100-34	3.167	-90°	90° Tee*	0.738	0.738	Ref. 11, sect 3-3. Elev 713'-2" down to 710'-0" Length 3.167 feet to Tee through branch
Total	287.311			2.881	2.881	

* the Tee from the 16" pipe to the 20" pipe is included in junction 103

Line 1HP01-20" piping for Volume #102, Suppression Pool suction:

Hydrodynamic Component Number	Length (ft)	Angle from Horiz (degrees)	Junction Component	Loss Coeff Forward	Loss Coeff Reverse	Reference & Comments
102-01	17.75	0°	90° elbow	0.338	0.338	Ref. 8, plan A. Elevation 720'-0", includes valves 1E22F318 and 1E22F015, Length 6.917+2.333+2+2.333+0.833+3.333=17.749 feet to elbow
102-02	10	-90°	90° elbow	0.142	0.142	Ref.11, sect 1-1 down to Elevation 710'-0"
102-03	8.4165	0°	Swing Check Vlv	0.59	0.59	Ref. 8, plan A. Elevation 710'-0", includes valves 1E22F016, Length 31.666-16.25-3+4.4167=16.833 feet to tee minus 3ft
102-04	8.4165	0°				divide by 2 volumes, 8.4165 feet
102-05	6	0°	Tee through Run	0.236	0.236	Arbitrary length to center Tee junction 103
102-06	4.625	0°		0	0	Ref. 8, plan A. Elevation 710'-0", Length 16.25-4-3=9.25 feet to elbow minus 3ft
102-07	4.625	0°	90° elbow	0.142	0.142	divide by 2 volumes, 4.625 feet
102-08	7.75	0°	90° elbow	0.142	0.142	Ref. 8, plan A. Elevation 710'-0", Length 7.5 feet to elbow
102-09	5.3073	0°				Ref. 8, plan A. Elevation 710'-0", Length 7.5 feet to HPCS pump inlet
Total	72.8903			1.59	1.59	

3.0 DETAILED EVALUATION Assumptions

1. The Reference 1 Alden Research Laboratory test used a 1/3 scale model mockup of the CPS RCIC storage tank and the HPCS attachment nozzle. Reference 1 provides detailed description of the testing performed and the basis for its applicability to CPS.

2. The Reference 1 Alden Research Laboratory testing did not quantify the void fraction entrained following the breakthrough. Discussion with test personnel indicated that the flow regime observed was bubbly flow rather than slug. The review of the test video clips showed that the tank level decrease was not significantly altered prior to reaching the top of the inlet pipe.

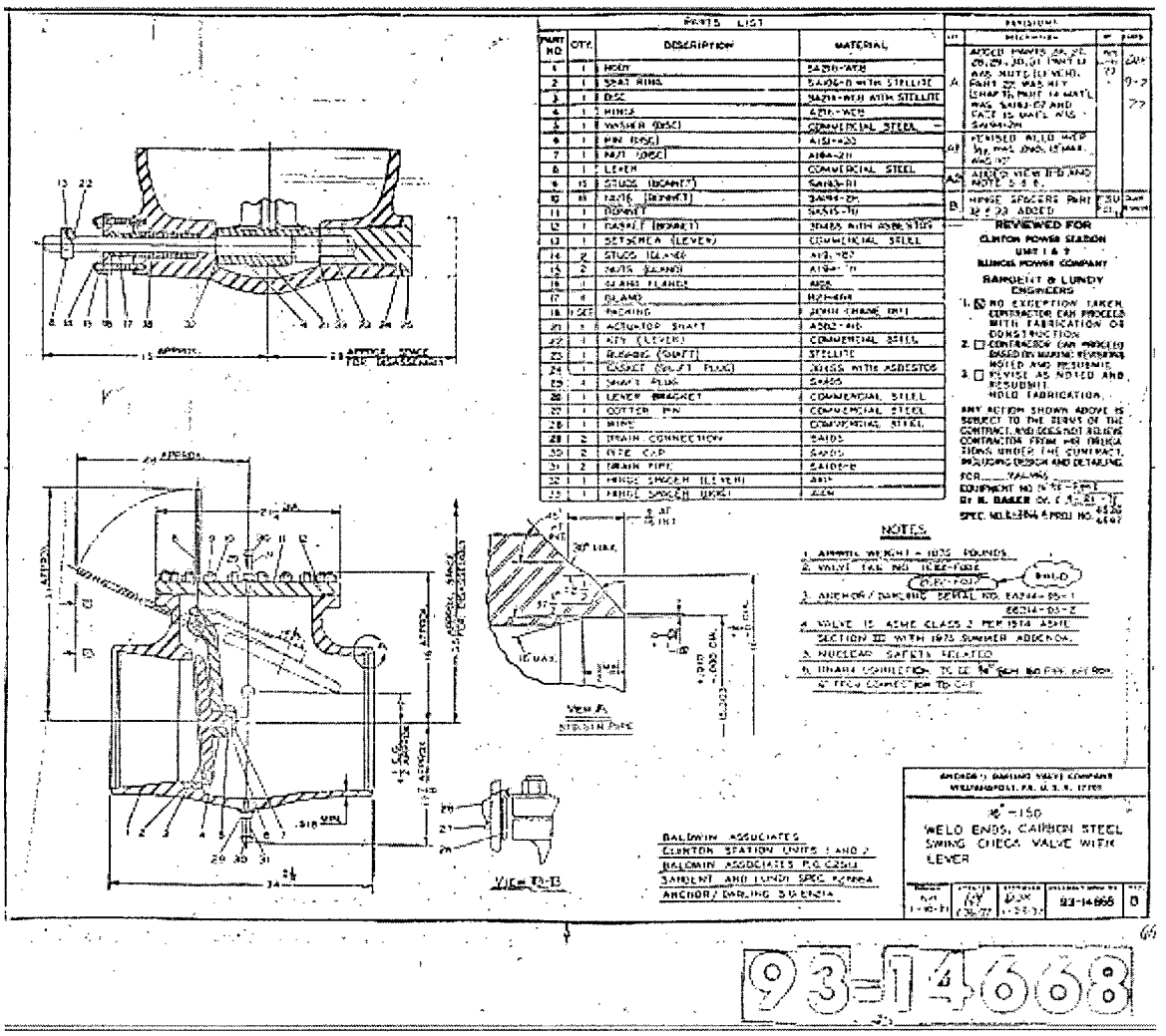
3. As noted previously, the Reference 1 testing did not quantify the air void fractions subsequent to breakthrough. The selection of 24% void fraction as the value of entrainment following breakthrough was made based on the following considerations:

   - The test personnel reported that the flow regime in the suction pipe remained as bubbly flow during the testing. No transition to slug flow was observed.
   - Review of sample test video showed that tank level continued to decrease at similar rate subsequent to breakthrough. Pipe voiding of less than 25% was observed.
   - Review of the RELAP5 flow regime maps and their transition points in Reference 7 suggests that transition to slug would occur for mass fluxes typical of this application at approximately 25% void content.
   - Additional review of the test tank level data for the 5500 gpm tests was performed to estimate an average and maximum void prediction. This review is attached as Attachment C, and further supports the selection of 24% as a representative, but bounding void estimate for this evaluation.
   - Side by side video comparisons of forced 24% void content and test 1a flows also support the conclusion that the test voiding was less than 24%.

   Therefore it was concluded that use of 24% void content following breakthrough would be reasonable yet conservative for this application. It is expected that the actual void content would be considerably less, closer to the average values computed in Attachment C.

4. The RCIC storage tank isolation valve is not modeled because its closing stroke time average of 70 seconds is more than 3 times longer than the suppression pool isolation valve opening time. The timing is such that it cannot close fast enough to reduce the amount air entrained to the suction of the pump. This assumption is justified since accurate modeling of the RCIC tank isolation valve would not change the results or conclusions.
5. The short section of increased diameter area 20"x24" reducer and strainer just at the inlet to the HPCS pump was not included in the RELAP5 model. The area change and strainer loss coefficient is not a sensitive input and does not influence the results, this assumption is justified.
6. The RCIC tank was initialized to 90 °F water temperature. The suppression pool was initialized to a temperature of 185F consistent with post-LOCA conditions.
7. The 19.32 psia suction pressure used in TDV 150 corresponds to 11. feet of elevation head assumed in the suppression pool . This is consistent with 11 feet of head of water at 185F plus the atmospheric pressure of 14.7. This is based on suppression pool minimum water level of 730' 11". In reality, following transfer of the contents of the RCIC storage tank to containment, a higher level would be expected.

8. A check valve with an assumed 0.5 psid lift is included in the RELAP5 model in the connection between the 16 inch and 20 inch headers. The 0.5 psid lift and closure pressure is not a sensitive input and does not influence the results, although having a check valve function as installed in the plant is important for the RELAP5 model to predict the post suction transfer behavior of the system. Specifically, including a check valve in the model precludes the suppression pool from refilling the 723' elevation 16" piping. This occurs after the peak void is seen at the pump and therefore does not influence the key parameter of interest. The pressure difference across the seat is reasonable based on the valve design (see diagram below). The pressure difference only has to overcome the friction at the hinge pin from the bearing and packing. This assumption is justified



4.0 References

1. "Hydraulic Model Study of High Pressure Core Spray Suction to Evaluate the Formation of Air Drawing Vortices and Air Withdrawal for Clinton Nuclear Power Station," Alden Research Laboratory, Inc. Test Report 2006-359_H258C, December, 2006.
2. "An Analysis of the Effects of Vortex Induced Air Ingestion in the Clinton High Pressure Core Spray Suction Line," Exelon Report MWMECH-2005-0003, Rev.0.
3. Calculation IP-C-0061, Rev. 0, Sheet 44.
4. Calculation IP-M-0384, Rev 1B, page 6.
5. Calculation 01HP09, Rev 6, page B-3.
6. DWG JN-D51749 RCIC Storage tank.
7. RELAP5/MOD3.3 CODE MANUAL, VOLUME I: CODE STRUCTURE, SYSTEM MODELS, AND SOLUTION METHODS, Nuclear Safety Analysis Division, December 2001, Information Systems Laboratories, Inc., sections 3.3.1 and 3.3.2
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10. CPS Plant Drawing MO6-1074 Sheet 4, Rev AC.
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13. CPS Plant Drawing MO5-1079 Sheet 2, Rev AH.
14. CPS Plant Drawing MO5-1074 Sheet 1, Rev AG
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16. CRANE Technical Paper No. 410, "Flow of Fluids Through Valves, Fittings and Pipe," 1988.
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19. SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION SUPPORTING AMENDMENT NO. 73 TO FACILITY OPERATING LICENSE NO. NPF-62, ILLINOIS POWER COMPANY, ET AL, CLINTON POWER STATION, UNIT 1, DOCKET NO. 50-461, April 9, 1993.
20. "OPL-4 and 5 Approval," Clinton Letter ELPU-0226 to Erik Stromqvist (GE) from Dale A. Spencer (CPS), dated January 22, 2001.
21. Clinton Piping Design Tables, B106CP, B940CP, and B140CP
22. Technical Specifications, License NPF-62, Amendment 172, February 24, 2006.
23. NUREG-1475, "Applying Statistics," February, 1994.
24. Calculation 01HP08, Rev. 1, "Determination of NPSH for Pump E22C001 at Source Switchover"
25. TODI CPS-06-021, Rev. 0, December 21, 2006
26. Alden Laboratories Addendum Test data of Level vs time (See Attachment C)
27. Calculation 01HP13, Rev. 0.

5.0 DETAILED EVALUATION Identification of Computer Programs

The methodology used for this calculation employs a RELAP5 MOD 3.3 model representation of Clinton piping. Per procedure CC-AA-309-1001, Revision 3, steps 4.3.6, use and documentation for this software is applicable to the Digital Technology Systems Procedure IT-AA-101. It requires the code to be identified with its operating system. The executable used was:
/nfs.prodlib/RELAP5-MOD3.3/exe/relap5_mod3.3.exe (FOR CONTROLLED ANALYSIS).

The UNIX computer machine/OS Info was: HP-UX union B.11.11 U 9000/800 2104760327 unlimited-user license.

The calculations were performed using the RELAP5 MOD3.3 computer code as installed on the Exelon HP UNIX platform. This code has been validated and verified as documented in Reference 18. Post processing was performed using the XMGR5 software package distributed with the RELAP5 code package.

6.0 DETAILED EVALUATION Method of Analysis and Acceptance Criteria

6.1 Statistical Treatment of Test Data Methods

The statistical treatment of the test data consists of two separate considerations, namely, quantification of test measurement uncertainty, and prediction of appropriate multipliers on the data distribution to ensure capture of 95% of the distribution with a 95% confidence level.

The test measurement uncertainty consists of two parts, the flow measurement and the level measurement. The flow measurement accuracy and level measurement accuracy was shown in section 2.3. The following steps calculated in detail in Attachment B were followed to compute an effective test measurement uncertainty for application in full scale:

1) The mean level for breakthrough was plotted and noted to be essentially linear. A first order equation relating level breakthrough to flow was generated.

2) The equation was employed to determine the full-scale level effects of a 2% flow measurement uncertainty (0.084 inches).

3) The level uncertainty scaled to full scale was determined to be 0.549 inches.

4) Combination of the two uncertainties via SRSS yields an effective test measurement uncertainty in full-scale level of 0.556 inches.

The distribution uncertainty was addressed by the examining the data points for poolability, creating a pooled set of data, and generating a single side 95/95 tolerance limit for the 5500 gpm data for use in analysis. Reference 23, NUREG-1475 methods were explicitly applied for this work. Key outcomes from this evaluation were:

1) The 3000 gpm and 5500 gpm data proved to be poolable.

2) The single sided 95/95 tolerance limit generated for the 5500 gpm case was 5.411 inches.

The distribution uncertainty was then added directly to the test measurement uncertainty to establish an analytical breakthrough initiation point of 5.967 inches, which was applied in the development of the RELAP5 input. The worksheets for this effort are provided in Attachment B.

6.2 Generation of RELAP5 Input Void Fraction Model

As noted below, the RCIC/HPCS storage tank is modeled as a Time Dependent Volume (TDV). By using the non-condensable option to specify the tank properties, a time dependent air introduction into the suction pipe can be modeled. Details of the calculation can be found in Attachment B. To summarize, the time dependency of the air entrainment is determined as follows:

1) The model is assumed to be at 12 inches level above the HPCS nozzle at time =100 seconds. The first 100 seconds are used to initiate flow in the model and achieve a steady state condition at the desired flow. At 100 seconds, the void fraction is assumed to be 0% and is held constant until breakthrough is achieved. (This is consistent with the behavior observed in the test).

2) The level drop vs time is computed from the tank volume and the HPCS pump flow rate. At 5500 gpm, the tank level will drop 1 inch in 4.787 seconds.

3) The time to reach the void breakthrough level is computed. At this point, the boundary volume properties are adjusted to achieve a 24% inlet void fraction at the nozzle. For this analysis, 128.9 seconds was determined to be the void breakthrough point.

4) The switchover setpoint allowable value is approximately 3.3 inches above the top of the pipe. The time at which the switchover initiates is then computed based on a reduced tank drawdown rate consistent with the 24% voiding assumption. For this case, this time is computed as 145.7 seconds. This value is used as the trip setpoint for the suppression pool suction transfer initiation.

5) The inlet void fraction is held constant at 24% (Assumption #3) until the level reaches the top of the pipe. When the tank level drops to the top of the suction pipe, the TDV properties are switched to all non-condensable, to conservatively maximize the air intrusion and drain down of the 16 inch suction pipe.

6.3 Description of the RELAP5, Mod 3.3 Dynamic Thermal Hydraulic Model

A detailed model of the HPCS suction piping has been prepared to analyze the air intrusion event. The 16 inch header is broken down into 34 subvolumes, based on the plant drawings. The 20 inch header is broken down into 9 subvolumes. The node size ranges from 5 to 10 feet in length. The following are key parameters used in the model:

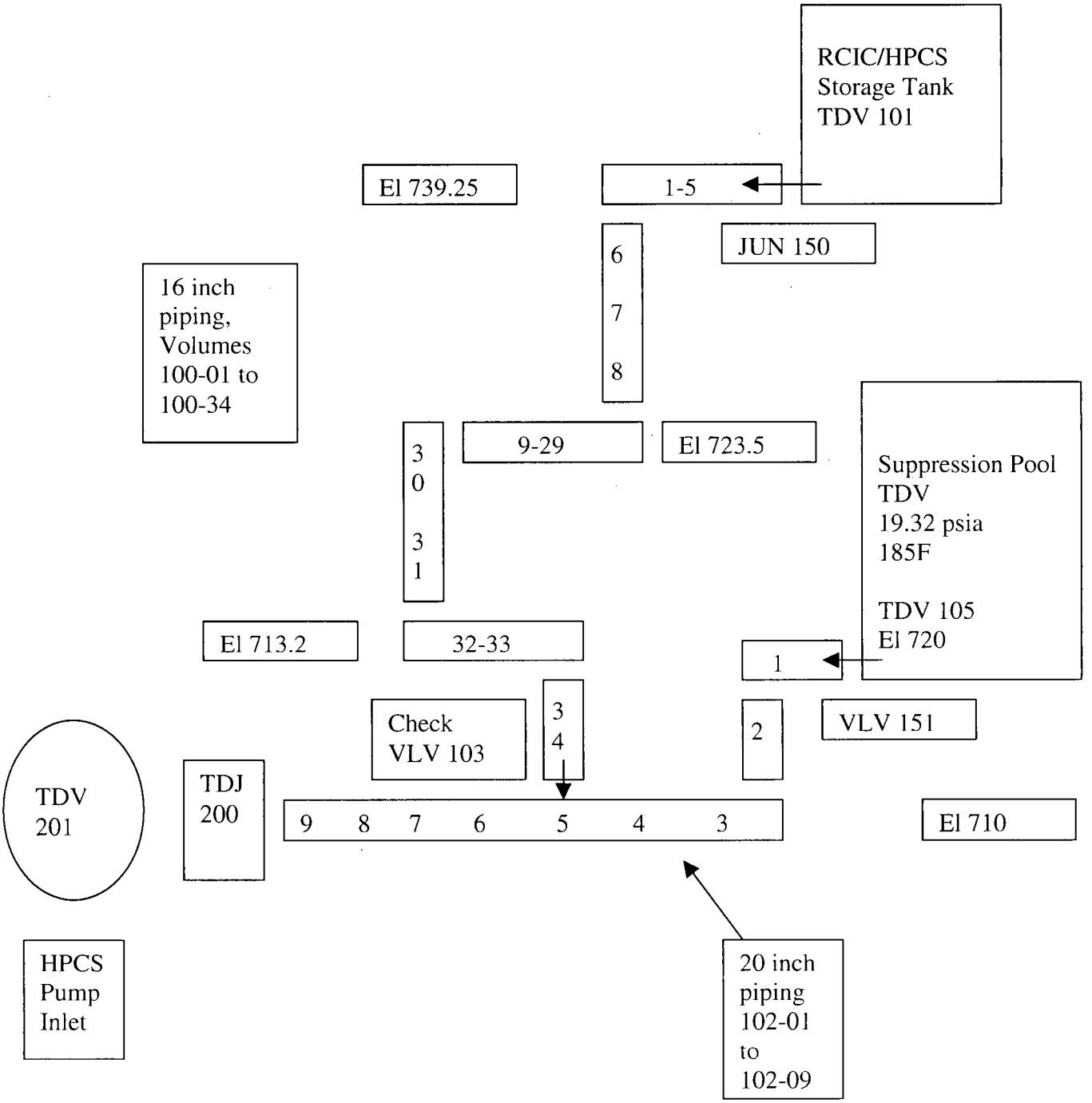
1. RCIC/HPCS tank is modeled as a time dependent volume. The test based air entrainment and transfer point setpoint are discussed in detail in Section 3.2.
2. Suppression pool is modeled as a TDV just outboard of the isolation valve. The suction is at 720 feet and a suppression pool level of 731.6 feet is assumed. No containment overpressure is assumed.
3. The pump suction is modeled as a time dependent junction with velocity specified. This is more appropriate for a volumetric component like a pump than to specify a mass flow rate.
4. The suppression pool isolation valve is assumed to open linearly in 28 seconds. A second case is also run using the maximum valve timing measurements taken over the life of the plant, 21 seconds.
5. A check valve with 0.5 psid lift is modeled at the connection between the 16 inch and 20 inch headers. The storage tank isolation valve is not modeled because its closing stroke time average of 70 seconds is more than 3 times longer than the suppression pool isolation valve opening time.
6. Piping is assumed to be standard size, based on plant drawings.

A diagram of the RELAP5 model is provided in Figure 1. A listing of the model is provided in Attachment A.

This analysis modified the model developed in Reference 2 in the following manner:

1. Historical measured valve data was applied as the basis for the suppression pool isolation valve (15 valve) transfer time for one case.
2. The allowable value for the low tank level transfer to the suppression pool was used, as opposed to the analytical value used in the previous analysis. This is a change to 3.3 inches above top of nozzle from 1.97 inches for the transfer level setpoint.
3. The HPCS pump is operating at 5500 gpm consistent with the testing performed.
4. Air entrainment is based on actual test data taken, with allowances for statistical uncertainty and distribution effects included. It should be noted that the previous model assumed entrainment started sooner (higher elevations) than is indicated by the subscale testing. The subscale testing displayed no entrainment prior to large scale breakthrough, and this is what is now modeled.
5. The effect of large scale entrainment on tank level behavior has been included in this analysis.
6. Suppression pool temperatures have been increased to 185F to ensure potential thermal/vapor pressure effects of bubble growth are included.
7. Additional losses in the suppression pool suction line have been added to bound historical plant configurations. Specifically "old" strainer losses are applied vs the new strainers.

Figure 1 RELAP 5 Model Diagram



6.4 Phenomenological Considerations and Acceptance Criteria

The historical plant RCIC/HPCS tank switchover setpoint has been questioned with respect to the submergence allowances typically employed to preclude vortex considerations. The historical switchover limit is low enough that vortex –induced air entrainment could reasonably be anticipated prior to suction switchover from the tank to the suppression pool. Most vortexing correlations are defined to preclude vortexing, to varying degrees of conservatism, depending on the correlation development. Computing air entrainment subsequent to vortex formation is not a well-documented situation. In addition, the pump vendors have little data supporting pump operation with large scale air entrainment. Based on industry experience, operation at 2% entrainment or less is generally agreed to be acceptable.

The prototypical vortex testing performed demonstrated that essentially no entrainment would occur until levels near the top of the inlet pipe were reached. At this point, breakthrough was experienced, in essence the development of a Bernoulli stream tube from the surface to the pipe inlet. The testing performed was unable to quantify the void fraction so that has to be estimated based on observed tank level decrease rate and pump behavior and flow regime observations.

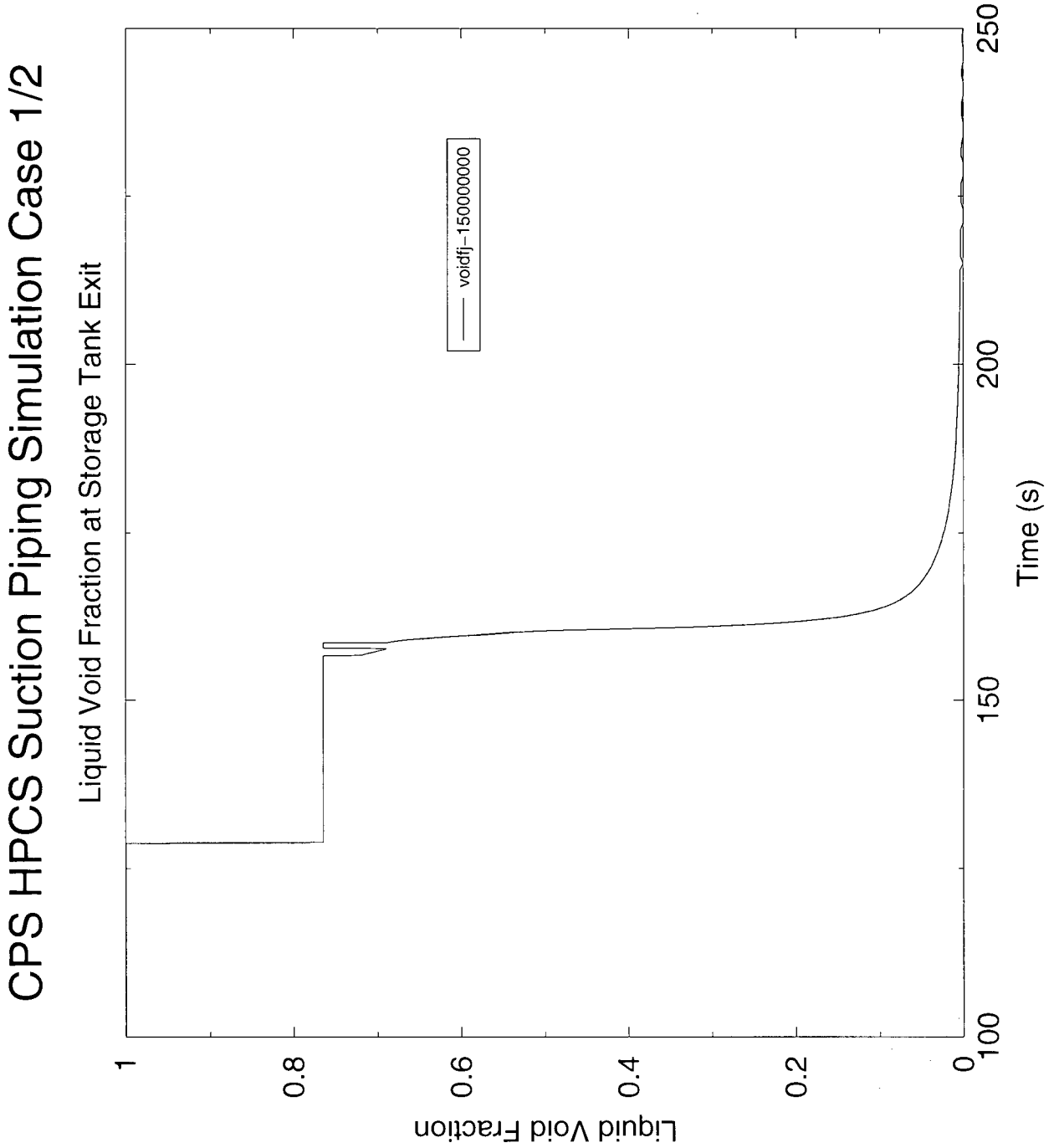
The acceptance criteria for the successful determination of HPCS operation is:

- Continuous air entrainment ≤ 2% volumetric void fraction

7.0 DETAILED EVALUATION Numeric Analysis

Figure 2 provides a plot of the Case 2 liquid void fractions versus time entering the suction pipe for the cases described. The model parameter plotted is actually the voidfj parameter for the junction connecting the tank TDV to the suction pipe, and as such represents the fluid composition entering the pipe. This RELAP5 output confirms the approach described earlier where the inlet void fraction is held constant at 24% (Assumption #3) until the level reaches the top of the pipe. When the tank level drops to the top of the suction pipe, the TDV properties are switched to all non-condensable, to conservatively maximize the air intrusion and drain down of the 16 inch suction pipe.

Figure 2 Liquid Void Fraction Entering 16 inch Suction Pipe Case 2



8.0 DETAILED EVALUATION Results

Figure 3 provides a time line for the HPCS suction transient, with the times estimated based on flow rates, fully mixed flow, and the assumed void content of the flow. The void transient can be thought of as a race between the void front traveling in the suction line, and the time to complete the suction transfer to the suppression pool. Since the void pull through determined in the test initiates at a level above the suction transfer setpoint, the suppression pool transfer delay is composed of the time to reach the isolation setpoint (with correction for reduced fluid flow due to voiding) plus the suppression pool valve stroke time. For this analysis, with a statistically determined breakthrough level assumed, the time for voids to transit the 16 inch header is less than the time to complete the suction transfer, and as a result, some air will be expected to reach the 20 inch header. The amount of air is governed by the dynamic response of the system during the switchover. Review of the RELAP results shows that RELAP as configured (standard hydrodynamic model elements) tends to transport the void front through the horizontal piping faster than would be predicted by use of a simple fluid velocity transport time computation. This is a result of slip between phases in the horizontal stratified flow regime that RELAP transitions to fairly quickly following the large scale air ingestion. Essentially, once stratified conditions exist, RELAP tends to accelerate the gas over the fluid in the long horizontal runs. This is recognized as conservative and is a potential area for model enhancement in the future.

Figure 4 shows the time dependent flow behavior of the system, as the suppression pool isolation valve opens. The draindown of the 16 inch header occurs to the 723.5 foot elevation level in both cases, which is below the elevation of the minimum suppression pool level. When the suppression pool isolation valve opens fully, the check valve in the 16 inch header closes and full suction flow is supplied by the suppression pool.

Figure 5 provides the predicted junction liquid void fractions for Case 1 at the entrance to the pump and at the tee connecting the 16 inch header to the 20 inch header. The liquid void fraction entering the pump is approximately 98% (gas void fraction of 0.02), which satisfies the 2% air ingestion limits typically applied to centrifugal pumps.

Figure 6 provides the time dependent flow behavior of the system for Case 2, with an assumed suppression pool isolation valve stroke time of 21 seconds. The effects of the more rapid suppression pool opening time are apparent, with less flow oscillation occurring at the junction between the 16 inch line and the 20 inch header.

Figure 7 provides the predicted junction liquid void fractions for Case 2 at the entrance to the pump and at the tee connecting the 16 inch header to the 20 inch header. The minimum liquid void fraction entering the pump is approximately 0.99 (gas void fraction of 0.01). With the more rapid transfer of suction supply to the suppression pool in this case, less air voiding would be expected and the results of this case are consistent with that expectation.

Design Attribute Review

"Engineering Technical Evaluations" procedure CC-AA-101, Rev. 6, step 4.2.5 requires a Design Attribute Review (DAR) per CC-AA-102, Rev. 13. The CC-AA-102, Attachment 1 DAR was included in the passport panel as required. To summarize the results, since this EC is a backward looking EC Evaluation of past functionality, and is not a configuration change in the past, or future, the DAR shows no impact based on the below evaluation.

The following was used to answer "not applicable" to DAR item 4.1.33: IDENTIFY Mechanical System Characteristics where design limits are placed on the mechanical properties of a system or components. The purpose of this EC was to determine the volumetric air void passing through the HPCS pump. Because the percentage met the acceptance criteria in section 6.4, there is no impact on the DAR for Item 4.1.33.

Figure 3 Time line for HPCS Suction Line Void Transient

Note: RCIC tank level assumed to be 12 inches at T=100 seconds in simulation

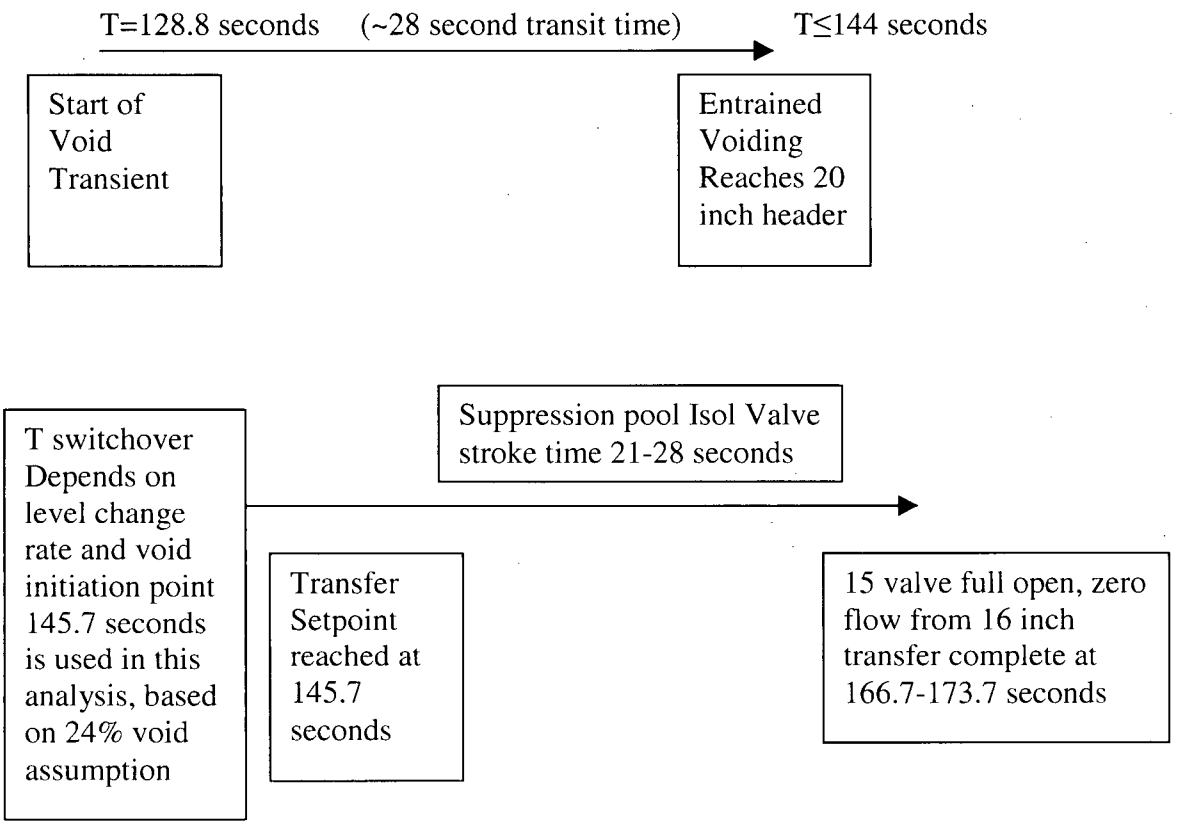


Figure 4 Case 1 Flow Response

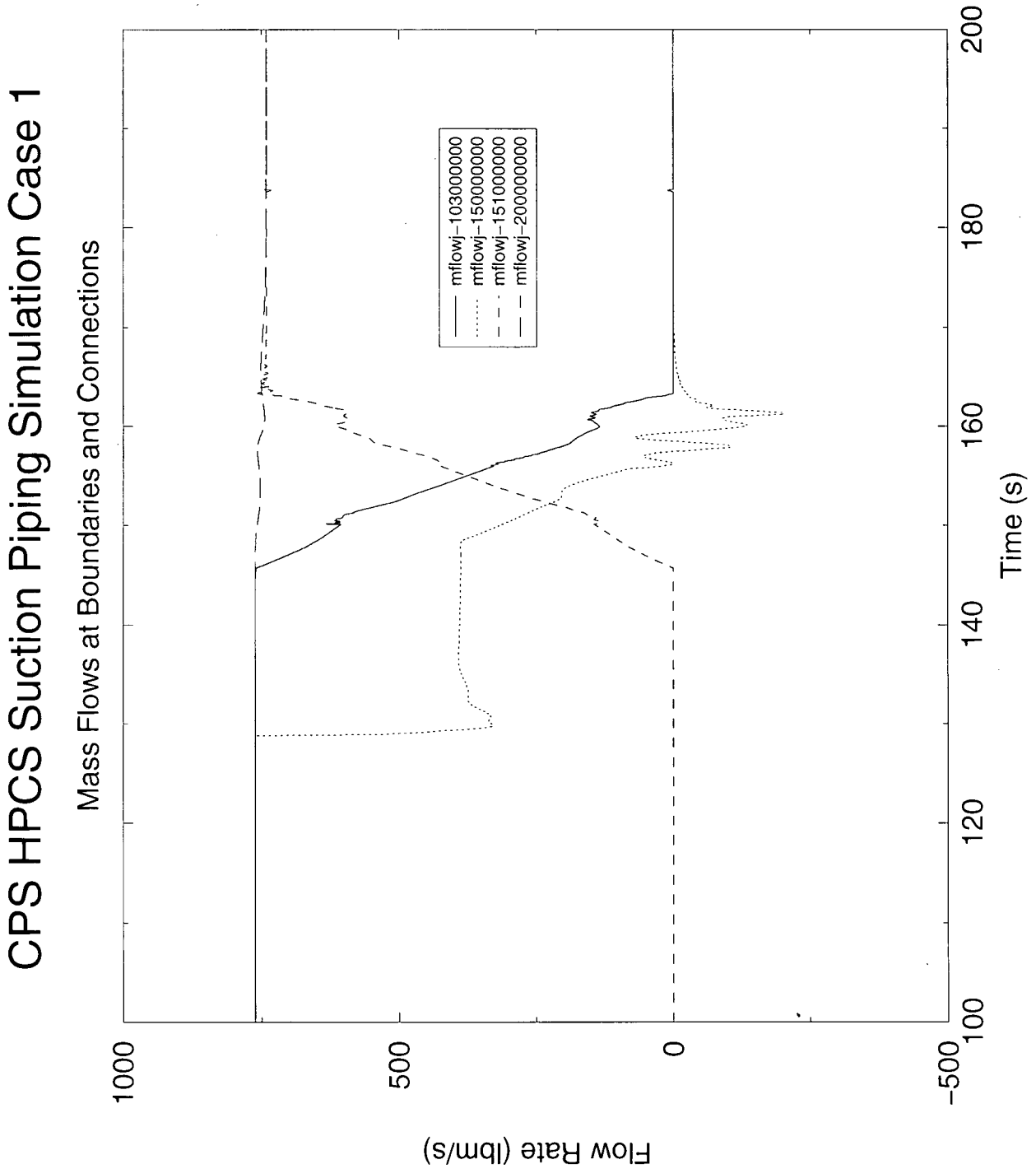


Figure 5 Case 1 Void Fraction in 20 inch header

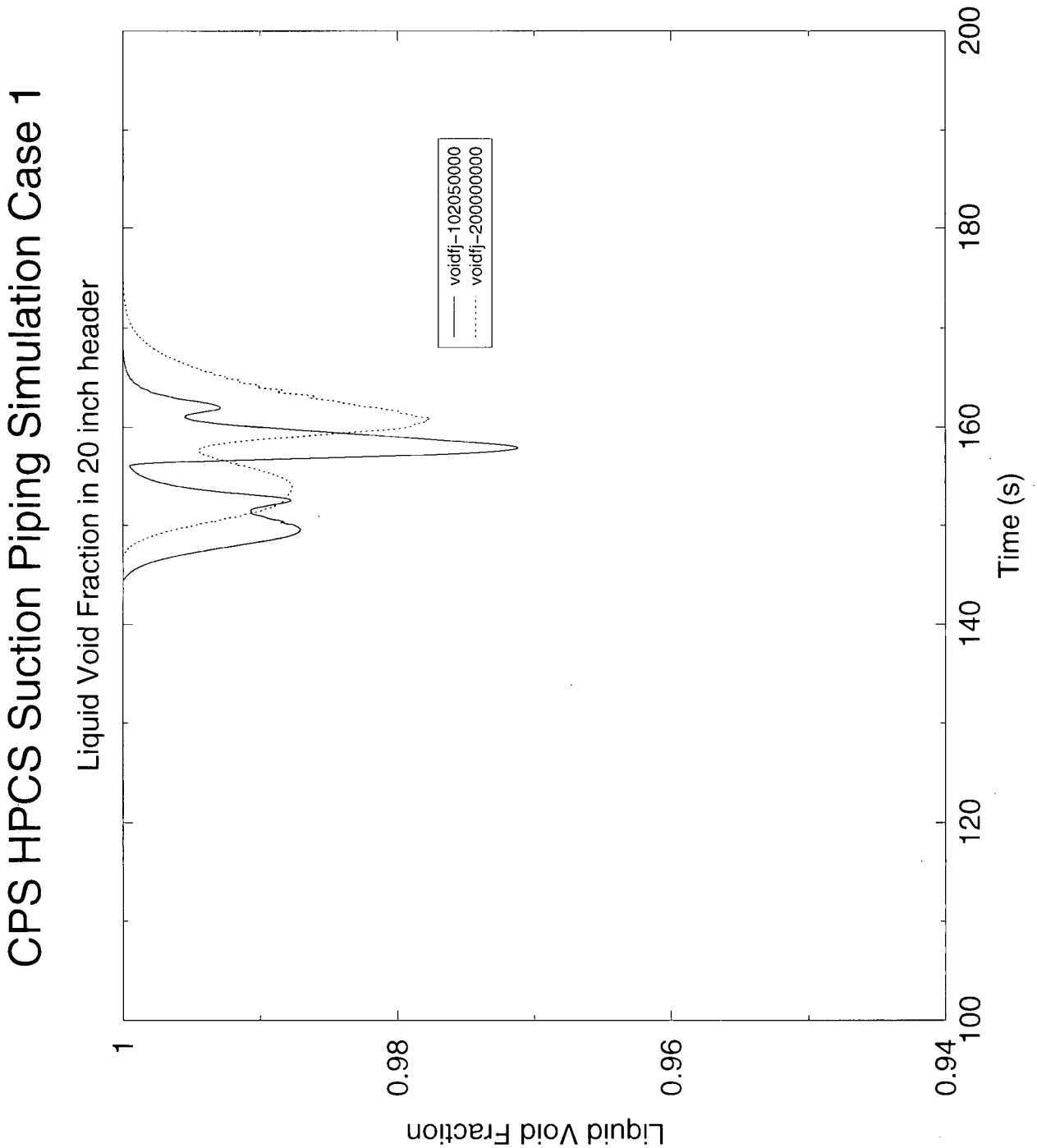


Figure 6 Case 2 Flow Response

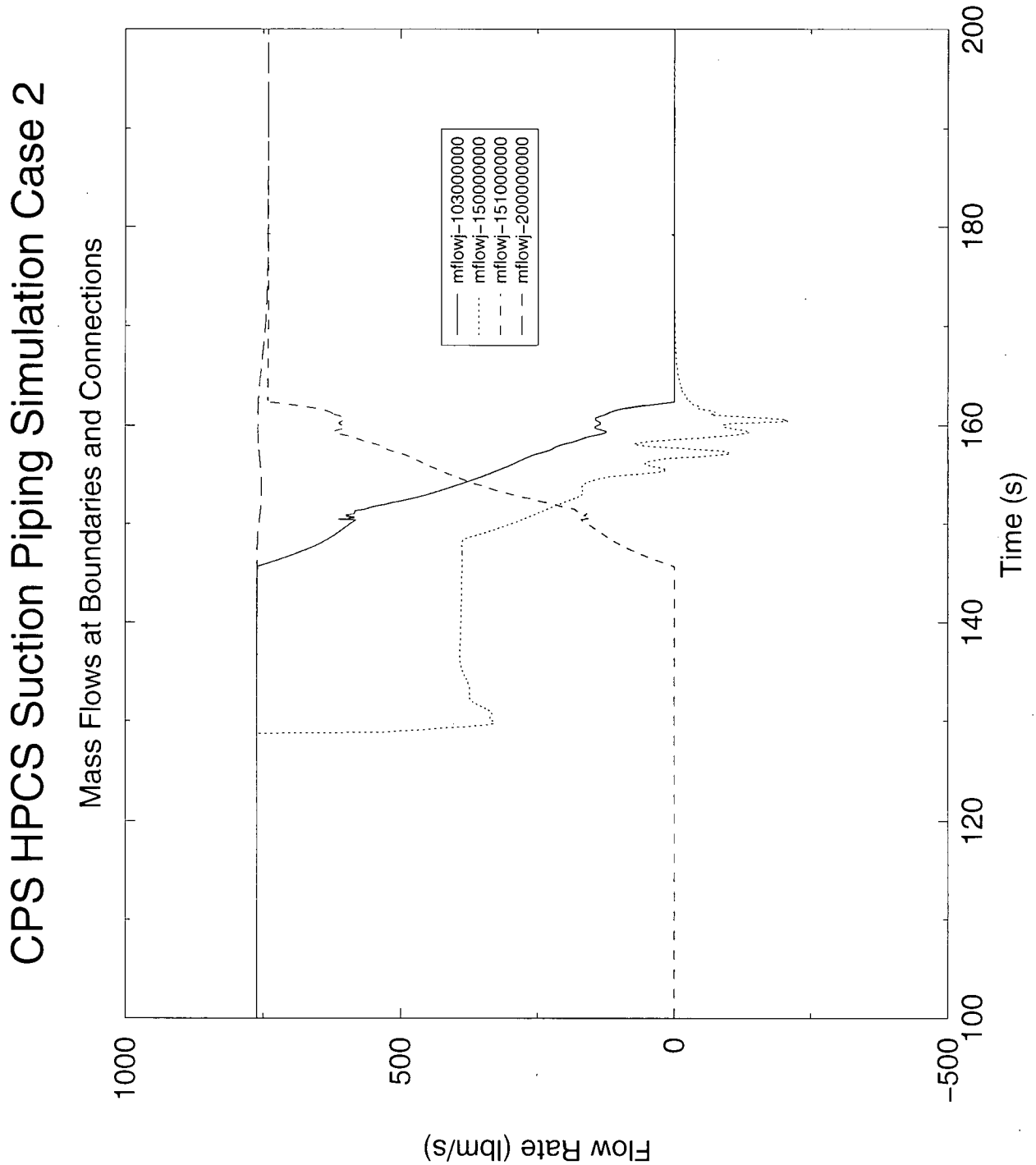
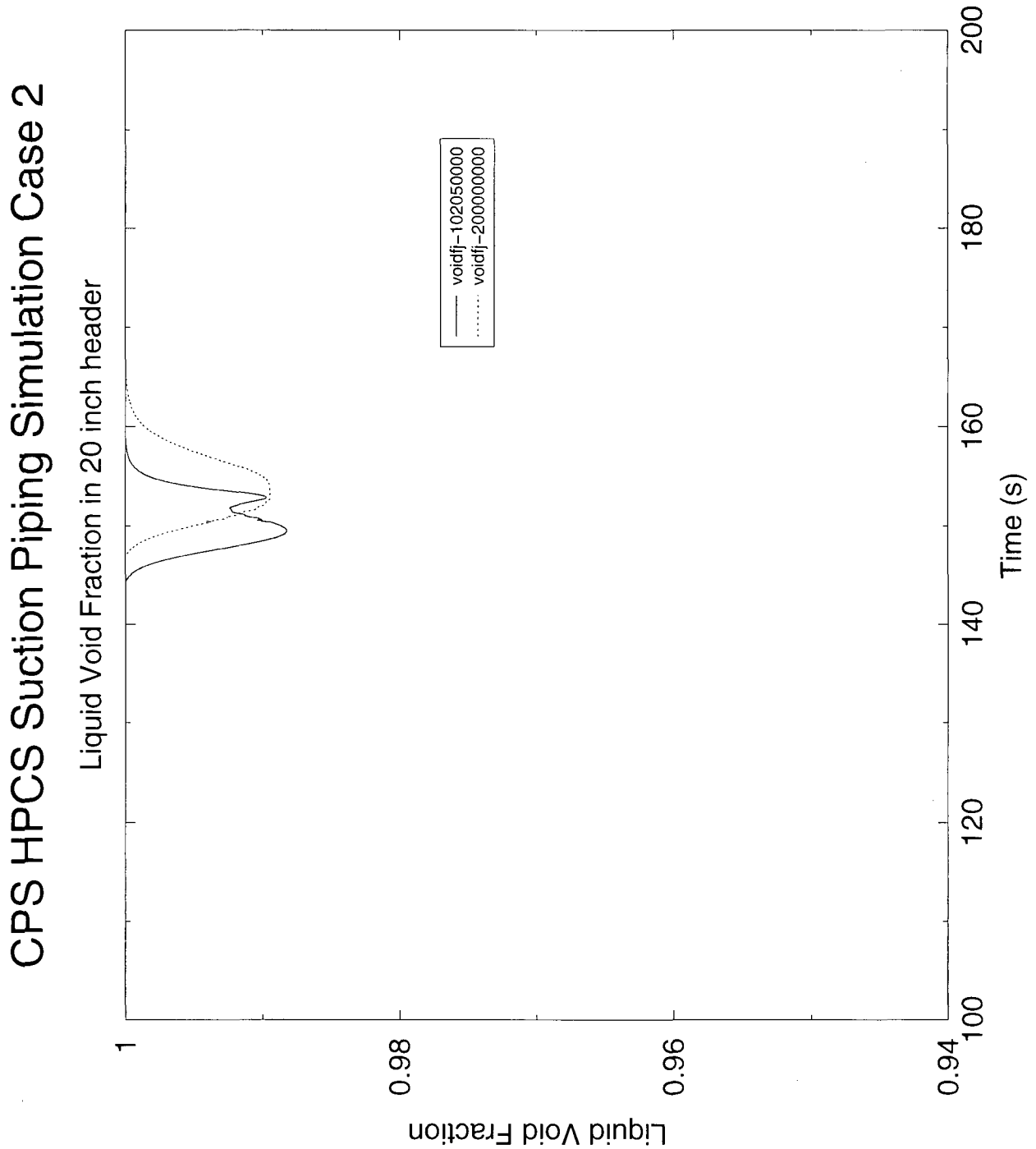


Figure 7 Case 2 Void Fraction in 20 inch header



9.0 CONCLUSIONS/FINDINGS

A model of the Clinton HPCS suction header has been prepared and exercised to simulate the time dependent response of the system during the approach to and completion of suction switchover to the suppression pool. The model was configured to simulate the historical plant RCIC/HPCS low level switchover setpoint. The air entrainment behavior was modeled based on the subscale testing performed. The following results were obtained:

1) Case 1 (Design suction transfer valve stroke time) showed that entrained air would reach the HPCS pump, but at levels of approximately 2%. No impact on pump performance is expected.
2) Case 2 (Actual suction transfer valve performance) showed that entrained air would reach the HPCS pump, but at levels of approximately 1%. No impact on pump performance is expected.

These results support a conclusion that the system would have been operable with the historical tank switchover setpoint. The following observations are salient to the application of this evaluation:

1) The model was developed to conservatively represent the plant response, particularly with respect to suction transfer time.
2) The model included statistically based methods to conservatively represent the test data uncertainty, both in terms of instrument accuracy as well as data distribution.
3) The void fraction assumed was conservatively selected and applied to maximize the potential for predicted entrainment at the HPCS pump.

Prepared by: Kevin B. Ramsden	**Date:** 12/20/06
Detailed Independent Review: John M. Freeman	**Date:** 12/21/06
Independent Third Party Review (MPR): Amol S. Limaye	**Date:** 12/21/06
Approved: Frank G. Lentine	**Date:** 12/21//06

Attachment A - Listing of RELAP5 Model

The listing of the model developed is provided below. It is configured for the Case 1 conditions.

```
=Detailed Model of CPS HPCS suction supply line
* this deck is set up to model the effect of void transport in piping
*it uses 100 seconds for steady state initialization, then adds void
*
100 new transnt
*
*
102  british   british
105  90.  100.
105    0.  0.
110 air
*******************************************************
*                                                     *
*               time step cards                       *
*                                                     *
*******************************************************
*     end   dtmin    dtmax  opt min  maj rstrt
201     120.  1.d-7    0.01   3   200   1000 10000
202     200.0  1.d-7    0.001   3   5   2000 20000
203     300.  1.d-7    .01   3   100   1000 20000
*
*******************************************************
*                                                     *
*              minor edit variables                   *
*                                                     *
*******************************************************
*
301 voidf 102010000
302 voidf 102090000
303 voidf 100010000
304 voidf 100100000
305 voidf 100180000
306 voidf 100280000
307 voidf 102050000
308 mflowj 151000000
309 mflowj 150000000
310 mflowj 103000000
311 mflowj 200000000
*
*
*****************************************************************
*                       trip cards                              *
*                                                               *
*                     trip identifier                           *
*                                                               *
*     510   opens the check valve at feed line at 1050 psia     *
*     511   closes the check valve at feed line                 *
*     512   open trip for air leakage tdv                       *
*     513   close trip for air leakage tdv                      *
*     514   open trip for test return valve                     *
```

```
*     515   close trip for test return valve                    *
*     516   open trip for 4 inch line valve                     *
*     517   close trip for 4 inch line valve                    *
*     550  <problem stop                                        *
*     600  < cards                                              *
*                                                               *
*****************************************************************
550  time   0            ge   null    0      300.0       1
600   550
*
522  time   0            ge   null    0      145.7       1
523  time   0            ge   null    0      10000.       1
525  time   0            ge   null    0      10.       1
*****************************************************
*                                                   *
*              hydrodynamic components              *
*                                                   *
*****************************************************
*
*volume 101 is a tdv setup to simulate hpcstank
****
 1010000   source      tmdpvol
*         flowa  l    vol   azi   incl  dz   rough hyd    fe
 1010101     1.e2 1.0  0.0   0.0   0.0   0.0   0.0   0.0   10
*        ebt
 1010200  4
*         time  press   temp     qual
1010201   0.0        14.7   90.0   0.00000001
1010202   100.0       14.7   90.0   0.00000001
1010203   100.1        14.7   90.   0.00000001 *stay at zero entrain
***this set of inputs corresponds to the 95-95 limit
1010204   128.8       14.7   90.         0.000022   * 2% entrain
1010204   128.8       14.7   90.         0.00000001   * 0% entrain
1010205   128.9      14.7   90.         0.00035
1010206   166.       14.7   90.         0.00035  *test
1010207   166.4       14.7   90.         0.999  *top of pipe 100%
1010208   500.0       14.7   90.         0.999
*****
*
1500000   connect  sngljun
1500101   101000000 100010001   0.0   0.5  1.       01000
*         flag lflow    vflow  interface flow
1500201   1    0.0       0.0      0.0
**
***
*
1000000   upper pipe
*         nv
1000001   34
*         flowa    nv
1000101   1.2684   34
*
*         jarea nj
*1000201   0.0 1
*1000202   1.9175e-4  2
*         length   nv
1000301   4.4124    5
```

```
1000302   5.25    8
1000303   10.55   18
1000304   8.5     20
1000305   10.75   22
1000306   11.15   27
1000307   12.0    29
1000308   5.166    31
1000309   6.125   33
1000310   3.167   34
*       incline angle  nv
1000601   0.0          5
1000602   -90.         8
1000603   0.0         29
1000604   -90.        31
1000605   0.0         33
1000606   -90.        34
*         rough  hyd dia  nv
1000801   0.00015 0.0     34
*
*   901   fjunf   fjunr    nj
1000901    0.098     0.098    4
1000902    0.148      0.148      5
1000903    0.0     0.0    7
1000904    0.148   0.148    8
1000905    0.0     0.0    17
1000906    0.148   0.148  18
1000907    0.0     0.0    19
1000908    0.148     0.148    20
1000909    0.0     0.0    21
1000910    0.148     0.148    22
1000911    0.0     0.0    26
1000912    0.148     0.148    27
1000913    0.0     0.0    28
1000914    0.148     0.148    29
1000915    0.0     0.0    30
1000916    0.148     0.148    31
1000917    0.0     0.0    32
1000918    0.861    0.861    33
*         fe   nv
1001001   00   34
*         cahs nj
1001101   0000  33
*1001102   0100  2
*        flag   p       t       x         dummy nv
1001201   3     14.7    90.0000   0.0  0.0   0.0  34
*         flag 1=lbm/sec
1001300   1
*         lflow    vflow  interface flow nj
1001301   0.0        0.0         0.0     33
*
1030000   line valve
1030101   100340002 102050004    1.2684   0.738      0.738       001100
1030201   1  0.0  0.0
1030300   chkvlv
1030301   0  1  0.5  0.0
*
*1030000   connect  sngljun
```

```
*1030101   100340002 102050004    0.   1.0  0.5       01000
*         flag lflow    vflow  interface flow
*1030201   1    0.0       0.0      0.0
**
*==================
 1050000   contain      tmdpvol
*         flowa  l    vol   azi   incl  dz   rough hyd    fe
 1050101     1.e2 1.0  0.0   0.0   0.0   0.0   0.0   0.0   10
*        ebt
 1050200  3
*         time  press   temp     qual
1050201   0.0    19.32    185.
1050202   500.0   19.32    185.
*         time  press   temp     qual

1510000   line valve
1510101   105000000 102010001    2.0142   2.926      2.926       001100
1510201   1  0.0  0.0
1510300   mtrvlv
*         opentrp  cltrp  rate   ip   vtn
1510301   522     523     0.036   0.0  *28 second stroke
*1510301   522     523     0.04762     0.0  *21 second stroke
*
1020000   lower pipe
*         nv
1020001   9
*         flowa    nv
1020101   2.0142   9
*         length   nv
1020301   17.75      1
1020302   10.0     2
1020303   8.4165    4
1020304   6.0      5
1020305   4.625    7
1020306   7.75     8
1020307   5.3073     9
*       incline angle  nv
1020601   0.0          1
1020602   -90.0        2
1020603   0.0          9
*         rough  hyd dia  nv
1020801   0.00015 0.0     9
*
*   901   fjunf   fjunr    nj
1020901    0.338     0.338      1
1020902    0.142     0.142      2
1020903    0.59     0.59      3
1020904    0.0     0.0        4
1020905    0.236     0.236      5
1020906    0.0    0.0     6
1020907    0.142     0.142      8
*         fe   nv
1021001   00   9
*         cahs nj
1021101   1000  8
*        flag   p       t       x         dummy nv
1021201   3     14.7     90.0    0.00   0.0  0.0 9
```

```
*          flag 1=lbm/sec
1021300    1
*          lflow    vflow  interface flow nj
1021301    0.0        0.0         0.0     8
*
**
2000000    pumpsuct   tmdpjun
2000101    102090002   201000000   0.0
2000200    1  525
2000201    -1.0  0.0     0.0   0.0
2000202    0.0   696.5   0.0   0.0
*tdj repeat with velocity specified
2000000    pumpsuct   tmdpjun
2000101    102090002   201000000   0.0
2000200    0  525
2000201    -1.0  0.0     0.0   0.0
2000202    0.0   0.0     0.0    0.0
2000203    10.0   5.542   5.542   0.0
2000204    1000.0   5.542   5.542   0.0
2000203    10.0   6.504   6.504   0.0  *5880gpm
2000204    1000.0   6.504   6.504   0.0
2000203    10.0   6.084   6.084   0.0 *5500gpm
2000204    1000.0   6.084   6.084   0.0
*
 2010000   sink       tmdpvol
*          flowa  l    vol   azi   incl  dz   rough hyd    fe
 2010101      1.e2 1.0  0.0   0.0   0.0   0.0   0.0   0.0   10
*         ebt
 2010200  2
*          time  press   temp     qual
2010201    0.0    14.7    1.
2010202    500.0   14.7    1.
*
*
*****************************************************************************
**********************************************
*                                            *
* end of input deck - problem end            *
*                                            *
**********************************************
.
```

Attachment B- Analysis of Alden Subscale Test Results

Statistical Treatment of Alden Test Data

This worksheet provides the statistical treatment of the Alden test data for application to the RELAP5 analysis. This treatment includes data poolability check between data sets and the generation of a single side 95-95 tolerance limit. The statistical methodology is based on NUREG-1475 guidance.

5500 gpm data, 3 points

Data5500 :=

	0	1
0	4.65E+000	
1	4.17E+000	

$Dat1 := Data5500^{\langle 0 \rangle}$ $\qquad Dat1 = \begin{pmatrix} 4.65 \\ 4.17 \\ 4.8 \end{pmatrix}$

$Stdev(Dat1) = 0.329$ $\qquad s := Stdev(Dat1)$

$mean(Dat1) = 4.54$ $\qquad \mu := mean(Dat1)$

Viewed in percentage change from mean

$Dat1a := \frac{Dat1 - \mu}{\mu} \cdot 100$ $\qquad Dat1a = \begin{pmatrix} 2.423 \\ -8.15 \\ 5.727 \end{pmatrix}$

$S1a := Stdev(Dat1a)$

$S1a = 7.249$

3000 gpm data

Data3000 :=

	0	1
0	2.6	
1	2.56	

$Dat2 := Data3000^{\langle 0 \rangle}$

$$Dat2 = \begin{pmatrix} 2.6 \\ 2.56 \\ 2.75 \end{pmatrix}$$

$s2 := Stdev(Dat2)$

$s2 = 0.1$

$\mu 2 := mean(Dat2)$

$\mu 2 = 2.637$

Viewed in percentage change from mean, as above

$$Dat2a := \frac{Dat2 - \mu 2}{\mu 2} \cdot 100$$

$$Dat2a = \begin{pmatrix} -1.391 \\ -2.908 \\ 4.298 \end{pmatrix}$$

$S2a := Stdev(Dat2a)$

$S2a = 3.799$

Data Poolability Check

set level of significance equal to 5%, the quantile then is 0.95

$$F := \frac{S1a^2}{S2a^2}$$

$F = 3.641$

From Table T-5 with q=0.95, k=2 and df=2

$Fmax := 39.0$

Since F is less than the critical value Fmax, poolability hypotheses cannot be rejected.

Pooling the data gives

$Dat3 := stack(Dat1a, Dat2a)$

$$Dat3 = \begin{pmatrix} 2.423 \\ -8.15 \\ 5.727 \\ -1.391 \\ -2.908 \\ 4.298 \end{pmatrix}$$

$S3a := Stdev(Dat3)$

$S3a = 5.176$

Development of a 95-95 based void initiation point

Based on the application intended, a maximum statistically based initiation point for void breakthrough, a single sided tolerance is appropriate. The methodology is based on NUREG 1475 Table 11b. From Table 11b, with n=6 and 95%population/95%confidence, a value of k=3.708 is obtained. This is then applied to the data as follows

95/95 at 5500 gpm case

$k1 := 3.708$

$\mu = 4.54$ mean of 5500 data

$$Set5500 := \mu + \frac{k1 \cdot S3a \cdot \mu}{100}$$

$Set5500 = 5.411$ level point for void initiation at 5500 gpm with 95/95 confidence, inches of tank level above nozzle

95/95 at 3000 gpm case

$\mu 2 = 2.637$ mean of 3000 gpm data

$$Set3000 := \mu 2 + \frac{k1 \cdot S3a \cdot \mu 2}{100}$$

$Set3000 = 3.143$ level point for void initiation at 3000 gpm with 95/95 confidence, inches of tank level above nozzle

Development of Additional Uncertainty terms for Test Instrument Accuracy

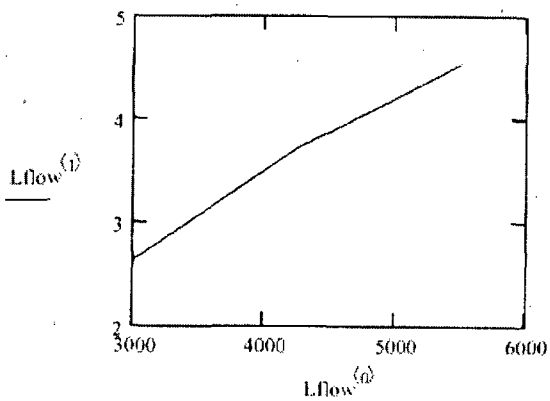
The Alden test report estimates that the flow measurement accuracy is 2% of the units of measure (gpm) and the level measurements are accurate to within 0.25% of the 72 inch measurement span. We need to establish a net accuracy in prototypical scale in units of inches for application to the initiation limits.

Initiation level change vs flow, based on the mean values

Lflow :=

	0	1
0	$3\cdot10^3$	2.637
1	$4.25\cdot10^3$	3.73

graphically presented



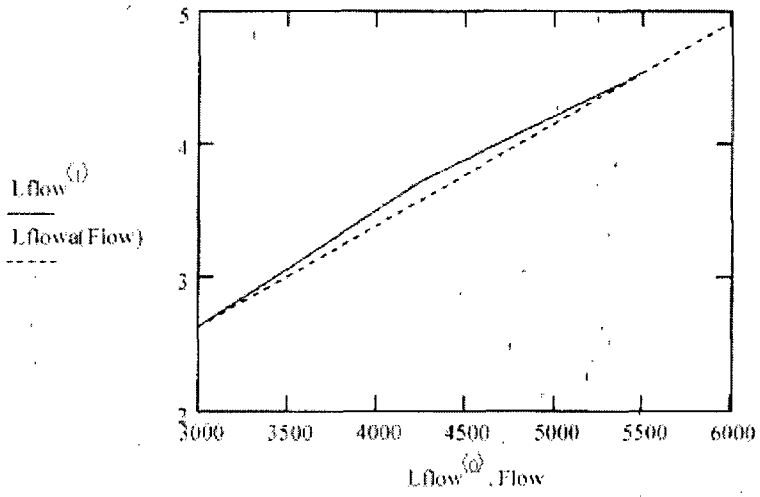
The effect of flow change on initiation level can be seen to be fairly linear in the range of interest, therefore a flow uncertainty can be expressed as a level term by performing a curve fit of the line and using the curve fit equation to determine the level effects due to flow

$$Flow := 3000, 3200 .. 6000$$

$$Lflowa(Flow) := \frac{4.54 - 2.637}{5500 - 3000}(Flow) + 0.353$$

$$Lflowa(5500) = 4.54$$

$$Lflowa(3000) = 2.637$$



therefore the effect of flow measurement on initiation level at the 5500 gpm point can be expressed by

$DeltaL := Lflowa(5500 \cdot 1.02) - Lflowa(5500)$

$DeltaL = 0.084$ 0.084 inches prototypical

Level measurement uncertainty in model

$L_{meas} := 0.0025 \cdot 72$

$L_{meas} = 0.18$ inches uncertainty in model measurement

this needs to be converted to prototypical scale for combination with flow uncertainty

$L_{pmeas} := L_{meas} \cdot 3.051$

$L_{pmeas} = 0.549$

Now the uncertainties are in common units and can be combined via SRSS since they are independent

$L_{testunc} := \sqrt{DeltaL^2 + L_{pmeas}^2}$

$L_{testunc} = 0.556$ inches

Applying this to the 5500 gpm single side limit yields

$Set5500 + L_{testunc} = 5.967$ this is the value that will be used in the 5500 gpm analysis

CPS HPCS Tank drainage issues

$delta := 438.8$ gals/inch based on tank volume/area calcs

$Q := 5500$ desired test flow gpm

tank level change/seconds per inch at test flow

$$DeltL_0 := \frac{delta}{Q} \cdot 60$$

$DeltL_0 = 4.787$ seconds per inch

we will assume an initial tank level of 12 inches above the top of the HPCS nozzle at 100 seconds into the simulation. The switchover point is at 3 inches above the top of the nozzle.

3.3 inches

$L_{test} := 5.967$ level determined from test where breakthrough starts, based on single sided 95/95 tolerance number+test uncertainty

time after 100 seconds to drain tank from 12 inches to breakthrough level is then

$$t_{brkthrough} := (12 - L_{test}) \cdot DeltL_0 + 100$$

$t_{brkthrough} = 128.879$

After breakthrough, void fraction will be estimated from testing. The tank level change will be reduced by the void fraction entering the pipe nozzle.

$voidg := 0.24$ assume 24% void fraction

$Q_1 := Q \cdot (1 - voidg)$

$DeltL_1 := \frac{delta}{Q_1} \cdot 60$

$DeltL_1 = 6.299$ seconds per inch

the switchover initiation time then becomes

$t_{switch} := t_{brkthrough} + (L_{test} - 3.3) \cdot DeltL_1$

$t_{switch} = 145.678$

time to top of pipe

$t_{pipe} := t_{brkthrough} + L_{test} \cdot DeltL_1$

$t_{pipe} = 166.463$

Attachment C- Estimation of Post-Breakthrough Void Fraction in 5500 gpm Tests

The purpose of this attachment is to document the review of the Alden test data for the 5500 gpm tests with respect to post-breakthrough void fraction. This parameter is important to the simulation of this event primarily in that the entrained void fraction reduces the tank level drop rate. For the 5500 gpm event, with breakthrough occurring at a level higher than the suppression pool switchover setpoint, the entrained void has a direct impact on the initiation of suction transfer.

Approach

The Alden test data includes about 5 seconds of data following the point at which breakthrough was observed. After this the pump was tripped to prevent damage due to the entrained air. For the purpose of this evaluation approximately 20 data points prior to breakthrough plus the data subsequent to breakthrough is used. The tank level is the key parameter of interest. The rate at which the level drops before and after breakthrough can be compared to develop an effective average void fraction post entrainment. In this evaluation, a three second interval is selected in each condition, with selection made to capture the highest steady level drop before the breakthrough, and capturing the slowest steady level drop in the post breakthrough points. The average post breakthrough void fraction can then be computed as:

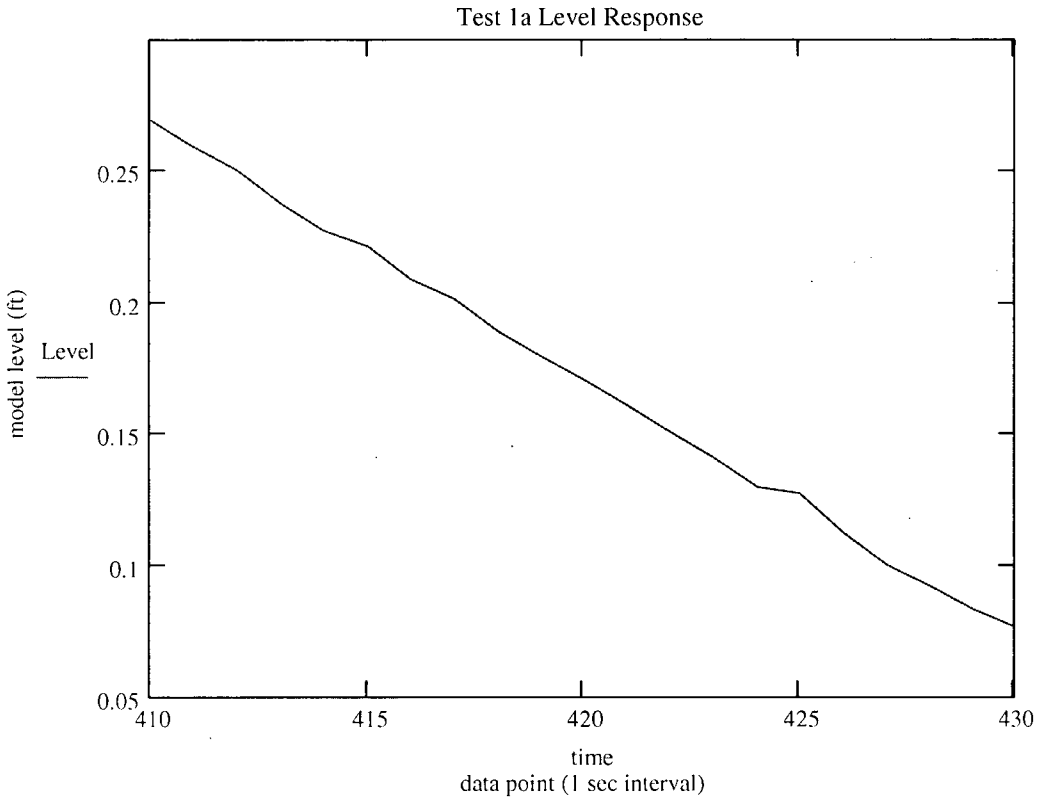
$$PostBreakthroughVoidfract = 1 - \frac{\Delta L_{post}}{\Delta L_{pre}}$$

$where$

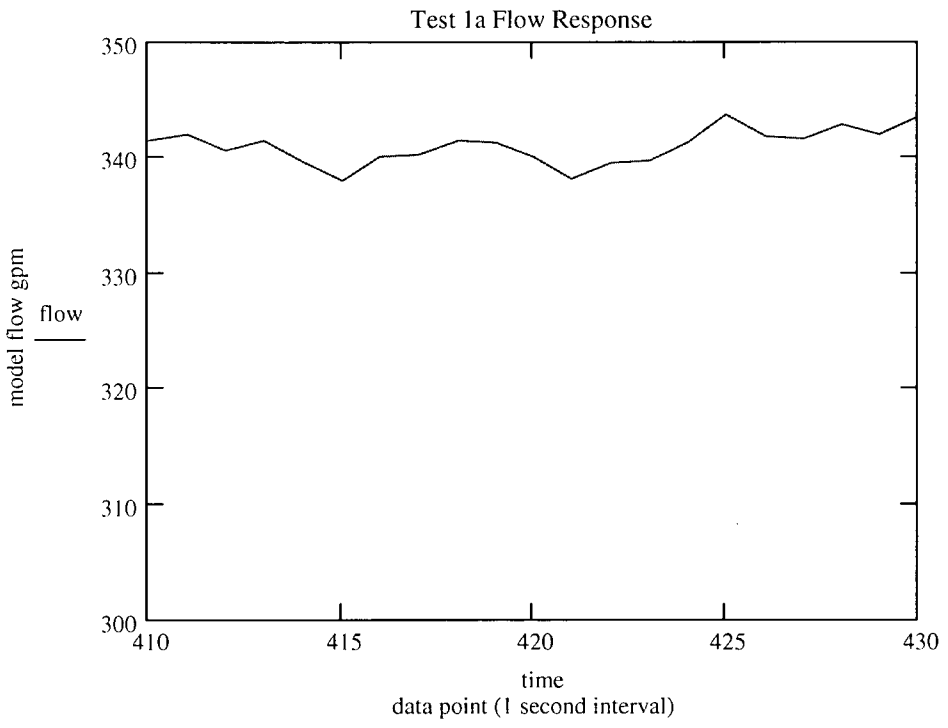
$$\Delta L_{post} = average_postbreakthrough_level_change$$

$$\Delta L_{pre} = average_prebreakthrough_level_change$$

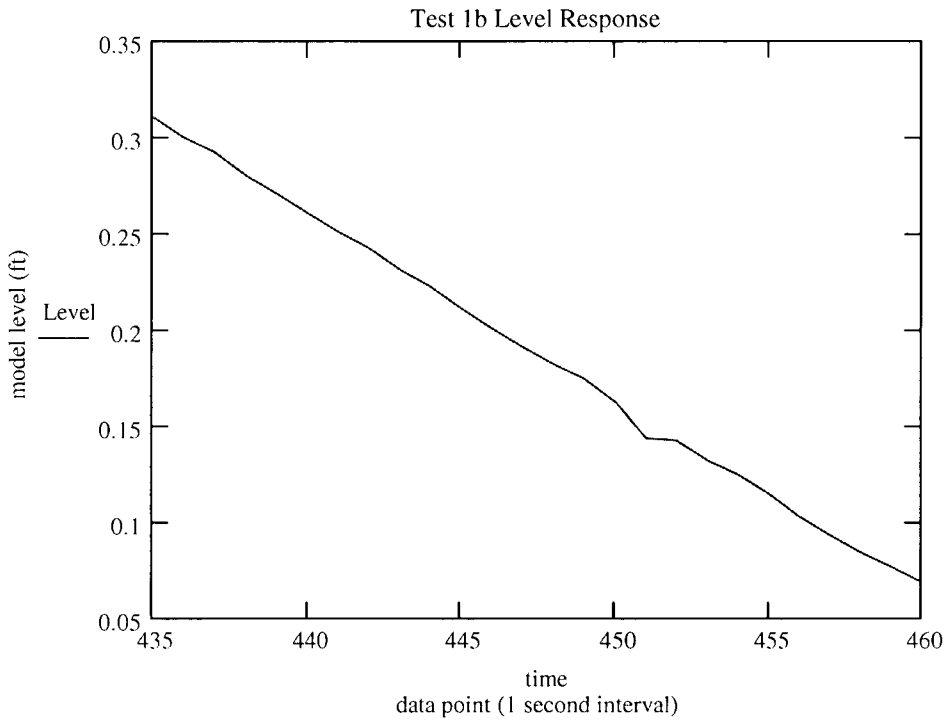
In addition to examining the level, it is important to review the flow data to ensure that no major changes in flow rate occur. Plots of the level response and flow response for each case are provided below.



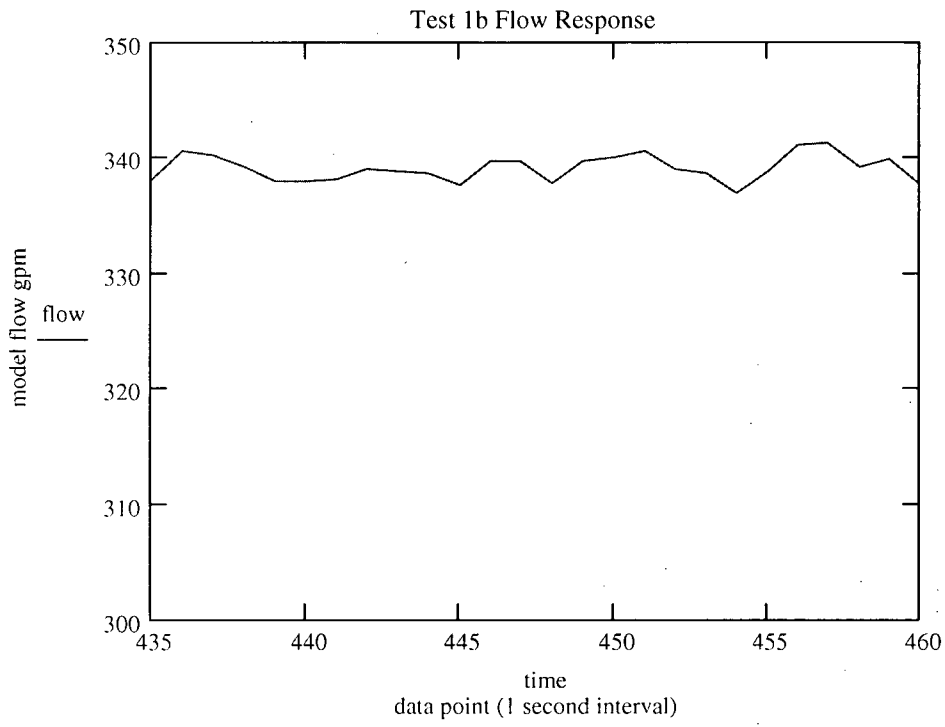
Breakthrough for Test 1a occurred at data point 425



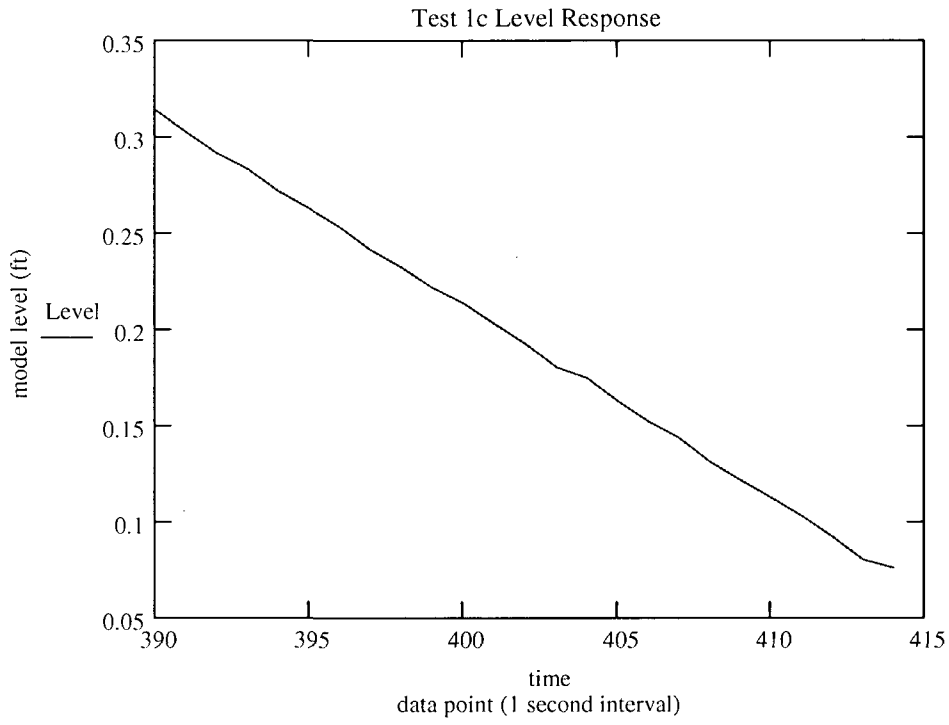
Breakthrough for Test 1a occurred at data point 425



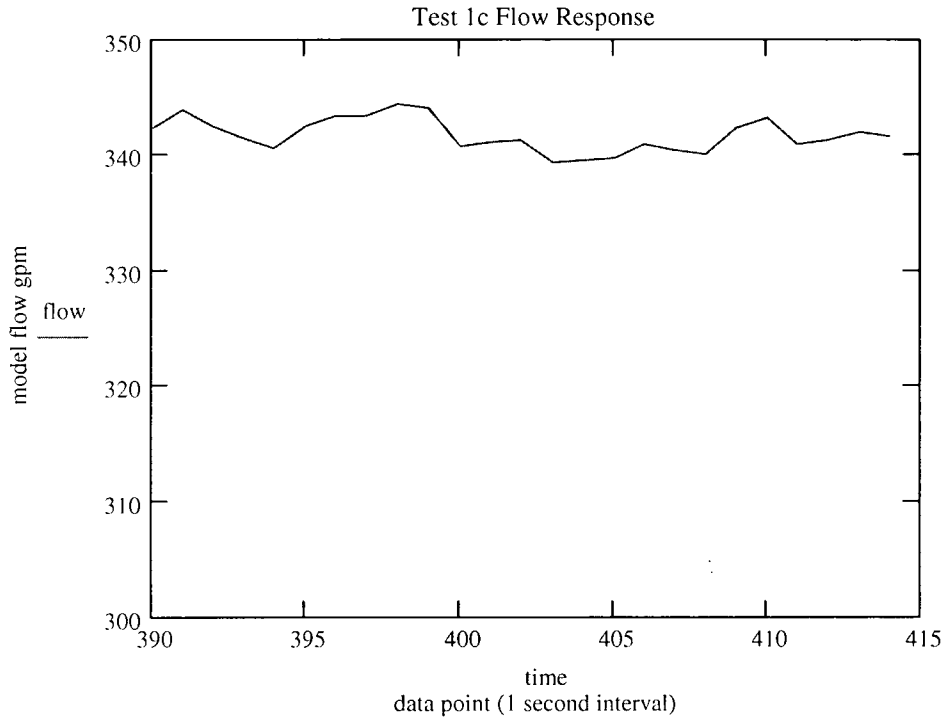
Breakthrough for Test 1b occurred at data point 455



Breakthrough for Test 1b occurred at data point 455



Breakthrough for Test 1c occurred at data point 408



Breakthrough for Test 1c occurred at data point 408

As can be seen, the flow data all show steady flow rates with little variation. Therefore, there is not need to correct for flow effects. The level data used to compute an average void fraction is identified below by data point numbers. A three second interval, (4 data points) was selected to maximize the use of the post breakthrough data. The use of multiple data points provides an average void fraction estimate.

Test 1a

based on review of the test data provided above, the void fraction can be inferred as follows

1. Breakthrough is noted in the testing as beginning at point 425
2. The slope of the level change prior is very consistent
3. The slope following the breakthrough becomes stable at point 427
4. Comparison of the slope prior and after will yield the entrainment

3 second point level drop starting at point 416

$$Prevoid := 0.209 - 0.18$$

3 second point level drop starting at point 427

$$Postvoid := 0.1 - 0.076$$

the void fraction is then 1- Postvoid/Prevoid

$$Void := 1 - \frac{Postvoid}{Prevoid}$$

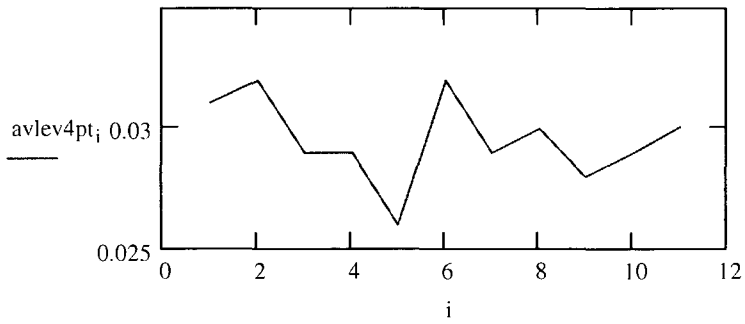
$$Void = 0.172$$

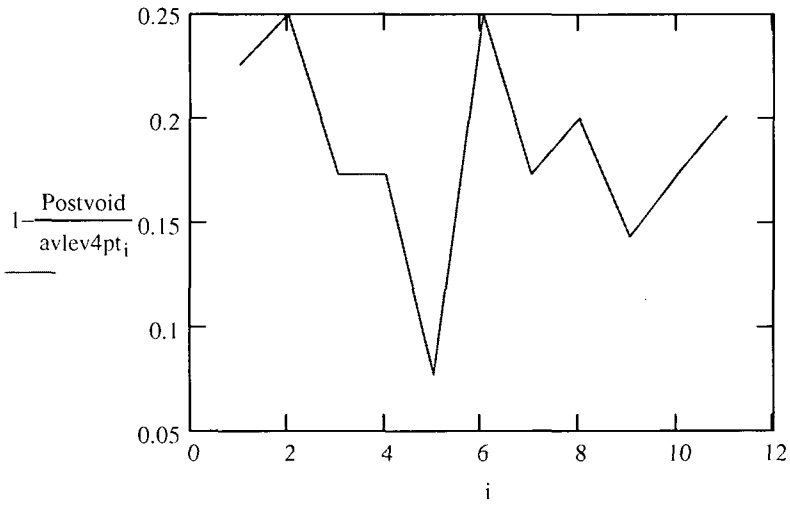
An alternative way to numerically compute the void fraction is to compute the running 4 point level changes up to the breakthrough point and compare that value to the post breakthrough level drop. This is done on the following page:

alternate way of computing pre-vortex average

$i := 1..11$

$avlev4pt_i := Level_{i-1} - Level_{i+2}$





$void_i := 1 - \frac{Postvoid}{avlev4pt_i}$ $\quad$ $mean(void) = 0.17$

Test 1b

based on review of the test data provided above, the void fraction can be inferred as follows

1. Breakthrough is noted in the testing as beginning at point 455
2. The slope of the level change prior is very consistent
3. The slope following the breakthrough becomes stable at point 457
4. Comparison of the slope prior and after will yield the entrainment

3 second point level drop starting at point 439

$$Prevoid := 0.27 - 0.242$$

3 second point level drop starting at point 457

$$Postvoid := 0.093 - 0.068$$

the void fraction is then 1- Postvoid/Prevoid

$$Void := 1 - \frac{Postvoid}{Prevoid}$$

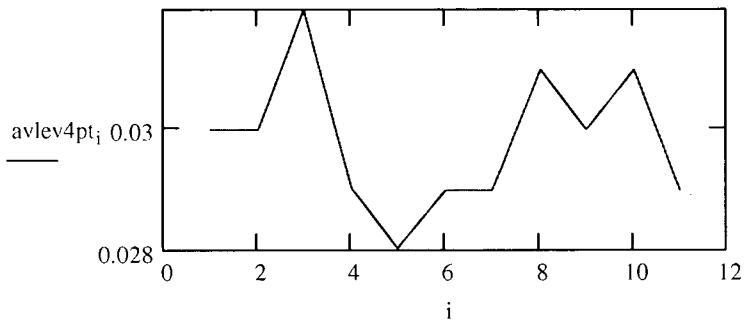
$$Void = 0.107$$

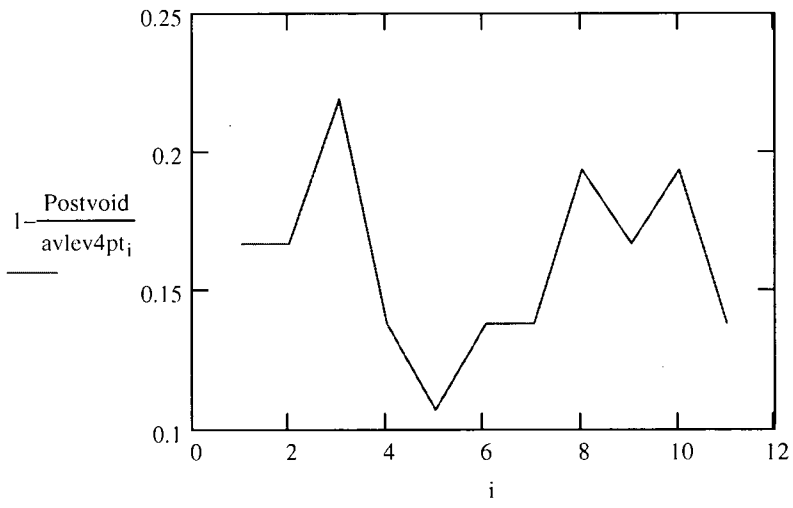
An alternative way to numerically compute the void fraction is to compute the running 4 point level changes up to the breakthrough point and compare that value to the post breakthrough level drop. This is done on the following page:

alternate way of computing pre-vortex average

$i := 1..11$

$avlev4pt_i := Level_{i-1} - Level_{i+2}$





$void_i := 1 - \frac{Postvoid}{avlev4pt_i}$ $\quad$ $mean(void) = 0.147$

Test 1c

based on review of the test data provided above, the void fraction can be inferred as follows

1. Breakthrough is noted in the testing as beginning at point 408
2. The slope of the level change prior is very consistent
3. The slope following the breakthrough becomes stable at point 411
4. Comparison of the slope prior and after will yield the entrainment

3 second point level drop starting at point 400

$$Prevoid := 0.213 - 0.18$$

3 second point level drop starting at point 411

$$Postvoid := 0.103 - 0.076$$

the void fraction is then 1- Postvoid/Prevoid

$$Void := 1 - \frac{Postvoid}{Prevoid}$$

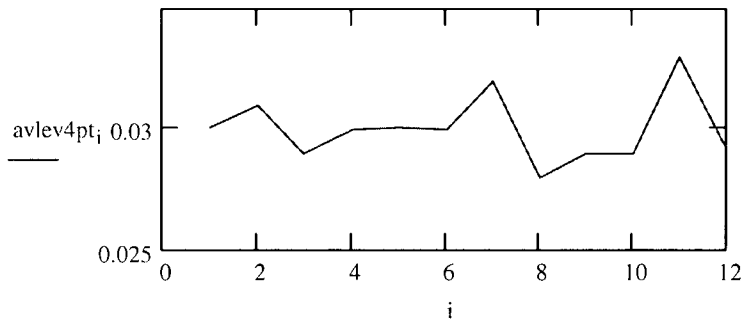
$$Void = 0.182$$

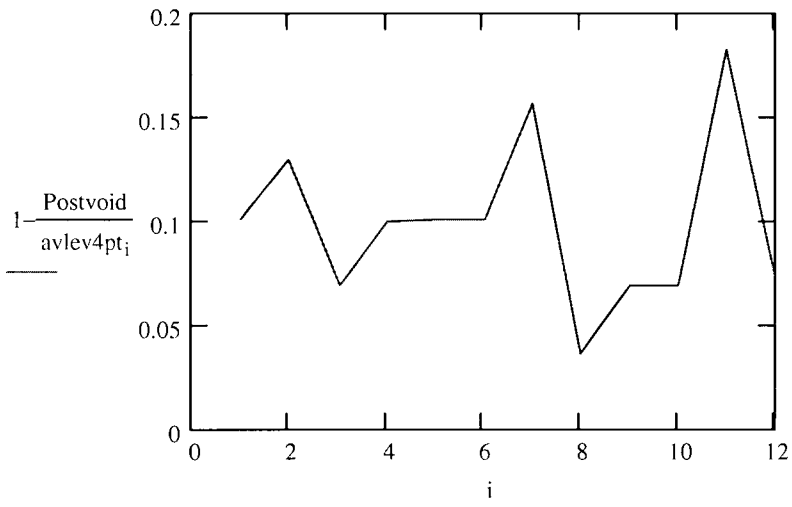
An alternative way to numerically compute the void fraction is to compute the running 4 point level changes up to the breakthrough point and compare that value to the post breakthrough level drop. This is done on the following page:

alternate way of computing pre-vortex average

$i := 1..12$

$avlev4pt_i := Level_{i-1} - Level_{i+2}$





$void_i := 1 - \frac{Postvoid}{avlev4pt_i}$ $\quad$ $mean(void) = 0.091$

Discussion

The tank level response has been examined to provide an estimated void fraction for the three 5500 gpm cases. The estimates based on visually selected points range from 10.7% up to 18.2% entrainment. These estimates appear reasonable, based on review of the test video data as well as the observed flow regime, (bubbly), reported by the test personnel. Using the running four point level drops alternative approach, one gets average void fraction estimates of 17%, 14.7%, and 9.1% for the three tests. The maximum single interval void fraction computed with the alternate approach is 25% for test1a, 21.9% for test1b, and 18.2% for test 1c. These results support a conclusion that the 24% assumed void fraction following breakthrough is a representative and likely bounding value for use in the analysis.

The data applied above covers a range of model tank levels down to approximately 0.07 ft., referenced to the inside top of the pipe. This is equivalent to a plant dimension of 2.56 inches, (3.051 x 0.07 x 12) referenced to the inside top diameter of the inlet pipe. The inlet pipe has a wall thickness of 0.57 inches. Therefore the data covers an elevation to 2.56-0.57 or 1.99 inches above the top of the inlet pipe. The switchover setpoint is at 3.3 inches above the top of the pipe, and therefore it can be concluded that the average void fraction estimates made above are appropriate to levels below the switchover setpoint.

Alden Test Data Files for 5500 gpm cases 1a, 1b, 1c.

Microsoft Excel Worksheet

Microsoft Excel Worksheet

Microsoft Excel Worksheet

Dec. 05 2006 11:23:38

ch1 slope	ch 1 int	ch2 slope	ch 2 int	ch 3 slope	ch3 int	c1	c2	c3	scale	ref lev
0.325792	-0.638112	1.25	-5	0.302893	-0.60487	214.8027	46.0382		1	0.006

point	6inch Meter (GPM Model)	% Air	level (ft Model)	time	vch1	vch2	vch3
1	0	0	4.001	11:27:56	1.955	0.002	7.712
2	0	0	4	11:27:57	1.954	0	7.711
3	0	0	4	11:27:58	1.957	-0.002	7.71
4	0	0	4	11:27:59	1.954	0.001	7.711
5	0	0	4.001	11:28:00	1.954	0.001	7.712
6	0	0	4	11:28:01	1.955	0.002	7.71
7	0	0	4	11:28:02	1.954	0	7.711
8	0	0	4.002	11:28:03	1.956	0.001	7.714
9	0	0	4	11:28:04	1.956	0.004	7.711
10	0	0	3.999	11:28:05	1.956	0.001	7.71
11	0	0	4.001	11:28:06	1.954	0.017	7.712
12	0	0	3.999	11:28:07	1.956	-0.002	7.709
13	0	0	3.999	11:28:08	1.956	-0.02	7.71
14	0	0	3.999	11:28:09	1.965	0	7.71
15	0	0	4.001	11:28:10	1.957	-0.001	7.713
16	0	0	3.999	11:28:11	1.955	-0.003	7.71
17	0	0	4	11:28:12	1.956	0.018	7.711
18	0	0	3.999	11:28:13	1.956	0.004	7.71
19	0	0	4.001	11:28:14	1.955	0.003	7.713
20	0	0	3.998	11:28:15	1.955	-0.002	7.708
21	0	0	4.001	11:28:16	1.956	0.002	7.713
22	0	0	3.999	11:28:17	1.983	0	7.709
23	61.241	0	3.994	11:28:18	2.067	-0.001	7.702
24	119.189	0	3.996	11:28:19	2.368	0.006	7.705
25	151.449	0	3.996	11:28:20	2.62	0	7.706
26	150.685	0	3.986	11:28:21	2.613	-0.002	7.691
27	153.92	0	3.981	11:28:22	2.642	0.004	7.684
28	169.217	0	3.976	11:28:23	2.784	-0.002	7.677
29	173.752	0	3.971	11:28:24	2.829	0.001	7.669
30	184.581	0	3.966	11:28:25	2.941	0.005	7.663
31	193.421	0	3.961	11:28:26	3.037	-0.006	7.655
32	201.53	0	3.956	11:28:27	3.129	-0.001	7.647
33	210.097	0	3.948	11:28:28	3.231	-0.001	7.636
34	216.023	0	3.943	11:28:29	3.304	0	7.63
35	217.267	0	3.942	11:28:30	3.319	0	7.628
36	219.032	0	3.937	11:28:31	3.342	-0.001	7.621
37	220.468	0	3.932	11:28:32	3.36	0.004	7.613
38	219.523	0	3.931	11:28:33	3.348	0.001	7.613
39	219.804	0	3.92	11:28:34	3.351	0	7.596
40	224.825	0	3.913	11:28:35	3.416	0	7.587
41	233.988	0	3.907	11:28:36	3.537	-0.001	7.579
42	235.398	0	3.9	11:28:37	3.556	-0.012	7.567
43	233.691	0	3.902	11:28:38	3.533	0.003	7.571
44	234.152	0	3.885	11:28:39	3.539	0.004	7.547
45	243.438	0	3.887	11:28:40	3.667	-0.001	7.55
46	256.317	0	3.871	11:28:41	3.853	0	7.527
47	270.92	0	3.864	11:28:42	4.074	0.007	7.516
48	286.339	0	3.856	11:28:43	4.322	0.027	7.504
49	294.557	0	3.845	11:28:44	4.46	0.028	7.489
50	299.482	0	3.837	11:28:45	4.544	0.008	7.478
51	302.246	0	3.829	11:28:46	4.592	0	7.466
52	303.593	0	3.821	11:28:47	4.616	0	7.454

53	307.248	0	3.812	11:28:48	4.68	0.003	7.442
54	308.548	0	3.795	11:28:49	4.703	0	7.418
55	309.495	0	3.792	11:28:50	4.72	0	7.413
56	311.899	0	3.785	11:28:51	4.763	-0.001	7.403
57	314.235	0	3.775	11:28:52	4.805	0.001	7.389
58	315.116	0	3.766	11:28:53	4.821	0.003	7.377
59	314.529	0	3.756	11:28:54	4.81	0	7.362
60	319.001	0	3.747	11:28:55	4.892	0.002	7.349
61	321.908	0	3.732	11:28:56	4.946	-0.002	7.328
62	325.192	0	3.73	11:28:57	5.007	0.003	7.324
63	331.361	0	3.719	11:28:58	5.124	0.044	7.309
64	333.099	0	3.71	11:28:59	5.157	-0.003	7.296
65	332.821	0	3.7	11:29:00	5.152	0.002	7.282
66	332.405	0	3.689	11:29:01	5.144	0.004	7.266
67	334.091	0	3.679	11:29:02	5.176	-0.004	7.252
68	333.515	0	3.669	11:29:03	5.165	-0.002	7.238
69	332.636	0	3.659	11:29:04	5.148	0.002	7.223
70	335.563	0	3.651	11:29:05	5.205	-0.001	7.211
71	338.077	0	3.641	11:29:06	5.253	0	7.197
72	341.273	0	3.632	11:29:07	5.316	0.055	7.185
73	341.251	0	3.62	11:29:08	5.316	0	7.168
74	341.002	0	3.611	11:29:09	5.311	-0.016	7.154
75	339.758	0	3.602	11:29:10	5.286	0.001	7.142
76	337.348	0	3.592	11:29:11	5.239	0	7.127
77	337.302	0	3.58	11:29:12	5.238	0.002	7.111
78	337.416	0	3.572	11:29:13	5.241	-0.003	7.099
79	337.758	0	3.562	11:29:14	5.247	0	7.084
80	339.94	0	3.547	11:29:15	5.29	0.001	7.063
81	340.709	0	3.542	11:29:16	5.305	0.021	7.056
82	342.084	0	3.532	11:29:17	5.332	-0.004	7.042
83	341.747	0	3.523	11:29:18	5.325	-0.001	7.029
84	341.611	0	3.512	11:29:19	5.323	0.01	7.013
85	339.532	0	3.502	11:29:20	5.282	0.001	6.998
86	339.668	0	3.493	11:29:21	5.285	0.004	6.985
87	339.736	0	3.483	11:29:22	5.286	0.007	6.971
88	338.419	0	3.472	11:29:23	5.26	0.002	6.956
89	339.6	0	3.461	11:29:24	5.283	0.001	6.94
90	341.341	0	3.454	11:29:25	5.317	0.002	6.93
91	339.464	0	3.443	11:29:26	5.281	0.002	6.915
92	339.305	0	3.433	11:29:27	5.277	0.004	6.9
93	342.579	0	3.423	11:29:28	5.342	0.004	6.885
94	341.904	0	3.415	11:29:29	5.328	0.002	6.874
95	341.499	0	3.393	11:29:30	5.32	0.001	6.842
96	342.984	0	3.392	11:29:31	5.35	0.005	6.842
97	343.051	0	3.383	11:29:32	5.351	0.005	6.829
98	342.377	0	3.373	11:29:33	5.338	0.003	6.813
99	341.724	0	3.363	11:29:34	5.325	0.001	6.8
100	341.115	0	3.353	11:29:35	5.313	0.04	6.786
101	342.197	0	3.344	11:29:36	5.334	0	6.772
102	342.714	0	3.333	11:29:37	5.344	0.005	6.756
103	341.679	0	3.324	11:29:38	5.324	0.005	6.744
104	338.191	0	3.313	11:29:39	5.256	-0.004	6.728
105	337.279	0	3.316	11:29:40	5.238	-0.002	6.733
106	339.237	0	3.293	11:29:41	5.276	-0.001	6.699
107	343.163	0	3.284	11:29:42	5.353	0.002	6.686
108	343.477	0	3.273	11:29:43	5.36	0.007	6.671
109	343.791	0	3.263	11:29:44	5.366	0.003	6.657

110	343.992	0	3.253	11:29:45	5.37	0.002	6.643
111	343.365	0	3.243	11:29:46	5.357	0.001	6.628
112	342.354	0	3.232	11:29:47	5.337	0	6.612
113	341.679	0	3.223	11:29:48	5.324	0.003	6.6
114	341.859	0	3.215	11:29:49	5.328	0.002	6.588
115	342.579	0	3.203	11:29:50	5.342	0.001	6.571
116	339.373	0	3.194	11:29:51	5.279	0	6.558
117	340.935	0	3.183	11:29:52	5.309	0.006	6.543
118	342.714	0	3.175	11:29:53	5.344	0.001	6.53
119	343.477	0	3.165	11:29:54	5.36	0	6.516
120	342.264	0	3.154	11:29:55	5.336	0.006	6.501
121	343.791	0	3.145	11:29:56	5.366	0.003	6.487
122	343.813	0	3.134	11:29:57	5.366	0.003	6.472
123	342.017	0	3.124	11:29:58	5.331	0.003	6.457
124	342.107	0	3.114	11:29:59	5.332	-0.055	6.444
125	342.039	0	3.104	11:30:00	5.331	-0.027	6.428
126	341.431	0	3.094	11:30:01	5.319	0	6.415
127	337.439	0	3.085	11:30:02	5.241	0.008	6.402
128	338.032	0	3.074	11:30:03	5.253	0	6.386
129	340.234	0	3.064	11:30:04	5.296	0.008	6.373
130	341.273	0	3.06	11:30:05	5.316	0.001	6.366
131	341.679	0	3.045	11:30:06	5.324	0	6.345
132	341.589	0	3.034	11:30:07	5.322	0	6.329
133	339.554	0	3.025	11:30:08	5.282	0	6.316
134	339.962	0	3.014	11:30:09	5.29	0	6.301
135	339.327	0	3.005	11:30:10	5.278	0.002	6.288
136	339.532	0	2.995	11:30:11	5.282	0.001	6.273
137	341.589	0	2.986	11:30:12	5.322	0.002	6.26
138	339.736	0	2.974	11:30:13	5.286	0	6.243
139	340.347	0	2.965	11:30:14	5.298	0.02	6.23
140	342.714	0	2.939	11:30:15	5.344	0	6.193
141	342.939	0	2.944	11:30:16	5.349	0	6.2
142	341.859	0	2.935	11:30:17	5.328	0.002	6.187
143	341.273	0	2.925	11:30:18	5.316	-0.002	6.173
144	340.618	0	2.913	11:30:19	5.303	0.005	6.156
145	341.972	0	2.906	11:30:20	5.33	0.004	6.145
146	343.365	0	2.895	11:30:21	5.357	0	6.13
147	342.332	0	2.884	11:30:22	5.337	0.002	6.115
148	342.129	0	2.875	11:30:23	5.333	0.003	6.101
149	342.467	0	2.865	11:30:24	5.34	0	6.087
150	342.017	0	2.855	11:30:25	5.331	0	6.073
151	340.211	0	2.847	11:30:26	5.295	0.001	6.061
152	339.032	0	2.835	11:30:27	5.272	0.023	6.045
153	341.183	0	2.826	11:30:28	5.314	-0.001	6.031
154	339.055	0	2.815	11:30:29	5.273	0.035	6.016
155	341.16	0	2.805	11:30:30	5.314	0.003	6.001
156	343.947	0	2.796	11:30:31	5.369	0.001	5.989
157	344.015	0	2.785	11:30:32	5.37	0.001	5.973
158	342.399	0	2.775	11:30:33	5.338	-0.002	5.958
159	341.296	0	2.766	11:30:34	5.316	0.012	5.945
160	340.889	0	2.755	11:30:35	5.309	0	5.93
161	341.454	0	2.749	11:30:36	5.32	0.049	5.921
162	341.499	0	2.736	11:30:37	5.32	-0.004	5.903
163	341.409	0	2.726	11:30:38	5.319	0.013	5.888
164	341.228	0	2.715	11:30:39	5.315	0.001	5.872
165	341.476	0	2.705	11:30:40	5.32	0	5.858
166	342.849	0	2.696	11:30:41	5.347	0.001	5.845

167	343.925	0	2.685	11:30:42	5.368	-0.001	5.83
168	341.093	0	2.676	11:30:43	5.312	0.001	5.817
169	340.234	0	2.666	11:30:44	5.296	0.006	5.803
170	341.115	0	2.656	11:30:45	5.313	-0.103	5.788
171	341.16	0	2.645	11:30:46	5.314	0.008	5.772
172	342.017	0	2.637	11:30:47	5.331	0.017	5.76
173	342.871	0	2.626	11:30:48	5.348	-0.002	5.745
174	340.347	0	2.617	11:30:49	5.298	0.002	5.732
175	340.822	0	2.601	11:30:50	5.307	-0.001	5.71
176	342.062	0	2.587	11:30:51	5.332	0.001	5.689
177	340.867	0	2.587	11:30:52	5.308	0.004	5.689
178	342.849	0	2.576	11:30:53	5.347	0.006	5.674
179	343.522	0	2.565	11:30:54	5.36	-0.002	5.657
180	340.641	0	2.557	11:30:55	5.304	0	5.646
181	339.645	0	2.546	11:30:56	5.284	-0.042	5.631
182	341.296	0	2.53	11:30:57	5.316	0.003	5.608
183	341.837	0	2.525	11:30:58	5.327	-0.002	5.601
184	341.589	0	2.511	11:30:59	5.322	-0.002	5.581
185	340.46	0	2.506	11:31:00	5.3	-0.001	5.574
186	337.872	0	2.496	11:31:01	5.249	-0.001	5.56
187	336.937	0	2.488	11:31:02	5.231	0.003	5.548
188	338.919	0	2.475	11:31:03	5.27	0.003	5.53
189	340.686	0	2.466	11:31:04	5.305	-0.002	5.516
190	342.737	0	2.457	11:31:05	5.345	0.001	5.503
191	341.183	0	2.446	11:31:06	5.314	-0.012	5.488
192	341.318	0	2.436	11:31:07	5.317	-0.001	5.474
193	341.296	0	2.427	11:31:08	5.316	-0.004	5.461
194	342.309	0	2.416	11:31:09	5.336	0.004	5.445
195	341.251	0	2.408	11:31:10	5.316	0.003	5.433
196	340.098	0	2.396	11:31:11	5.293	0	5.417
197	339.849	0	2.387	11:31:12	5.288	0	5.403
198	338.555	0	2.37	11:31:13	5.263	-0.001	5.379
199	339.532	0	2.368	11:31:14	5.282	0	5.376
200	340.844	0	2.357	11:31:15	5.308	-0.03	5.36
201	342.039	0	2.348	11:31:16	5.331	0.003	5.348
202	341.657	0	2.337	11:31:17	5.324	0	5.332
203	339.69	0	2.328	11:31:18	5.285	0.002	5.319
204	338.601	0	2.319	11:31:19	5.264	0.001	5.306
205	338.919	0	2.308	11:31:20	5.27	0.001	5.29
206	339.214	0	2.295	11:31:21	5.276	0	5.272
207	342.084	0	2.293	11:31:22	5.332	0	5.269
208	341.273	0	2.277	11:31:23	5.316	-0.003	5.246
209	338.942	0	2.269	11:31:24	5.27	0.004	5.234
210	338.441	0	2.257	11:31:25	5.261	0.002	5.218
211	340.505	0	2.249	11:31:26	5.301	-0.006	5.206
212	339.6	0	2.238	11:31:27	5.283	0	5.19
213	340.709	0	2.229	11:31:28	5.305	-0.001	5.178
214	340.573	0	2.228	11:31:29	5.302	-0.003	5.176
215	341.318	0	2.208	11:31:30	5.317	0.004	5.147
216	340.912	0	2.189	11:31:31	5.309	0	5.12
217	342.084	0	2.19	11:31:32	5.332	0.017	5.122
218	340.075	0	2.179	11:31:33	5.293	0.004	5.106
219	338.419	0	2.17	11:31:34	5.26	0.002	5.093
220	337.211	0	2.158	11:31:35	5.237	0	5.075
221	339.645	0	2.15	11:31:36	5.284	0.002	5.064
222	342.332	0	2.138	11:31:37	5.337	-0.003	5.047
223	342.422	0	2.13	11:31:38	5.339	-0.001	5.036

224	341.341	0	2.119	11:31:39	5.317	0.005	5.02
225	341.994	0	2.109	11:31:40	5.33	0.004	5.006
226	343.23	0	2.099	11:31:41	5.355	0.001	4.991
227	343.903	0	2.09	11:31:42	5.368	-0.017	4.978
228	343.41	0	2.086	11:31:43	5.358	-0.006	4.972
229	338.919	0	2.07	11:31:44	5.27	-0.07	4.95
230	340.641	0	2.06	11:31:45	5.304	0.001	4.936
231	340.754	0	2.05	11:31:46	5.306	0.001	4.921
232	340.844	0	2.04	11:31:47	5.308	0.001	4.906
233	342.871	0	2.029	11:31:48	5.348	-0.011	4.891
234	342.557	0	2.018	11:31:49	5.341	0.002	4.875
235	341.251	0	2.01	11:31:50	5.316	0.008	4.863
236	339.486	0	1.996	11:31:51	5.281	0	4.845
237	338.532	0	1.99	11:31:52	5.262	0.04	4.835
238	341.363	0	1.979	11:31:53	5.318	0	4.82
239	340.799	0	1.97	11:31:54	5.307	0	4.807
240	338.805	0	1.96	11:31:55	5.268	0.001	4.792
241	338.464	0	1.95	11:31:56	5.261	0.001	4.778
242	339.078	0	1.94	11:31:57	5.273	0	4.763
243	340.234	0	1.93	11:31:58	5.296	0.004	4.75
244	340.844	0	1.919	11:31:59	5.308	0.004	4.733
245	339.554	0	1.911	11:32:00	5.282	-0.002	4.722
246	339.373	0	1.899	11:32:01	5.279	0.003	4.706
247	340.98	0	1.892	11:32:02	5.31	0.002	4.695
248	342.107	0	1.879	11:32:03	5.332	0.004	4.677
249	341.386	0	1.869	11:32:04	5.318	0.001	4.663
250	339.962	0	1.861	11:32:05	5.29	0.019	4.651
251	338.805	0	1.851	11:32:06	5.268	0.004	4.636
252	339.758	0	1.841	11:32:07	5.286	-0.002	4.622
253	339.758	0	1.83	11:32:08	5.286	0	4.607
254	342.332	0	1.821	11:32:09	5.337	-0.001	4.594
255	343.679	0	1.811	11:32:10	5.364	0.006	4.58
256	340.754	0	1.801	11:32:11	5.306	-0.022	4.565
257	338.805	0	1.791	11:32:12	5.268	-0.004	4.55
258	338.805	0	1.781	11:32:13	5.268	0	4.537
259	339.826	0	1.771	11:32:14	5.288	0	4.522
260	341.409	0	1.761	11:32:15	5.319	0.01	4.507
261	341.566	0	1.75	11:32:16	5.322	0.004	4.493
262	340.731	0	1.742	11:32:17	5.305	0.004	4.481
263	339.713	0	1.73	11:32:18	5.285	0.003	4.464
264	340.279	0	1.722	11:32:19	5.297	0.005	4.452
265	339.418	0	1.711	11:32:20	5.28	0.005	4.436
266	338.191	0	1.698	11:32:21	5.256	0.001	4.418
267	339.962	0	1.691	11:32:22	5.29	0.009	4.408
268	341.589	0	1.683	11:32:23	5.322	0.001	4.396
269	340.664	0	1.672	11:32:24	5.304	0.017	4.38
270	337.872	0	1.662	11:32:25	5.249	0.003	4.366
271	339.554	0	1.652	11:32:26	5.282	0.001	4.351
272	339.373	0	1.644	11:32:27	5.279	0.014	4.34
273	335.723	0	1.632	11:32:28	5.208	-0.004	4.324
274	335.838	0	1.624	11:32:29	5.21	0.002	4.311
275	337.621	0	1.612	11:32:30	5.245	0.001	4.294
276	337.325	0	1.604	11:32:31	5.239	0.002	4.283
277	340.211	0	1.593	11:32:32	5.295	0	4.267
278	342.039	0	1.582	11:32:33	5.331	-0.04	4.252
279	341.927	0	1.574	11:32:34	5.329	-0.043	4.24
280	343.32	0	1.562	11:32:35	5.356	0.027	4.223

281	342.894	0	1.553	11:32:36	5.348	-0.015	4.21
282	342.534	0	1.543	11:32:37	5.341	-0.001	4.195
283	342.737	0	1.533	11:32:38	5.345	-0.001	4.181
284	343.522	0	1.523	11:32:39	5.36	-0.002	4.167
285	342.826	0	1.514	11:32:40	5.347	0.004	4.154
286	342.647	0	1.502	11:32:41	5.343	0.001	4.138
287	342.489	0	1.49	11:32:42	5.34	0.004	4.12
288	342.399	0	1.494	11:32:43	5.338	0.004	4.125
289	341.724	0	1.475	11:32:44	5.325	0.001	4.098
290	342.039	0	1.463	11:32:45	5.331	-0.009	4.082
291	342.444	0	1.453	11:32:46	5.339	0	4.066
292	343.656	0	1.443	11:32:47	5.363	-0.016	4.052
293	343.455	0	1.434	11:32:48	5.359	-0.005	4.04
294	343.186	0	1.424	11:32:49	5.354	0.003	4.025
295	340.686	0	1.412	11:32:50	5.305	0.001	4.008
296	340.844	0	1.401	11:32:51	5.308	0	3.993
297	340.889	0	1.398	11:32:52	5.309	0	3.988
298	341.972	0	1.383	11:32:53	5.33	0.004	3.968
299	342.242	0	1.372	11:32:54	5.335	0	3.952
300	341.386	0	1.364	11:32:55	5.318	0.001	3.94
301	342.309	0	1.352	11:32:56	5.336	0.016	3.923
302	340.098	0	1.343	11:32:57	5.293	-0.05	3.909
303	341.882	0	1.333	11:32:58	5.328	0	3.895
304	341.769	0	1.323	11:32:59	5.326	-0.013	3.882
305	343.208	0	1.312	11:33:00	5.354	0.001	3.866
306	341.386	0	1.309	11:33:01	5.318	-0.004	3.861
307	341.927	0	1.294	11:33:02	5.329	0.003	3.839
308	342.849	0	1.283	11:33:03	5.347	-0.001	3.824
309	342.624	0	1.275	11:33:04	5.343	0.004	3.813
310	344.059	0	1.262	11:33:05	5.371	0.005	3.794
311	344.35	0	1.254	11:33:06	5.377	0.002	3.782
312	343.096	0	1.242	11:33:07	5.352	0.011	3.765
313	341.904	0	1.235	11:33:08	5.328	0.002	3.755
314	340.279	0	1.223	11:33:09	5.297	0.004	3.738
315	344.059	0	1.214	11:33:10	5.371	0.002	3.725
316	342.107	0	1.203	11:33:11	5.332	0.001	3.71
317	342.647	0	1.193	11:33:12	5.343	-0.001	3.695
318	339.69	0	1.19	11:33:13	5.285	0	3.691
319	339.849	0	1.173	11:33:14	5.288	-0.007	3.667
320	339.781	0	1.165	11:33:15	5.287	0.002	3.655
321	340.573	0	1.159	11:33:16	5.302	0.047	3.646
322	341.025	0	1.144	11:33:17	5.311	-0.012	3.624
323	339.849	0	1.134	11:33:18	5.288	0	3.611
324	338.054	0	1.124	11:33:19	5.253	-0.002	3.596
325	338.964	0	1.115	11:33:20	5.271	0.004	3.583
326	339.509	0	1.103	11:33:21	5.281	-0.001	3.567
327	338.259	0	1.095	11:33:22	5.257	0.003	3.554
328	337.211	0	1.085	11:33:23	5.237	0.013	3.54
329	338.919	0	1.076	11:33:24	5.27	0.004	3.527
330	341.386	0	1.064	11:33:25	5.318	-0.02	3.51
331	341.634	0	1.055	11:33:26	5.323	0	3.498
332	340.03	0	1.045	11:33:27	5.292	-0.002	3.484
333	337.188	0	1.036	11:33:28	5.236	0.006	3.47
334	338.009	0	1.027	11:33:29	5.252	0.002	3.458
335	338.919	0	1.014	11:33:30	5.27	0.001	3.439
336	336.777	0	1.005	11:33:31	5.228	0.003	3.427
337	337.188	0	0.996	11:33:32	5.236	0.003	3.413

338	340.166	0	0.983	11:33:33	5.294	-0.001	3.395
339	339.486	0	0.973	11:33:34	5.281	0.002	3.38
340	339.849	0	0.966	11:33:35	5.288	0	3.37
341	339.826	0	0.965	11:33:36	5.288	-0.001	3.369
342	338.601	0	0.934	11:33:37	5.264	0.011	3.325
343	337.53	0	0.939	11:33:38	5.243	0.049	3.332
344	337.325	0	0.928	11:33:39	5.239	0.024	3.316
345	339.736	0	0.916	11:33:40	5.286	0.01	3.299
346	336.777	0	0.906	11:33:41	5.228	-0.004	3.284
347	337.028	0	0.895	11:33:42	5.233	0.015	3.269
348	338.805	0	0.885	11:33:43	5.268	-0.002	3.255
349	340.528	0	0.876	11:33:44	5.301	-0.008	3.241
350	341.679	0	0.869	11:33:45	5.324	0	3.231
351	342.017	0	0.857	11:33:46	5.331	0.001	3.214
352	341.476	0	0.848	11:33:47	5.32	-0.075	3.201
353	340.709	0	0.837	11:33:48	5.305	0.026	3.185
354	340.234	0	0.827	11:33:49	5.296	0.003	3.171
355	341.228	0	0.818	11:33:50	5.315	-0.018	3.159
356	340.256	0	0.807	11:33:51	5.296	0.003	3.143
357	341.611	0	0.798	11:33:52	5.323	-0.001	3.13
358	340.957	0	0.787	11:33:53	5.31	-0.001	3.114
359	337.371	0	0.78	11:33:54	5.24	0.006	3.104
360	338.737	0	0.765	11:33:55	5.266	0.004	3.083
361	340.347	0	0.763	11:33:56	5.298	0.002	3.079
362	340.98	0	0.744	11:33:57	5.31	0.001	3.053
363	339.894	0	0.738	11:33:58	5.289	-0.002	3.045
364	340.573	0	0.73	11:33:59	5.302	-0.001	3.032
365	340.075	0	0.718	11:34:00	5.293	-0.04	3.015
366	338.828	0	0.707	11:34:01	5.268	-0.003	3
367	342.422	0	0.7	11:34:02	5.339	0.03	2.99
368	343.791	0	0.686	11:34:03	5.366	0.013	2.971
369	344.238	0	0.666	11:34:04	5.375	0	2.941
370	340.596	0	0.663	11:34:05	5.303	0	2.936
371	340.279	0	0.658	11:34:06	5.297	0.003	2.93
372	342.894	0	0.647	11:34:07	5.348	0	2.915
373	343.208	0	0.638	11:34:08	5.354	0	2.902
374	343.746	0	0.629	11:34:09	5.365	0.002	2.888
375	341.566	0	0.616	11:34:10	5.322	0.008	2.869
376	341.882	0	0.609	11:34:11	5.328	-0.003	2.859
377	344.037	0	0.599	11:34:12	5.371	0.001	2.845
378	344.842	0	0.587	11:34:13	5.387	-0.002	2.828
379	340.551	0	0.578	11:34:14	5.302	0.003	2.815
380	339.509	0	0.57	11:34:15	5.281	0	2.805
381	342.152	0	0.556	11:34:16	5.333	0	2.785
382	342.219	0	0.55	11:34:17	5.335	0.042	2.776
383	341.657	0	0.538	11:34:18	5.324	0.002	2.758
384	341.972	0	0.529	11:34:19	5.33	0.034	2.746
385	344.059	0	0.518	11:34:20	5.371	0.003	2.729
386	342.332	0	0.508	11:34:21	5.337	0	2.715
387	344.171	0	0.499	11:34:22	5.373	0.002	2.702
388	343.567	0	0.487	11:34:23	5.361	0.002	2.686
389	341.927	0	0.483	11:34:24	5.329	0.001	2.679
390	342.084	0	0.467	11:34:25	5.332	0	2.657
391	343.701	0	0.459	11:34:26	5.364	-0.002	2.645
392	342.849	0	0.449	11:34:27	5.347	0.024	2.631
393	339.237	0	0.438	11:34:28	5.276	0.004	2.615
394	338.305	0	0.43	11:34:29	5.258	0.002	2.603

	395	340.053	0	0.419	11:34:30	5.292	0.003	2.587
	396	340.528	0	0.408	11:34:31	5.301	0	2.571
	397	338.191	0	0.399	11:34:32	5.256	0.001	2.559
	398	339.214	0	0.389	11:34:33	5.276	0	2.544
	399	340.008	0	0.379	11:34:34	5.291	0	2.531
	400	343.791	0	0.368	11:34:35	5.366	0.002	2.516
	401	342.961	0	0.359	11:34:36	5.349	0.004	2.502
	402	341.296	0	0.347	11:34:37	5.316	-0.001	2.485
	403	340.075	0	0.341	11:34:38	5.293	-0.003	2.477
	404	341.093	0	0.327	11:34:39	5.312	0.002	2.456
	405	342.826	0	0.32	11:34:40	5.347	0.003	2.446
	406	342.467	0	0.309	11:34:41	5.34	0.014	2.43
	407	339.441	0	0.299	11:34:42	5.28	0.007	2.416
	408	340.709	0	0.29	11:34:43	5.305	0.001	2.404
	409	341.521	0	0.279	11:34:44	5.321	-0.008	2.388
	410	341.409	0	0.269	11:34:45	5.319	0.038	2.374
	411	341.859	0	0.259	11:34:46	5.328	0.004	2.359
	412	340.46	0	0.25	11:34:47	5.3	0.002	2.346
	413	341.476	0	0.238	11:34:48	5.32	0	2.329
	414	339.486	0	0.227	11:34:49	5.281	0	2.314
	415	337.918	0	0.221	11:34:50	5.25	0.005	2.304
	416	340.008	0	0.209	11:34:51	5.291	0.004	2.288
	417	340.256	0	0.201	11:34:52	5.296	-0.073	2.276
	418	341.341	0	0.189	11:34:53	5.317	-0.002	2.259
	419	341.273	0	0.18	11:34:54	5.316	-0.02	2.246
	420	340.098	0	0.171	11:34:55	5.293	-0.004	2.234
	421	338.168	0	0.161	11:34:56	5.255	0.001	2.219
	422	339.418	0	0.151	11:34:57	5.28	0.003	2.204
	423	339.645	0	0.141	11:34:58	5.284	0.001	2.19
	424	341.273	0	0.13	11:34:59	5.316	0.001	2.174
	425	343.724	0	0.127	11:35:00	5.364	0.001	2.17
COARSE	-	-	-					
	426	341.679	0	0.112	11:35:01	5.324	0.002	2.148
	427	341.521	0	0.1	11:35:02	5.321	0.004	2.131
	428	342.714	0	0.092	11:35:03	5.344	0.004	2.12
	429	341.859	0	0.083	11:35:04	5.328	0.007	2.108
	430	343.455	0	0.076	11:35:05	5.359	0.005	2.097

Highlighted Area is Onset of Air Entrainment Based on Review of test Video
Data point above where it is marked "Coarse" is the onset of Air based on Visual Observations During Testing

Dec. 05 20 11:59:02

ch1 slope	ch 1 int	ch2 slope	ch 2 int	ch 3 slope	ch3 int	c1	c2	c3	scale	ref lev
0.325792	-0.638112	1.25	-5	0.302893	-0.604871	214.8027	46.0382		1	0.006

point	6inch Meter (GPM Model)	% Air	level (ft Model)	time	vch1	vch2	vch3
1	0	0	3.985	11:59:23	1.957	0.003	7.689
2	0	0	3.984	11:59:24	1.955	0	7.687
3	0	0	3.983	11:59:25	1.954	0	7.687
4	0	0	3.985	11:59:26	1.956	0.002	7.689
5	0	0	3.983	11:59:27	1.955	0	7.687
6	0	0	3.984	11:59:28	1.954	-0.001	7.688
7	0	0	3.985	11:59:29	1.954	0.001	7.69
8	0	0	3.985	11:59:30	1.955	0.002	7.689
9	0	0	3.983	11:59:31	1.955	-0.004	7.686
10	0	0	3.985	11:59:32	1.955	0	7.689
11	0	0	3.984	11:59:33	1.956	0.004	7.688
12	0	0	3.984	11:59:34	1.956	0.003	7.687
13	0	0	3.985	11:59:35	1.955	0.002	7.69
14	0	0	3.983	11:59:36	1.958	0.004	7.687
15	0	0	3.983	11:59:37	1.956	-0.001	7.687
16	0	0	3.984	11:59:38	1.955	0.002	7.688
17	0	0	3.984	11:59:39	1.956	0.002	7.688
18	0	0	3.985	11:59:40	1.954	0.001	7.689
19	0	0	3.985	11:59:41	1.956	0.001	7.69
20	0	0	3.984	11:59:42	1.954	0.005	7.688
21	0	0	3.984	11:59:43	1.954	0.002	7.688
22	0	0	3.985	11:59:44	1.953	0	7.689
23	0	0	3.984	11:59:45	1.957	0.002	7.688
24	0	0	3.983	11:59:46	1.955	0	7.687
25	0	0	3.984	11:59:47	1.954	-0.001	7.687
26	0	0	3.985	11:59:48	1.956	0.005	7.689
27	0	0	3.983	11:59:49	1.956	-0.003	7.687
28	0	0	3.984	11:59:50	1.955	-0.001	7.688
29	0	0	3.984	11:59:51	1.957	0.005	7.688
30	0	0	3.984	11:59:52	1.957	-0.003	7.688
31	0	0	3.984	11:59:53	1.955	0	7.687
32	0	0	3.985	11:59:54	1.957	0.005	7.689
33	0	0	3.984	11:59:55	1.957	0	7.687
34	0	0	3.985	11:59:56	1.955	0.001	7.689
35	0	0	3.985	11:59:57	1.957	0.004	7.689
36	0	0	3.984	11:59:58	1.955	-0.001	7.688
37	0	0	3.984	11:59:59	1.955	-0.001	7.688
38	0	0	3.984	12:00:00	1.955	0.005	7.688
39	0	0	3.985	12:00:01	1.955	0	7.689
40	0	0	3.985	12:00:02	1.958	-0.002	7.689
41	0	0	3.985	12:00:03	1.957	0.006	7.69
42	0	0	3.984	12:00:04	1.957	0.004	7.687
43	0	0	3.984	12:00:05	1.955	-0.002	7.688
44	0	0	3.984	12:00:06	1.956	0.001	7.688
45	0	0	3.986	12:00:07	1.957	0.004	7.69
46	0	0	3.985	12:00:08	1.954	-0.001	7.689
47	0	0	3.984	12:00:09	1.955	0.002	7.688
48	0	0	3.984	12:00:10	1.957	0.008	7.688

49	0	0	3.984	12:00:11	1.956	-0.021	7.687
50	0	0	3.985	12:00:12	1.989	0.003	7.689
51	65.377	0	3.981	12:00:13	2.082	-0.002	7.683
52	62.977	0	3.973	12:00:14	2.073	-0.001	7.672
53	64.308	0	3.978	12:00:15	2.078	0.004	7.68
54	87.356	0	3.983	12:00:16	2.179	-0.005	7.686
55	97.439	0	3.972	12:00:17	2.232	0.002	7.671
56	98.305	0	3.97	12:00:18	2.237	0.003	7.667
57	98.226	0	3.967	12:00:19	2.237	0.001	7.663
58	102.972	0	3.963	12:00:20	2.264	0.004	7.658
59	112.066	0	3.962	12:00:21	2.321	0.003	7.657
60	119.256	0	3.956	12:00:22	2.369	-0.004	7.648
61	136.025	0	3.954	12:00:23	2.492	0.003	7.645
62	144.799	0	3.949	12:00:24	2.563	0.004	7.637
63	145.436	0	3.946	12:00:25	2.568	0.002	7.633
64	146.438	0	3.943	12:00:26	2.577	0.002	7.629
65	164.654	0	3.944	12:00:27	2.74	0.003	7.63
66	180.194	0	3.939	12:00:28	2.895	0.005	7.623
67	187.81	0	3.934	12:00:29	2.975	0.002	7.617
68	208.703	0	3.93	12:00:30	3.214	0.004	7.611
69	217.236	0	3.922	12:00:31	3.319	0.047	7.599
70	228.296	0	3.915	12:00:32	3.461	-0.002	7.589
71	242.365	0	3.909	12:00:33	3.652	0.001	7.581
72	246.522	0	3.902	12:00:34	3.71	0.011	7.571
73	248.389	0	3.895	12:00:35	3.737	0.005	7.56
74	248.389	0	3.887	12:00:36	3.737	0.001	7.55
75	267.666	0	3.881	12:00:37	4.024	0.003	7.54
76	287.15	0	3.872	12:00:38	4.335	0	7.528
77	288.247	0	3.864	12:00:39	4.354	0.004	7.516
78	299.41	0	3.854	12:00:40	4.543	-0.001	7.501
79	309.127	0	3.845	12:00:41	4.713	-0.001	7.489
80	309.277	0	3.837	12:00:42	4.716	0.006	7.478
81	309.625	0	3.827	12:00:43	4.722	0.004	7.464
82	310.246	0	3.82	12:00:44	4.733	-0.001	7.454
83	312.817	0	3.811	12:00:45	4.779	0.003	7.441
84	316.511	0	3.8	12:00:46	4.846	0	7.424
85	319.827	0	3.79	12:00:47	4.907	-0.002	7.411
86	321.052	0	3.782	12:00:48	4.93	0.006	7.399
87	322.321	0	3.772	12:00:49	4.953	0.003	7.385
88	322.082	0	3.763	12:00:50	4.949	-0.002	7.371
89	323.132	0	3.754	12:00:51	4.968	0.005	7.359
90	328.098	0	3.743	12:00:52	5.062	0.001	7.344
91	333.29	0	3.734	12:00:53	5.161	0.001	7.33
92	335.477	0	3.725	12:00:54	5.203	0.029	7.317
93	336.669	0	3.712	12:00:55	5.226	-0.001	7.299
94	338.038	0	3.705	12:00:56	5.253	-0.005	7.288
95	339.311	0	3.694	12:00:57	5.277	0.007	7.274
96	342.361	0	3.68	12:00:58	5.337	0.001	7.252
97	342.63	0	3.676	12:00:59	5.343	-0.02	7.247
98	344.893	0	3.666	12:01:00	5.388	0.033	7.232
99	344.133	0	3.653	12:01:01	5.372	0.008	7.215
100	345.25	0	3.645	12:01:02	5.395	0.002	7.203
101	344.736	0	3.634	12:01:03	5.384	0.002	7.188

102	341.257	0	3.623	12:01:04	5.316	0.001	7.172
103	343.371	0	3.614	12:01:05	5.357	0.007	7.159
104	346.718	0	3.604	12:01:06	5.424	0.002	7.145
105	347.517	0	3.594	12:01:07	5.44	0.002	7.13
106	345.762	0	3.582	12:01:08	5.405	-0.002	7.113
107	347.051	0	3.552	12:01:09	5.431	0.002	7.07
108	345.629	0	3.563	12:01:10	5.402	0.001	7.086
109	345.762	0	3.557	12:01:11	5.405	0.003	7.077
110	340.557	0	3.544	12:01:12	5.302	0.005	7.058
111	344.245	0	3.533	12:01:13	5.375	-0.059	7.042
112	348.181	0	3.524	12:01:14	5.453	0.001	7.029
113	347.428	0	3.513	12:01:15	5.438	0.005	7.014
114	346.696	0	3.503	12:01:16	5.423	-0.005	7
115	345.272	0	3.493	12:01:17	5.395	0	6.986
116	346.052	0	3.485	12:01:18	5.411	0.004	6.974
117	344.692	0	3.473	12:01:19	5.384	0	6.956
118	344.446	0	3.463	12:01:20	5.379	0.002	6.942
119	344.826	0	3.453	12:01:21	5.386	0.001	6.928
120	343.618	0	3.446	12:01:22	5.362	-0.05	6.918
121	342.765	0	3.433	12:01:23	5.345	0.002	6.899
122	342.833	0	3.423	12:01:24	5.347	0.003	6.885
123	343.909	0	3.411	12:01:25	5.368	0.017	6.869
124	344.781	0	3.403	12:01:26	5.385	0.004	6.857
125	344.222	0	3.393	12:01:27	5.374	0.003	6.842
126	340.941	0	3.383	12:01:28	5.309	-0.013	6.828
127	341.234	0	3.372	12:01:29	5.315	0	6.812
128	341.911	0	3.362	12:01:30	5.328	0.006	6.799
129	340.738	0	3.352	12:01:31	5.305	0.007	6.784
130	340.828	0	3.343	12:01:32	5.307	0.001	6.77
131	340.557	0	3.333	12:01:33	5.302	0.003	6.757
132	340.873	0	3.324	12:01:34	5.308	0.001	6.743
133	339.968	0	3.314	12:01:35	5.29	-0.059	6.729
134	340.036	0	3.302	12:01:36	5.292	-0.027	6.713
135	341.866	0	3.293	12:01:37	5.328	-0.001	6.699
136	341.257	0	3.285	12:01:38	5.316	0.012	6.687
137	340.918	0	3.273	12:01:39	5.309	0.001	6.67
138	341.618	0	3.264	12:01:40	5.323	0.006	6.657
139	342.675	0	3.255	12:01:41	5.344	-0.02	6.645
140	341.911	0	3.245	12:01:42	5.328	0.006	6.63
141	340.67	0	3.234	12:01:43	5.304	-0.006	6.615
142	340.331	0	3.224	12:01:44	5.297	0.005	6.601
143	339.22	0	3.214	12:01:45	5.276	0.05	6.586
144	339.107	0	3.205	12:01:46	5.273	0.001	6.573
145	337.787	0	3.194	12:01:47	5.248	0.002	6.558
146	339.629	0	3.185	12:01:48	5.284	0	6.544
147	340.941	0	3.175	12:01:49	5.309	0.003	6.531
148	340.76	0	3.164	12:01:50	5.306	0.004	6.515
149	339.424	0	3.154	12:01:51	5.28	0.001	6.5
150	339.787	0	3.145	12:01:52	5.287	0.012	6.487
151	339.152	0	3.134	12:01:53	5.274	0.022	6.472
152	338.675	0	3.125	12:01:54	5.265	-0.005	6.459
153	340.828	0	3.113	12:01:55	5.307	-0.042	6.442
154	338.22	0	3.103	12:01:56	5.256	0.031	6.428

155	336.989	0	3.085	12:01:57	5.232	0.002	6.402
156	339.878	0	3.085	12:01:58	5.289	0.004	6.402
157	341.325	0	3.075	12:01:59	5.317	-0.002	6.388
158	340.76	0	3.059	12:02:00	5.306	-0.001	6.365
159	339.016	0	3.056	12:02:01	5.272	0.006	6.361
160	339.81	0	3.045	12:02:02	5.287	0.003	6.345
161	340.625	0	3.042	12:02:03	5.303	0.004	6.34
162	340.466	0	3.026	12:02:04	5.3	0.001	6.317
163	338.834	0	3.016	12:02:05	5.268	0.001	6.302
164	338.106	0	3.006	12:02:06	5.254	0	6.288
165	337.901	0	2.996	12:02:07	5.25	0.023	6.275
166	338.425	0	2.985	12:02:08	5.26	0.002	6.258
167	337.171	0	2.976	12:02:09	5.236	0	6.246
168	340.014	0	2.965	12:02:10	5.291	0.006	6.23
169	340.376	0	2.957	12:02:11	5.298	-0.004	6.218
170	339.334	0	2.947	12:02:12	5.278	0.002	6.204
171	341.37	0	2.938	12:02:13	5.318	0.006	6.191
172	338.902	0	2.933	12:02:14	5.269	0.001	6.184
173	336.371	0	2.918	12:02:15	5.22	0.002	6.163
174	338.061	0	2.905	12:02:16	5.253	0.006	6.145
175	338.197	0	2.896	12:02:17	5.256	-0.007	6.132
176	338.88	0	2.888	12:02:18	5.269	-0.047	6.12
177	339.107	0	2.877	12:02:19	5.273	0.002	6.104
178	339.674	0	2.868	12:02:20	5.285	-0.002	6.091
179	338.766	0	2.858	12:02:21	5.267	-0.06	6.076
180	338.129	0	2.846	12:02:22	5.254	-0.006	6.06
181	337.582	0	2.838	12:02:23	5.244	0.005	6.048
182	337.582	0	2.829	12:02:24	5.244	0.001	6.035
183	338.561	0	2.819	12:02:25	5.263	-0.073	6.021
184	339.402	0	2.807	12:02:26	5.279	0	6.005
185	340.466	0	2.798	12:02:27	5.3	0.006	5.991
186	338.971	0	2.788	12:02:28	5.271	0.004	5.977
187	336.577	0	2.777	12:02:29	5.224	0.002	5.961
188	336.989	0	2.769	12:02:30	5.232	0.003	5.949
189	338.357	0	2.758	12:02:31	5.259	-0.001	5.934
190	337.331	0	2.749	12:02:32	5.239	-0.02	5.921
191	336.165	0	2.739	12:02:33	5.216	-0.003	5.907
192	335.385	0	2.722	12:02:34	5.201	0.005	5.882
193	335.431	0	2.727	12:02:35	5.202	0.02	5.89
194	339.334	0	2.71	12:02:36	5.278	0.037	5.865
195	340.512	0	2.7	12:02:37	5.301	-0.008	5.851
196	337.011	0	2.69	12:02:38	5.233	-0.002	5.837
197	336.44	0	2.667	12:02:39	5.222	0.004	5.804
198	337.263	0	2.671	12:02:40	5.237	-0.003	5.81
199	336.829	0	2.651	12:02:41	5.229	0	5.781
200	335.179	0	2.652	12:02:42	5.197	-0.051	5.782
201	333.936	0	2.64	12:02:43	5.173	0	5.765
202	334.074	0	2.631	12:02:44	5.176	-0.001	5.753
203	337.878	0	2.621	12:02:45	5.249	0.002	5.737
204	339.515	0	2.611	12:02:46	5.281	0	5.724
205	339.311	0	2.6	12:02:47	5.277	-0.016	5.708
206	339.039	0	2.591	12:02:48	5.272	0.007	5.695
207	345.562	0	2.58	12:02:49	5.401	0.006	5.679

208	347.96	0	2.571	12:02:50	5.449	0	5.667
209	346.519	0	2.56	12:02:51	5.42	0.003	5.651
210	344.982	0	2.551	12:02:52	5.389	0.001	5.637
211	347.672	0	2.541	12:02:53	5.443	-0.002	5.624
212	346.407	0	2.53	12:02:54	5.418	0.011	5.608
213	346.296	0	2.518	12:02:55	5.415	-0.002	5.59
214	346.763	0	2.514	12:02:56	5.425	0.004	5.585
215	343.551	0	2.5	12:02:57	5.361	-0.005	5.566
216	341.347	0	2.49	12:02:58	5.317	-0.001	5.55
217	340.918	0	2.481	12:02:59	5.309	0.005	5.538
218	340.828	0	2.469	12:03:00	5.307	0.013	5.521
219	340.489	0	2.459	12:03:01	5.301	0.004	5.506
220	340.489	0	2.45	12:03:02	5.301	-0.034	5.493
221	343.057	0	2.441	12:03:03	5.351	0.002	5.48
222	342.158	0	2.43	12:03:04	5.333	0.003	5.465
223	342.563	0	2.421	12:03:05	5.341	-0.006	5.452
224	342.9	0	2.409	12:03:06	5.348	0.002	5.435
225	341.798	0	2.4	12:03:07	5.326	-0.005	5.422
226	342.878	0	2.39	12:03:08	5.348	0.003	5.407
227	342.765	0	2.382	12:03:09	5.345	0.004	5.396
228	344.155	0	2.37	12:03:10	5.373	-0.001	5.379
229	343.259	0	2.361	12:03:11	5.355	0.002	5.366
230	343.685	0	2.349	12:03:12	5.364	0	5.349
231	343.394	0	2.34	12:03:13	5.358	-0.006	5.336
232	342.563	0	2.33	12:03:14	5.341	0.017	5.322
233	341.55	0	2.319	12:03:15	5.321	0.009	5.306
234	341.595	0	2.31	12:03:16	5.322	0.003	5.293
235	340.76	0	2.3	12:03:17	5.306	0.004	5.279
236	342.608	0	2.289	12:03:18	5.342	-0.023	5.264
237	341.933	0	2.28	12:03:19	5.329	0.003	5.25
238	340.715	0	2.269	12:03:20	5.305	0.003	5.235
239	340.376	0	2.259	12:03:21	5.298	0.003	5.221
240	339.266	0	2.251	12:03:22	5.277	0.004	5.208
241	342.63	0	2.239	12:03:23	5.343	0.003	5.191
242	343.887	0	2.229	12:03:24	5.368	0	5.177
243	340.783	0	2.22	12:03:25	5.306	0.002	5.164
244	340.489	0	2.209	12:03:26	5.301	0.002	5.149
245	342.675	0	2.2	12:03:27	5.344	-0.017	5.136
246	343.864	0	2.19	12:03:28	5.367	0.01	5.122
247	343.326	0	2.181	12:03:29	5.356	0.005	5.108
248	341.798	0	2.166	12:03:30	5.326	0.001	5.087
249	343.999	0	2.161	12:03:31	5.37	0.001	5.08
250	345.094	0	2.15	12:03:32	5.392	0.006	5.064
251	345.25	0	2.142	12:03:33	5.395	0	5.052
252	343.954	0	2.129	12:03:34	5.369	0.002	5.034
253	340.941	0	2.112	12:03:35	5.309	-0.004	5.01
254	339.311	0	2.11	12:03:36	5.277	-0.001	5.007
255	341.978	0	2.101	12:03:37	5.33	0	4.993
256	343.439	0	2.087	12:03:38	5.359	0.001	4.974
257	341.573	0	2.081	12:03:39	5.322	0.004	4.965
258	337.787	0	2.069	12:03:40	5.248	0.001	4.949
259	341.753	0	2.061	12:03:41	5.325	0.006	4.937
260	340.512	0	2.049	12:03:42	5.301	-0.021	4.919

261	339.651	0	2.041	12:03:43	5.284	-0.002	4.908
262	340.851	0	2.029	12:03:44	5.308	0.002	4.892
263	342.091	0	2.021	12:03:45	5.332	0	4.879
264	342.653	0	2.011	12:03:46	5.343	0.003	4.865
265	343.573	0	1.998	12:03:47	5.361	0.002	4.847
266	342.226	0	1.99	12:03:48	5.335	0	4.835
267	343.147	0	1.98	12:03:49	5.353	0	4.822
268	343.528	0	1.969	12:03:50	5.36	0.004	4.805
269	342.698	0	1.961	12:03:51	5.344	0.002	4.793
270	340.444	0	1.951	12:03:52	5.3	0.004	4.779
271	339.22	0	1.939	12:03:53	5.276	0.003	4.763
272	342.203	0	1.93	12:03:54	5.334	0.001	4.749
273	341.167	0	1.92	12:03:55	5.314	0.008	4.735
274	342.091	0	1.909	12:03:56	5.332	0.008	4.72
275	341.144	0	1.901	12:03:57	5.313	0.002	4.707
276	339.243	0	1.89	12:03:58	5.276	0.008	4.693
277	342.967	0	1.881	12:03:59	5.349	0.004	4.68
278	338.083	0	1.87	12:04:00	5.253	-0.001	4.664
279	338.675	0	1.861	12:04:01	5.265	0.003	4.651
280	342.136	0	1.849	12:04:02	5.333	0.004	4.634
281	343.439	0	1.84	12:04:03	5.359	-0.001	4.621
282	342.271	0	1.831	12:04:04	5.336	0.002	4.608
283	340.444	0	1.82	12:04:05	5.3	0.003	4.593
284	343.326	0	1.81	12:04:06	5.356	-0.002	4.578
285	339.81	0	1.801	12:04:07	5.287	0.003	4.565
286	340.783	0	1.79	12:04:08	5.306	0.008	4.549
287	340.986	0	1.779	12:04:09	5.31	0	4.534
288	341.054	0	1.772	12:04:10	5.312	0.001	4.524
289	340.218	0	1.761	12:04:11	5.295	-0.006	4.507
290	341.618	0	1.752	12:04:12	5.323	0.007	4.494
291	340.331	0	1.741	12:04:13	5.297	0.002	4.478
292	341.55	0	1.732	12:04:14	5.321	0.003	4.466
293	343.282	0	1.721	12:04:15	5.356	0	4.45
294	341.821	0	1.712	12:04:16	5.327	0.005	4.438
295	342.248	0	1.701	12:04:17	5.335	0	4.422
296	342.248	0	1.686	12:04:18	5.335	-0.004	4.401
297	341.076	0	1.679	12:04:19	5.312	0.004	4.391
298	339.583	0	1.671	12:04:20	5.283	0.001	4.379
299	340.896	0	1.661	12:04:21	5.309	0	4.365
300	342.541	0	1.653	12:04:22	5.341	-0.002	4.353
301	339.697	0	1.642	12:04:23	5.285	0.003	4.337
302	340.692	0	1.632	12:04:24	5.305	-0.007	4.323
303	341.415	0	1.621	12:04:25	5.319	0.003	4.307
304	340.805	0	1.612	12:04:26	5.307	0.002	4.295
305	340.082	0	1.601	12:04:27	5.293	-0.003	4.279
306	339.81	0	1.592	12:04:28	5.287	0.006	4.266
307	341.821	0	1.58	12:04:29	5.327	0.001	4.248
308	340.285	0	1.572	12:04:30	5.297	-0.024	4.237
309	340.738	0	1.552	12:04:31	5.305	0.003	4.209
310	339.515	0	1.551	12:04:32	5.281	0.002	4.207
311	340.692	0	1.543	12:04:33	5.305	-0.005	4.195
312	341.821	0	1.532	12:04:34	5.327	0.003	4.181
313	341.821	0	1.52	12:04:35	5.327	0.004	4.162

314	340.466	0	1.512	12:04:36	5.3	-0.004	4.152
315	339.129	0	1.503	12:04:37	5.274	0.005	4.138
316	339.47	0	1.491	12:04:38	5.281	0.001	4.122
317	339.016	0	1.484	12:04:39	5.272	0.003	4.111
318	339.81	0	1.472	12:04:40	5.287	0.004	4.094
319	340.399	0	1.464	12:04:41	5.299	0.007	4.082
320	339.561	0	1.454	12:04:42	5.282	-0.002	4.068
321	338.63	0	1.443	12:04:43	5.264	0.004	4.053
322	341.167	0	1.432	12:04:44	5.314	0.004	4.037
323	341.821	0	1.425	12:04:45	5.327	0.004	4.027
324	341.595	0	1.413	12:04:46	5.322	0.002	4.01
325	341.28	0	1.397	12:04:47	5.316	0	3.987
326	338.607	0	1.4	12:04:48	5.264	-0.002	3.991
327	336.737	0	1.383	12:04:49	5.227	0.002	3.968
328	341.46	0	1.373	12:04:50	5.32	0.001	3.952
329	339.243	0	1.364	12:04:51	5.276	0.011	3.939
330	339.129	0	1.356	12:04:52	5.274	-0.029	3.928
331	339.379	0	1.343	12:04:53	5.279	0.004	3.91
332	339.81	0	1.335	12:04:54	5.287	0.005	3.899
333	338.902	0	1.325	12:04:55	5.269	0.001	3.884
334	338.402	0	1.316	12:04:56	5.26	0.003	3.871
335	339.129	0	1.303	12:04:57	5.274	-0.002	3.853
336	340.964	0	1.295	12:04:58	5.31	-0.004	3.841
337	342.248	0	1.284	12:04:59	5.335	0	3.826
338	338.834	0	1.274	12:05:00	5.268	0	3.81
339	337.468	0	1.264	12:05:01	5.241	-0.028	3.796
340	338.971	0	1.254	12:05:02	5.271	0.004	3.782
341	340.376	0	1.246	12:05:03	5.298	0.016	3.771
342	341.685	0	1.235	12:05:04	5.324	0.01	3.755
343	341.054	0	1.226	12:05:05	5.312	0.013	3.742
344	340.353	0	1.215	12:05:06	5.298	0	3.727
345	339.356	0	1.205	12:05:07	5.278	-0.057	3.713
346	339.991	0	1.195	12:05:08	5.291	0.001	3.698
347	339.968	0	1.184	12:05:09	5.29	0.002	3.683
348	339.061	0	1.176	12:05:10	5.273	0	3.67
349	340.851	0	1.167	12:05:11	5.308	0.008	3.657
350	341.708	0	1.155	12:05:12	5.324	-0.004	3.641
351	339.039	0	1.146	12:05:13	5.272	-0.002	3.627
352	338.083	0	1.136	12:05:14	5.253	0.002	3.614
353	338.493	0	1.124	12:05:15	5.261	0.004	3.596
354	337.901	0	1.116	12:05:16	5.25	-0.002	3.585
355	339.493	0	1.107	12:05:17	5.281	0.004	3.572
356	339.47	0	1.095	12:05:18	5.281	0.002	3.555
357	341.528	0	1.086	12:05:19	5.321	-0.001	3.543
358	340.014	0	1.076	12:05:20	5.291	0.002	3.527
359	340.805	0	1.067	12:05:21	5.307	-0.001	3.515
360	341.821	0	1.056	12:05:22	5.327	0	3.5
361	342.473	0	1.047	12:05:23	5.34	0.002	3.486
362	340.783	0	1.036	12:05:24	5.306	0.001	3.47
363	339.198	0	1.026	12:05:25	5.275	-0.003	3.456
364	338.357	0	1.017	12:05:26	5.259	0.003	3.443
365	339.152	0	1.006	12:05:27	5.274	0	3.428
366	341.325	0	0.999	12:05:28	5.317	-0.003	3.417

367	338.675	0	0.987	12:05:29	5.265	0	3.4
368	338.652	0	0.977	12:05:30	5.265	0.008	3.386
369	340.76	0	0.966	12:05:31	5.306	0	3.371
370	342.316	0	0.957	12:05:32	5.336	0.004	3.358
371	342.541	0	0.946	12:05:33	5.341	0.001	3.342
372	341.753	0	0.936	12:05:34	5.325	-0.017	3.328
373	341.528	0	0.926	12:05:35	5.321	0	3.313
374	341.46	0	0.917	12:05:36	5.32	0.002	3.3
375	344.133	0	0.906	12:05:37	5.372	0.001	3.285
376	344.245	0	0.897	12:05:38	5.375	0	3.272
377	344.446	0	0.886	12:05:39	5.379	-0.002	3.256
378	342.99	0	0.878	12:05:40	5.35	0.007	3.244
379	343.394	0	0.867	12:05:41	5.358	-0.001	3.229
380	344.401	0	0.857	12:05:42	5.378	0.002	3.215
381	342.9	0	0.847	12:05:43	5.348	0.003	3.2
382	341.392	0	0.833	12:05:44	5.318	0.001	3.18
383	342.586	0	0.827	12:05:45	5.342	-0.005	3.172
384	339.674	0	0.817	12:05:46	5.285	0.001	3.157
385	339.606	0	0.806	12:05:47	5.283	-0.016	3.142
386	341.392	0	0.797	12:05:48	5.318	0.001	3.128
387	343.663	0	0.787	12:05:49	5.363	0.004	3.115
388	341.167	0	0.776	12:05:50	5.314	0.008	3.098
389	340.082	0	0.768	12:05:51	5.293	0.009	3.086
390	342.9	0	0.758	12:05:52	5.348	0.008	3.072
391	342.113	0	0.747	12:05:53	5.332	0.002	3.057
392	339.538	0	0.738	12:05:54	5.282	-0.001	3.044
393	341.956	0	0.727	12:05:55	5.329	0	3.029
394	342.541	0	0.717	12:05:56	5.341	-0.003	3.014
395	342.653	0	0.709	12:05:57	5.343	0	3.002
396	343.012	0	0.697	12:05:58	5.35	0.003	2.986
397	340.715	0	0.687	12:05:59	5.305	-0.002	2.972
398	343.506	0	0.677	12:06:00	5.36	0.001	2.957
399	343.819	0	0.669	12:06:01	5.366	0.004	2.946
400	343.125	0	0.657	12:06:02	5.352	-0.004	2.928
401	342.608	0	0.647	12:06:03	5.342	0	2.915
402	342.586	0	0.638	12:06:04	5.342	0.003	2.901
403	341.122	0	0.627	12:06:05	5.313	0.004	2.886
404	341.031	0	0.617	12:06:06	5.311	-0.001	2.871
405	341.46	0	0.608	12:06:07	5.32	-0.001	2.858
406	340.602	0	0.599	12:06:08	5.303	0.004	2.845
407	341.144	0	0.588	12:06:09	5.313	0.004	2.829
408	338.925	0	0.578	12:06:10	5.27	-0.002	2.815
409	340.218	0	0.568	12:06:11	5.295	0.006	2.801
410	341.054	0	0.558	12:06:12	5.312	0.001	2.786
411	341.798	0	0.548	12:06:13	5.326	0.002	2.773
412	339.901	0	0.539	12:06:14	5.289	0.003	2.759
413	339.833	0	0.527	12:06:15	5.288	0.004	2.742
414	340.625	0	0.518	12:06:16	5.303	-0.001	2.73
415	340.195	0	0.509	12:06:17	5.295	-0.004	2.716
416	340.24	0	0.499	12:06:18	5.296	-0.001	2.702
417	339.651	0	0.489	12:06:19	5.284	-0.008	2.688
418	339.039	0	0.479	12:06:20	5.272	-0.001	2.674
419	339.651	0	0.469	12:06:21	5.284	0.003	2.659

420	339.084	0	0.46	12:06:22	5.273	0.002	2.646
421	337.377	0	0.448	12:06:23	5.24	-0.002	2.63
422	340.896	0	0.44	12:06:24	5.309	0.003	2.617
423	340.873	0	0.429	12:06:25	5.308	0.001	2.602
424	340.195	0	0.418	12:06:26	5.295	0.001	2.587
425	341.708	0	0.409	12:06:27	5.324	0.002	2.574
426	341.392	0	0.4	12:06:28	5.318	-0.008	2.56
427	341.618	0	0.391	12:06:29	5.323	-0.001	2.547
428	342.203	0	0.38	12:06:30	5.334	-0.044	2.532
429	341.505	0	0.37	12:06:31	5.32	-0.001	2.517
430	343.08	0	0.36	12:06:32	5.352	0.002	2.503
431	342.383	0	0.35	12:06:33	5.338	-0.04	2.49
432	340.263	0	0.34	12:06:34	5.296	0	2.475
433	338.288	0	0.338	12:06:35	5.257	0.003	2.472
434	338.448	0	0.32	12:06:36	5.261	0.048	2.446
435	338.175	0	0.31	12:06:37	5.255	0.003	2.432
436	340.534	0	0.3	12:06:38	5.301	0.004	2.417
437	340.218	0	0.292	12:06:39	5.295	0.002	2.405
438	339.175	0	0.28	12:06:40	5.275	-0.001	2.389
439	337.947	0	0.27	12:06:41	5.251	0	2.375
440	337.992	0	0.26	12:06:42	5.252	0	2.36
441	338.152	0	0.251	12:06:43	5.255	-0.049	2.347
442	339.039	0	0.242	12:06:44	5.272	0.011	2.334
443	338.721	0	0.231	12:06:45	5.266	0.003	2.319
444	338.652	0	0.222	12:06:46	5.265	0.013	2.306
445	337.605	0	0.211	12:06:47	5.244	0.004	2.291
446	339.651	0	0.201	12:06:48	5.284	-0.003	2.276
447	339.719	0	0.191	12:06:49	5.285	0.004	2.261
448	337.81	0	0.182	12:06:50	5.248	0.001	2.248
449	339.651	0	0.175	12:06:51	5.284	0.001	2.239
450	339.991	0	0.162	12:06:52	5.291	0.002	2.221
451	340.489	0	0.143	12:06:53	5.301	0.002	2.193
452	338.948	0	0.142	12:06:54	5.27	0.003	2.192
453	338.584	0	0.132	12:06:55	5.263	0.004	2.178
454	336.806	0	0.125	12:06:56	5.229	-0.001	2.167
455	338.857	0	0.114	12:06:57	5.269	0	2.151
COARSE -	-	-					
456	341.099	0	0.103	12:06:58	5.312	0.008	2.136
457	341.212	0	0.093	12:06:59	5.315	0.006	2.121
458	339.175	0	0.084	12:07:00	5.275	-0.002	2.109
459	339.878	0	0.077	12:07:01	5.289	0.012	2.098
460	337.673	0	0.068	12:07:02	5.245	0.001	2.086
461	309.401	0	0.062	12:07:03	4.718	-0.002	2.077
462	237.325	0	0.056	12:07:04	3.582	0.002	2.068
463	162.204	0	0.05	12:07:05	2.717	0	2.06
464	92.66	0	0.047	12:07:06	2.206	0.002	2.056
465	0	0	0.045	12:07:07	1.985	-0.003	2.053
466	0	0	0.047	12:07:08	1.942	0.004	2.056
467	0	0	0.044	12:07:09	1.942	0.003	2.051
468	0	0	0.053	12:07:10	1.962	0	2.064
469	0	0	0.04	12:07:11	1.95	0.003	2.046
470	0	0	0.054	12:07:12	1.958	0.005	2.065
471	0	0	0.038	12:07:13	1.965	0.002	2.043

Highlighted Area is Onset of Air Entrainment Based on Review of test Video

Data point above where it is marked "Coarse" is the onset of Air based on Visual Observations During Testing

472	0	0	0.054	12:07:14	1.946	0.001	2.065
473	0	0	0.042	12:07:15	1.966	0	2.048
474	0	0	0.051	12:07:16	1.954	0.003	2.061
475	0	0	0.042	12:07:17	1.956	-0.001	2.049
476	0	0	0.053	12:07:18	1.958	0.003	2.064
477	0	0	0.04	12:07:19	1.954	0.003	2.045
478	0	0	0.054	12:07:20	1.959	0.001	2.065
479	0	0	0.042	12:07:21	1.953	0.002	2.048
480	0	0	0.051	12:07:22	1.957	0.006	2.061
481	0	0	0.044	12:07:23	1.958	0.002	2.051
482	0	0	0.048	12:07:24	1.953	0.003	2.057
483	0	0	0.042	12:07:25	1.958	0.001	2.049
484	0	0	0.049	12:07:26	1.957	0.006	2.058
485	0	0	0.045	12:07:27	1.957	-0.001	2.053
486	0	0	0.047	12:07:28	1.956	-0.001	2.056

Dec. 05 20 13:20:33

ch1 slope	ch 1 int	ch2 slope	ch 2 int	ch 3 slope	ch3 int	c1	c2	c3	scale	ref lev
0.325792	-0.638112	1.25	-5	0.302893	-0.604871	214.8027	46.0382		1	0.006

point	6inch Meter (GPM Model)	% Air	level (ft Model)	time	vch1	vch2	vch3
1	0	0	3.984	13:21:25	1.954	0.001	7.687
2	0	0	3.984	13:21:26	1.954	-0.012	7.688
3	0	0	3.984	13:21:27	1.958	0.005	7.688
4	0	0	3.985	13:21:28	1.957	0.007	7.69
5	0	0	3.984	13:21:29	1.955	0	7.688
6	0	0	3.983	13:21:30	1.958	0.002	7.686
7	0	0	3.983	13:21:31	1.955	-0.01	7.686
8	0	0	3.983	13:21:32	1.955	0.025	7.686
9	0	0	3.984	13:21:33	1.957	0.005	7.687
10	0	0	3.982	13:21:34	1.957	0.001	7.686
11	0	0	3.984	13:21:35	1.955	-0.005	7.687
12	0	0	3.985	13:21:36	1.954	0.002	7.69
13	0	0	3.976	13:21:37	1.958	0.003	7.677
14	0	0	3.982	13:21:38	1.962	0.002	7.686
15	46.191	0	3.983	13:21:39	2.02	0	7.686
16	88.755	0	3.979	13:21:40	2.186	0.003	7.681
17	143.785	0	3.978	13:21:41	2.555	0.005	7.679
18	161.109	0	3.972	13:21:42	2.707	0.005	7.67
19	167.528	0	3.966	13:21:43	2.768	0.04	7.662
20	176	0	3.962	13:21:44	2.852	0.001	7.656
21	199.884	0	3.956	13:21:45	3.11	0.001	7.648
22	258.684	0	3.949	13:21:46	3.888	0	7.637
23	283.589	0	3.942	13:21:47	4.277	0.034	7.627
24	285.725	0	3.939	13:21:48	4.312	0.002	7.624
25	285.024	0	3.932	13:21:49	4.3	-0.001	7.613
26	285.591	0	3.923	13:21:50	4.31	0.001	7.6
27	286.345	0	3.917	13:21:51	4.322	0.004	7.591
28	286.21	0	3.901	13:21:52	4.32	0.005	7.569
29	298.947	0	3.9	13:21:53	4.535	0.004	7.567
30	315	0	3.891	13:21:54	4.819	0	7.554
31	316.73	0	3.882	13:21:55	4.85	-0.004	7.542
32	316.171	0	3.872	13:21:56	4.84	0.005	7.528
33	316.633	0	3.863	13:21:57	4.849	-0.061	7.515
34	317.992	0	3.853	13:21:58	4.873	-0.032	7.501
35	322.894	0	3.846	13:21:59	4.964	-0.003	7.49
36	323.775	0	3.835	13:22:00	4.98	-0.087	7.474
37	326.522	0	3.825	13:22:01	5.032	0.004	7.46
38	326.168	0	3.815	13:22:02	5.025	0.003	7.446
39	325.931	0	3.807	13:22:03	5.021	0.004	7.434
40	327.158	0	3.785	13:22:04	5.044	-0.001	7.404
41	331.785	0	3.787	13:22:05	5.132	-0.004	7.406
42	334.12	0	3.776	13:22:06	5.177	0	7.39
43	332.202	0	3.767	13:22:07	5.14	-0.047	7.378
44	333.775	0	3.759	13:22:08	5.17	0.002	7.366
45	336.577	0	3.746	13:22:09	5.224	0	7.347
46	339.334	0	3.74	13:22:10	5.278	0.002	7.339
47	341.234	0	3.728	13:22:11	5.315	0	7.321
48	340.941	0	3.721	13:22:12	5.309	0.005	7.311

49	341.821	0	3.707	13:22:13	5.327	-0.003	7.291
50	342.518	0	3.699	13:22:14	5.34	0	7.28
51	342.765	0	3.688	13:22:15	5.345	-0.045	7.264
52	341.821	0	3.677	13:22:16	5.327	0.001	7.249
53	342.046	0	3.672	13:22:17	5.331	0.005	7.242
54	342.586	0	3.658	13:22:18	5.342	-0.002	7.222
55	340.195	0	3.649	13:22:19	5.295	0.002	7.208
56	339.447	0	3.639	13:22:20	5.28	-0.003	7.194
57	341.167	0	3.63	13:22:21	5.314	0.002	7.181
58	342.81	0	3.618	13:22:22	5.346	0.008	7.164
59	342.023	0	3.6	13:22:23	5.331	-0.017	7.139
60	343.887	0	3.597	13:22:24	5.368	0.003	7.135
61	341.933	0	3.589	13:22:25	5.329	-0.001	7.123
62	341.866	0	3.577	13:22:26	5.328	0.004	7.105
63	340.444	0	3.569	13:22:27	5.3	0	7.095
64	340.738	0	3.557	13:22:28	5.305	0	7.077
65	341.076	0	3.557	13:22:29	5.312	-0.019	7.077
66	341.933	0	3.539	13:22:30	5.329	0.005	7.051
67	341.392	0	3.529	13:22:31	5.318	0.004	7.037
68	342.316	0	3.517	13:22:32	5.336	0.022	7.02
69	339.765	0	3.509	13:22:33	5.286	0.001	7.008
70	341.776	0	3.5	13:22:34	5.326	-0.001	6.995
71	339.81	0	3.489	13:22:35	5.287	-0.056	6.98
72	337.833	0	3.47	13:22:36	5.249	0	6.952
73	340.421	0	3.469	13:22:37	5.299	0.002	6.951
74	340.466	0	3.459	13:22:38	5.3	-0.006	6.936
75	342.428	0	3.449	13:22:39	5.339	-0.002	6.922
76	341.46	0	3.44	13:22:40	5.32	0.002	6.91
77	339.061	0	3.428	13:22:41	5.273	0.001	6.893
78	341.099	0	3.42	13:22:42	5.312	-0.002	6.88
79	341.753	0	3.408	13:22:43	5.325	0	6.863
80	341.956	0	3.4	13:22:44	5.329	0.036	6.852
81	342.9	0	3.39	13:22:45	5.348	0.001	6.838
82	342.113	0	3.38	13:22:46	5.332	0.003	6.824
83	340.579	0	3.368	13:22:47	5.302	-0.009	6.806
84	341.144	0	3.36	13:22:48	5.313	0.003	6.795
85	342.271	0	3.35	13:22:49	5.336	0.004	6.78
86	341.167	0	3.341	13:22:50	5.314	0.004	6.768
87	339.515	0	3.33	13:22:51	5.281	-0.008	6.753
88	339.175	0	3.32	13:22:52	5.275	-0.004	6.738
89	340.353	0	3.311	13:22:53	5.298	0.006	6.725
90	340.896	0	3.299	13:22:54	5.309	0	6.708
91	342.608	0	3.292	13:22:55	5.342	0.001	6.698
92	340.602	0	3.28	13:22:56	5.303	0	6.681
93	340.082	0	3.269	13:22:57	5.293	-0.001	6.665
94	340.738	0	3.26	13:22:58	5.305	0	6.652
95	340.918	0	3.252	13:22:59	5.309	0.004	6.64
96	341.076	0	3.24	13:23:00	5.312	0.005	6.623
97	340.104	0	3.231	13:23:01	5.293	-0.004	6.61
98	340.512	0	3.218	13:23:02	5.301	0.008	6.593
99	340.805	0	3.211	13:23:03	5.307	-0.002	6.582
100	339.968	0	3.2	13:23:04	5.29	-0.014	6.566
101	340.059	0	3.191	13:23:05	5.292	0.003	6.554

102	341.55	0	3.179	13:23:06	5.321	0.002	6.537
103	341.009	0	3.171	13:23:07	5.311	0.005	6.524
104	339.561	0	3.161	13:23:08	5.282	-0.006	6.511
105	340.308	0	3.151	13:23:09	5.297	0.003	6.497
106	339.606	0	3.141	13:23:10	5.283	0.002	6.481
107	340.918	0	3.131	13:23:11	5.309	-0.003	6.467
108	340.692	0	3.121	13:23:12	5.305	-0.001	6.454
109	340.104	0	3.11	13:23:13	5.293	-0.048	6.438
110	339.424	0	3.102	13:23:14	5.28	0.014	6.427
111	339.334	0	3.09	13:23:15	5.278	0.01	6.409
112	340.67	0	3.082	13:23:16	5.304	-0.054	6.397
113	341.28	0	3.071	13:23:17	5.316	-0.002	6.382
114	338.175	0	3.062	13:23:18	5.255	-0.005	6.369
115	337.559	0	3.051	13:23:19	5.243	0.02	6.353
116	339.787	0	3.041	13:23:20	5.287	0.004	6.338
117	339.946	0	3.032	13:23:21	5.29	0.006	6.326
118	341.347	0	3.024	13:23:22	5.317	0.002	6.314
119	339.923	0	3.011	13:23:23	5.289	0.004	6.296
120	341.28	0	3.003	13:23:24	5.316	0	6.285
121	340.014	0	2.992	13:23:25	5.291	0	6.269
122	340.896	0	2.982	13:23:26	5.309	0.003	6.254
123	339.719	0	2.973	13:23:27	5.285	-0.001	6.241
124	341.708	0	2.963	13:23:28	5.324	0.004	6.227
125	341.483	0	2.951	13:23:29	5.32	0.007	6.21
126	339.084	0	2.935	13:23:30	5.273	0	6.187
127	339.583	0	2.933	13:23:31	5.283	0.007	6.184
128	337.901	0	2.922	13:23:32	5.25	0.002	6.169
129	338.038	0	2.913	13:23:33	5.253	0.002	6.156
130	339.901	0	2.902	13:23:34	5.289	-0.008	6.139
131	338.902	0	2.9	13:23:35	5.269	-0.002	6.137
132	339.356	0	2.883	13:23:36	5.278	0	6.112
133	340.805	0	2.875	13:23:37	5.307	0.002	6.101
134	342.136	0	2.863	13:23:38	5.333	0.003	6.084
135	340.76	0	2.854	13:23:39	5.306	0	6.072
136	337.97	0	2.843	13:23:40	5.251	0.04	6.056
137	337.628	0	2.835	13:23:41	5.245	-0.003	6.044
138	337.559	0	2.823	13:23:42	5.243	0.004	6.027
139	336.348	0	2.815	13:23:43	5.22	0.002	6.015
140	334.282	0	2.804	13:23:44	5.18	-0.002	6
141	338.425	0	2.794	13:23:45	5.26	0	5.986
142	342.72	0	2.785	13:23:46	5.344	0.003	5.972
143	343.707	0	2.774	13:23:47	5.364	0.004	5.957
144	342.068	0	2.765	13:23:48	5.332	0.002	5.943
145	342.923	0	2.755	13:23:49	5.348	-0.001	5.929
146	344.87	0	2.743	13:23:50	5.387	-0.001	5.913
147	345.294	0	2.734	13:23:51	5.396	0.001	5.9
148	345.027	0	2.723	13:23:52	5.39	0.001	5.884
149	343.282	0	2.714	13:23:53	5.356	-0.014	5.871
150	343.371	0	2.703	13:23:54	5.357	-0.005	5.856
151	344.736	0	2.694	13:23:55	5.384	-0.006	5.843
152	343.73	0	2.675	13:23:56	5.364	0.004	5.815
153	343.282	0	2.674	13:23:57	5.356	0	5.813
154	344.379	0	2.664	13:23:58	5.377	-0.003	5.799

155	343.394	0	2.653	13:23:59	5.358	0.003	5.784
156	342.855	0	2.644	13:24:00	5.347	-0.003	5.771
157	340.986	0	2.633	13:24:01	5.31	0.004	5.755
158	343.371	0	2.62	13:24:02	5.357	-0.001	5.737
159	343.819	0	2.613	13:24:03	5.366	-0.002	5.727
160	342.81	0	2.605	13:24:04	5.346	0	5.715
161	340.263	0	2.594	13:24:05	5.296	0.002	5.7
162	336.851	0	2.585	13:24:06	5.229	0	5.687
163	341.009	0	2.573	13:24:07	5.311	0.001	5.67
164	345.428	0	2.565	13:24:08	5.398	-0.002	5.658
165	345.027	0	2.553	13:24:09	5.39	-0.008	5.64
166	344.848	0	2.545	13:24:10	5.387	0.054	5.629
167	343.282	0	2.532	13:24:11	5.356	-0.018	5.611
168	342.923	0	2.524	13:24:12	5.348	0	5.599
169	342.428	0	2.513	13:24:13	5.339	0	5.583
170	342.046	0	2.504	13:24:14	5.331	0.002	5.57
171	342.878	0	2.494	13:24:15	5.348	0.005	5.556
172	343.259	0	2.483	13:24:16	5.355	0	5.541
173	342.113	0	2.474	13:24:17	5.332	0.002	5.527
174	341.37	0	2.465	13:24:18	5.318	0	5.515
175	342.855	0	2.453	13:24:19	5.347	0.001	5.497
176	344.043	0	2.444	13:24:20	5.371	0.002	5.485
177	344.289	0	2.433	13:24:21	5.376	-0.001	5.469
178	344.736	0	2.424	13:24:22	5.384	-0.006	5.456
179	345.272	0	2.415	13:24:23	5.395	0.003	5.443
180	343.169	0	2.405	13:24:24	5.353	0.007	5.428
181	341.73	0	2.393	13:24:25	5.325	0.003	5.412
182	342.293	0	2.383	13:24:26	5.336	-0.005	5.398
183	344.58	0	2.376	13:24:27	5.381	-0.047	5.387
184	343.439	0	2.365	13:24:28	5.359	0.004	5.372
185	342.967	0	2.353	13:24:29	5.349	0.002	5.354
186	344.535	0	2.343	13:24:30	5.38	0.051	5.34
187	342.203	0	2.333	13:24:31	5.334	-0.001	5.326
188	341.46	0	2.327	13:24:32	5.32	0	5.317
189	341.189	0	2.306	13:24:33	5.314	0.004	5.287
190	340.625	0	2.305	13:24:34	5.303	0.001	5.285
191	341.437	0	2.294	13:24:35	5.319	0.002	5.27
192	340.76	0	2.283	13:24:36	5.306	-0.01	5.255
193	341.708	0	2.274	13:24:37	5.324	0.004	5.241
194	342.63	0	2.264	13:24:38	5.343	0.004	5.228
195	344.334	0	2.253	13:24:39	5.376	0.002	5.211
196	344.982	0	2.237	13:24:40	5.389	0	5.189
197	343.954	0	2.234	13:24:41	5.369	0	5.185
198	341.64	0	2.224	13:24:42	5.323	0.002	5.17
199	339.719	0	2.213	13:24:43	5.285	0	5.155
200	339.878	0	2.205	13:24:44	5.289	0.002	5.143
201	340.557	0	2.194	13:24:45	5.302	-0.001	5.127
202	344.289	0	2.185	13:24:46	5.376	0.003	5.114
203	342.855	0	2.173	13:24:47	5.347	0.004	5.097
204	341.054	0	2.165	13:24:48	5.312	0.003	5.086
205	337.4	0	2.154	13:24:49	5.24	0.005	5.069
206	337.034	0	2.145	13:24:50	5.233	0.042	5.056
207	340.602	0	2.135	13:24:51	5.303	-0.003	5.042

208	340.353	0	2.124	13:24:52	5.298	0.008	5.027
209	342.271	0	2.114	13:24:53	5.336	-0.067	5.012
210	343.349	0	2.104	13:24:54	5.357	0.001	4.999
211	340.24	0	2.094	13:24:55	5.296	0.004	4.984
212	342.653	0	2.084	13:24:56	5.343	-0.001	4.969
213	341.663	0	2.073	13:24:57	5.324	0	4.954
214	341.753	0	2.065	13:24:58	5.325	0	4.942
215	341.685	0	2.052	13:24:59	5.324	-0.003	4.924
216	342.945	0	2.044	13:25:00	5.349	0.003	4.913
217	342.518	0	2.034	13:25:01	5.34	0	4.898
218	343.147	0	2.023	13:25:02	5.353	-0.079	4.882
219	342.496	0	2.013	13:25:03	5.34	-0.001	4.869
220	342.226	0	2.006	13:25:04	5.335	0	4.858
221	339.81	0	1.993	13:25:05	5.287	-0.054	4.84
222	340.444	0	1.985	13:25:06	5.3	0.009	4.828
223	340.647	0	1.974	13:25:07	5.304	-0.002	4.813
224	342.9	0	1.966	13:25:08	5.348	0.002	4.802
225	342.99	0	1.953	13:25:09	5.35	0.003	4.783
226	343.595	0	1.946	13:25:10	5.362	0.002	4.772
227	341.64	0	1.934	13:25:11	5.323	0.003	4.755
228	339.061	0	1.926	13:25:12	5.273	-0.001	4.743
229	340.828	0	1.91	13:25:13	5.307	0.004	4.72
230	340.24	0	1.907	13:25:14	5.296	0.002	4.716
231	342.293	0	1.893	13:25:15	5.336	-0.02	4.697
232	340.738	0	1.885	13:25:16	5.305	0	4.685
233	340.851	0	1.874	13:25:17	5.308	0.034	4.669
234	340.15	0	1.866	13:25:18	5.294	-0.015	4.657
235	342.338	0	1.853	13:25:19	5.337	0.01	4.64
236	341.663	0	1.847	13:25:20	5.324	-0.002	4.631
237	341.888	0	1.834	13:25:21	5.328	-0.012	4.612
238	343.371	0	1.825	13:25:22	5.357	0.004	4.6
239	342.833	0	1.814	13:25:23	5.347	-0.012	4.584
240	342.068	0	1.805	13:25:24	5.332	0.01	4.57
241	339.152	0	1.794	13:25:25	5.274	0.002	4.555
242	338.584	0	1.786	13:25:26	5.263	0.004	4.544
243	340.15	0	1.769	13:25:27	5.294	0.004	4.519
244	341.46	0	1.762	13:25:28	5.32	0.001	4.509
245	343.775	0	1.755	13:25:29	5.365	-0.021	4.498
246	341.392	0	1.746	13:25:30	5.318	0.003	4.486
247	339.493	0	1.737	13:25:31	5.281	0.003	4.474
248	338.402	0	1.726	13:25:32	5.26	0.012	4.458
249	337.992	0	1.716	13:25:33	5.252	0.002	4.443
250	338.789	0	1.707	13:25:34	5.267	-0.024	4.43
251	341.866	0	1.696	13:25:35	5.328	0.001	4.414
252	340.647	0	1.68	13:25:36	5.304	-0.047	4.392
253	341.347	0	1.677	13:25:37	5.317	0.007	4.388
254	340.489	0	1.666	13:25:38	5.301	0.002	4.371
255	339.629	0	1.65	13:25:39	5.284	0.001	4.348
256	336.554	0	1.646	13:25:40	5.224	0.004	4.343
257	336.257	0	1.635	13:25:41	5.218	0.001	4.328
258	340.24	0	1.626	13:25:42	5.296	-0.001	4.315
259	341.099	0	1.617	13:25:43	5.312	-0.003	4.302
260	339.991	0	1.605	13:25:44	5.291	0	4.284

261	337.148	0	1.598	13:25:45	5.235	0.003	4.275
262	335.638	0	1.587	13:25:46	5.206	0.005	4.259
263	341.28	0	1.575	13:25:47	5.316	0.001	4.242
264	341.573	0	1.57	13:25:48	5.322	-0.001	4.234
265	339.606	0	1.558	13:25:49	5.283	0.024	4.218
266	336.691	0	1.547	13:25:50	5.226	0.001	4.201
267	337.582	0	1.526	13:25:51	5.244	0.001	4.172
268	339.288	0	1.527	13:25:52	5.277	-0.001	4.173
269	339.334	0	1.517	13:25:53	5.278	0.002	4.159
270	338.22	0	1.507	13:25:54	5.256	0.003	4.144
271	336.829	0	1.498	13:25:55	5.229	0	4.132
272	338.152	0	1.487	13:25:56	5.255	0.005	4.116
273	339.878	0	1.478	13:25:57	5.289	0.004	4.102
274	338.652	0	1.469	13:25:58	5.265	0.002	4.09
275	337.856	0	1.458	13:25:59	5.249	0.002	4.074
276	339.674	0	1.449	13:26:00	5.285	-0.001	4.061
277	342.833	0	1.437	13:26:01	5.347	0.04	4.045
278	343.685	0	1.429	13:26:02	5.364	-0.003	4.033
279	344.021	0	1.417	13:26:03	5.37	-0.004	4.015
280	343.573	0	1.409	13:26:04	5.361	0.002	4.005
281	344.178	0	1.397	13:26:05	5.373	-0.077	3.987
282	342.293	0	1.388	13:26:06	5.336	0	3.974
283	343.125	0	1.377	13:26:07	5.352	0.002	3.959
284	341.73	0	1.368	13:26:08	5.325	0.001	3.945
285	343.192	0	1.364	13:26:09	5.354	-0.002	3.939
286	342.496	0	1.348	13:26:10	5.34	0	3.917
287	342.338	0	1.339	13:26:11	5.337	-0.007	3.904
288	340.331	0	1.326	13:26:12	5.297	-0.001	3.886
289	341.122	0	1.32	13:26:13	5.313	-0.002	3.877
290	342.518	0	1.307	13:26:14	5.34	0	3.859
291	342.226	0	1.299	13:26:15	5.335	0.004	3.847
292	343.08	0	1.287	13:26:16	5.352	0.004	3.83
293	342.383	0	1.278	13:26:17	5.338	-0.002	3.817
294	340.67	0	1.267	13:26:18	5.304	0	3.801
295	338.88	0	1.259	13:26:19	5.269	0.005	3.789
296	341.28	0	1.249	13:26:20	5.316	0.005	3.776
297	341.302	0	1.238	13:26:21	5.316	-0.002	3.759
298	340.285	0	1.23	13:26:22	5.297	0.001	3.748
299	342.158	0	1.218	13:26:23	5.333	0.002	3.731
300	341.843	0	1.209	13:26:24	5.327	0.003	3.718
301	341.55	0	1.198	13:26:25	5.321	0.001	3.703
302	342.765	0	1.19	13:26:26	5.345	0.001	3.691
303	341.843	0	1.178	13:26:27	5.327	0.008	3.674
304	339.719	0	1.169	13:26:28	5.285	-0.003	3.661
305	339.968	0	1.16	13:26:29	5.29	0.011	3.647
306	340.263	0	1.149	13:26:30	5.296	0.002	3.632
307	340.036	0	1.14	13:26:31	5.292	0	3.619
308	341.302	0	1.128	13:26:32	5.316	0.046	3.602
309	342.923	0	1.12	13:26:33	5.348	-0.003	3.59
310	338.766	0	1.107	13:26:34	5.267	0	3.572
311	338.47	0	1.1	13:26:35	5.261	-0.001	3.562
312	339.765	0	1.089	13:26:36	5.286	0.002	3.546
313	341.663	0	1.081	13:26:37	5.324	0.003	3.535

314	342.248	0	1.069	13:26:38	5.335	0	3.518
315	341.573	0	1.059	13:26:39	5.322	0.041	3.504
316	340.263	0	1.051	13:26:40	5.296	0.008	3.492
317	342.181	0	1.039	13:26:41	5.334	0.003	3.474
318	343.909	0	1.031	13:26:42	5.368	0.001	3.463
319	342.518	0	1.019	13:26:43	5.34	0.004	3.446
320	341.708	0	1.01	13:26:44	5.324	-0.002	3.434
321	343.192	0	1	13:26:45	5.354	0.001	3.419
322	342.473	0	0.989	13:26:46	5.34	0.003	3.404
323	339.946	0	0.98	13:26:47	5.29	0.001	3.39
324	338.402	0	0.971	13:26:48	5.26	-0.002	3.378
325	338.675	0	0.961	13:26:49	5.265	0.002	3.363
326	337.536	0	0.949	13:26:50	5.243	0.002	3.346
327	339.742	0	0.942	13:26:51	5.286	0.005	3.335
328	340.918	0	0.929	13:26:52	5.309	0	3.318
329	341.325	0	0.921	13:26:53	5.317	0.001	3.306
330	340.828	0	0.912	13:26:54	5.307	-0.009	3.293
331	340.285	0	0.899	13:26:55	5.297	0.007	3.274
332	340.625	0	0.893	13:26:56	5.303	0.002	3.266
333	340.218	0	0.88	13:26:57	5.295	0	3.248
334	342.203	0	0.871	13:26:58	5.334	0.004	3.234
335	341.392	0	0.86	13:26:59	5.318	0.001	3.219
336	339.515	0	0.85	13:27:00	5.281	-0.009	3.204
337	337.924	0	0.843	13:27:01	5.25	0.003	3.194
338	338.47	0	0.83	13:27:02	5.261	0.005	3.176
339	338.834	0	0.822	13:27:03	5.268	0.003	3.164
340	337.673	0	0.81	13:27:04	5.245	-0.002	3.148
341	337.97	0	0.803	13:27:05	5.251	0.003	3.137
342	337.833	0	0.794	13:27:06	5.249	0.001	3.124
343	341.234	0	0.781	13:27:07	5.315	0.004	3.105
344	340.67	0	0.771	13:27:08	5.304	0	3.091
345	339.697	0	0.759	13:27:09	5.285	0.028	3.074
346	343.752	0	0.753	13:27:10	5.365	0.001	3.065
347	342.136	0	0.74	13:27:11	5.333	0.018	3.047
348	341.099	0	0.731	13:27:12	5.312	-0.01	3.034
349	342.158	0	0.722	13:27:13	5.333	0	3.022
350	341.956	0	0.709	13:27:14	5.329	-0.004	3.003
351	343.819	0	0.702	13:27:15	5.366	0.005	2.992
352	343.931	0	0.69	13:27:16	5.368	0	2.976
353	343.125	0	0.681	13:27:17	5.352	0	2.963
354	342.945	0	0.672	13:27:18	5.349	0.002	2.95
355	343.394	0	0.66	13:27:19	5.358	0.003	2.932
356	343.573	0	0.651	13:27:20	5.361	0.012	2.919
357	341.392	0	0.64	13:27:21	5.318	-0.001	2.904
358	339.923	0	0.632	13:27:22	5.289	-0.003	2.893
359	340.873	0	0.623	13:27:23	5.308	0.005	2.879
360	342.855	0	0.61	13:27:24	5.347	0.003	2.861
361	343.528	0	0.603	13:27:25	5.36	0.002	2.851
362	342.698	0	0.577	13:27:26	5.344	-0.008	2.814
363	341.978	0	0.581	13:27:27	5.33	0.001	2.82
364	343.618	0	0.573	13:27:28	5.362	0.002	2.808
365	343.528	0	0.561	13:27:29	5.36	0	2.791
366	342.81	0	0.552	13:27:30	5.346	0	2.779

367	344.043	0	0.541	13:27:31	5.371	-0.008	2.762
368	343.954	0	0.533	13:27:32	5.369	0.004	2.751
369	342.113	0	0.523	13:27:33	5.332	-0.001	2.737
370	341.234	0	0.511	13:27:34	5.315	0.002	2.719
371	343.819	0	0.504	13:27:35	5.366	0.003	2.71
372	344.96	0	0.491	13:27:36	5.389	0.005	2.69
373	343.73	0	0.48	13:27:37	5.364	0.015	2.676
374	343.394	0	0.471	13:27:38	5.358	0.001	2.662
375	344.893	0	0.46	13:27:39	5.388	0.004	2.646
376	344.714	0	0.452	13:27:40	5.384	-0.071	2.634
377	344.87	0	0.443	13:27:41	5.387	0.001	2.622
378	342.316	0	0.43	13:27:42	5.336	0.003	2.604
379	341.415	0	0.422	13:27:43	5.319	-0.045	2.593
380	342.361	0	0.41	13:27:44	5.337	0.003	2.575
381	343.08	0	0.402	13:27:45	5.352	0.001	2.563
382	344.289	0	0.39	13:27:46	5.376	0	2.546
383	345.227	0	0.381	13:27:47	5.394	0.001	2.533
384	343.842	0	0.372	13:27:48	5.367	0.004	2.52
385	343.909	0	0.362	13:27:49	5.368	0.002	2.507
386	343.797	0	0.351	13:27:50	5.366	0.002	2.49
387	341.663	0	0.341	13:27:51	5.324	0.004	2.476
388	341.595	0	0.332	13:27:52	5.322	0.006	2.464
389	343.439	0	0.32	13:27:53	5.359	0	2.447
390	342.361	0	0.313	13:27:54	5.337	0.002	2.436
391	343.887	0	0.302	13:27:55	5.368	-0.028	2.42
392	342.473	0	0.291	13:27:56	5.34	-0.013	2.405
393	341.392	0	0.283	13:27:57	5.318	-0.006	2.393
394	340.466	0	0.271	13:27:58	5.3	0.002	2.376
395	342.496	0	0.262	13:27:59	5.34	0	2.363
396	343.237	0	0.253	13:28:00	5.355	-0.003	2.351
397	343.304	0	0.241	13:28:01	5.356	0.052	2.333
398	344.356	0	0.232	13:28:02	5.377	-0.012	2.32
399	343.931	0	0.221	13:28:03	5.368	-0.002	2.305
400	340.692	0	0.213	13:28:04	5.305	-0.002	2.294
401	341.144	0	0.203	13:28:05	5.313	-0.003	2.278
402	341.302	0	0.192	13:28:06	5.316	0	2.263
403	339.266	0	0.18	13:28:07	5.277	0.004	2.247
404	339.47	0	0.174	13:28:08	5.281	-0.033	2.237
405	339.742	0	0.162	13:28:09	5.286	0.044	2.219
406	340.918	0	0.152	13:28:10	5.309	-0.018	2.205
407	340.399	0	0.143	13:28:11	5.299	0.009	2.193
408	340.014	0	0.131	13:28:12	5.291	0.006	2.176
COARSE -	-	-					
409	342.361	0	0.121	13:28:13	5.337	-0.001	2.161
410	343.08	0	0.112	13:28:14	5.352	-0.003	2.149
411	340.918	0	0.103	13:28:15	5.309	0.004	2.136
412	341.28	0	0.092	13:28:16	5.316	0.006	2.12
413	341.933	0	0.08	13:28:17	5.329	0.003	2.103
414	341.595	0	0.076	13:28:18	5.322	-0.002	2.098
415	337.217	0	0.068	13:28:19	5.237	0.005	2.086
416	292.148	0	0.063	13:28:20	4.419	0.004	2.078
417	218.86	0	0.056	13:28:21	3.339	-0.011	2.069
418	143.839	0	0.049	13:28:22	2.555	-0.002	2.059

Highlighted Area is Onset of Air Entrainment Based on Review of test Video

Data point above where it is marked "Coarse" is the onset of Air based on Visual Observations During Testing

419	76.953	0	0.05	13:28:23	2.129	0.002	2.06