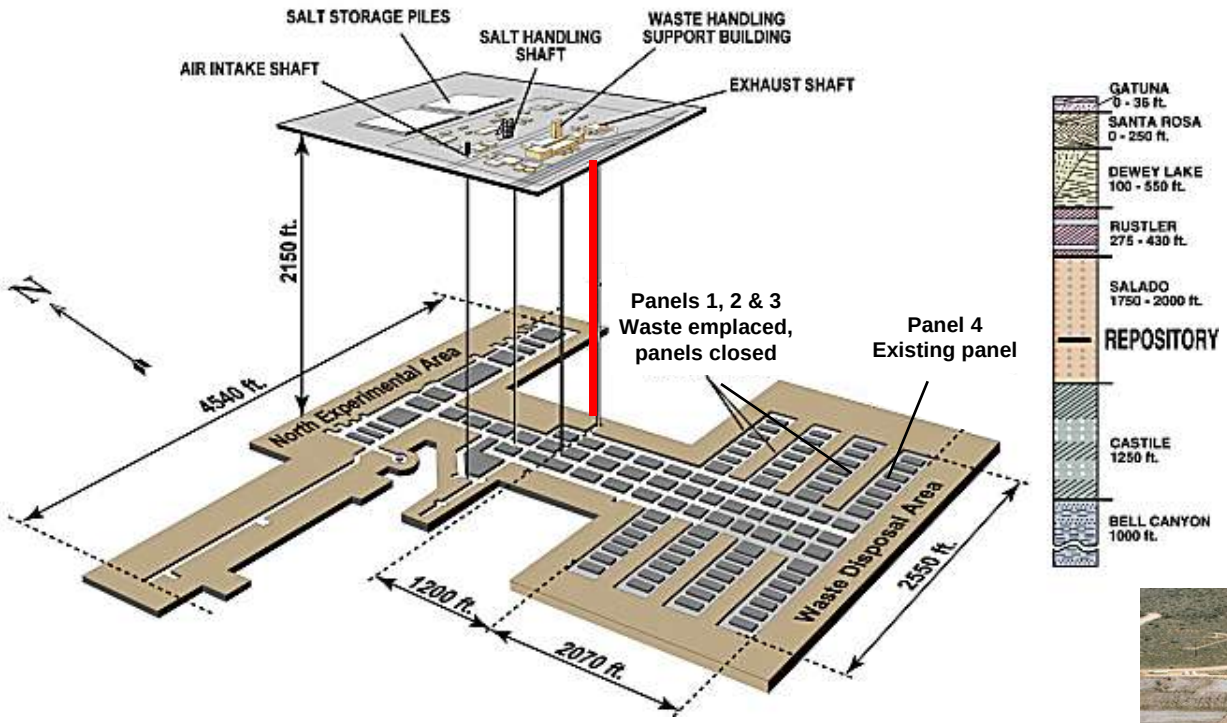
Methods for Calculating the Opening of the "As-Found" Inlet Probe

Hung-Cheng Chiou, Ph.D. and Larry Landrum

Waste Isolation Pilot Plant

WIPP Facility and Stratigraphic Sequence

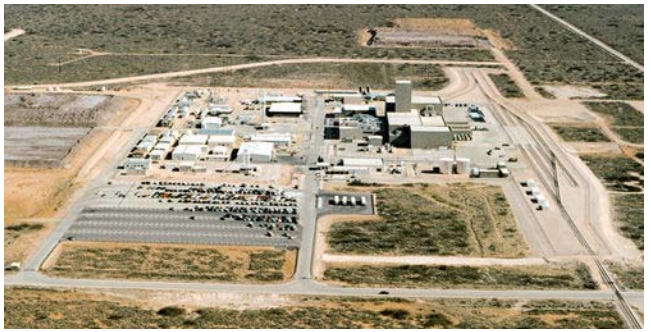


Waste

Isolation

Pilot

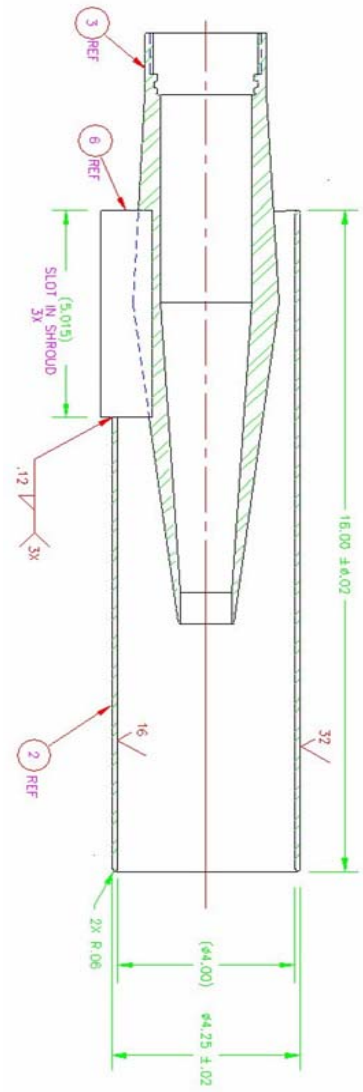
Plant

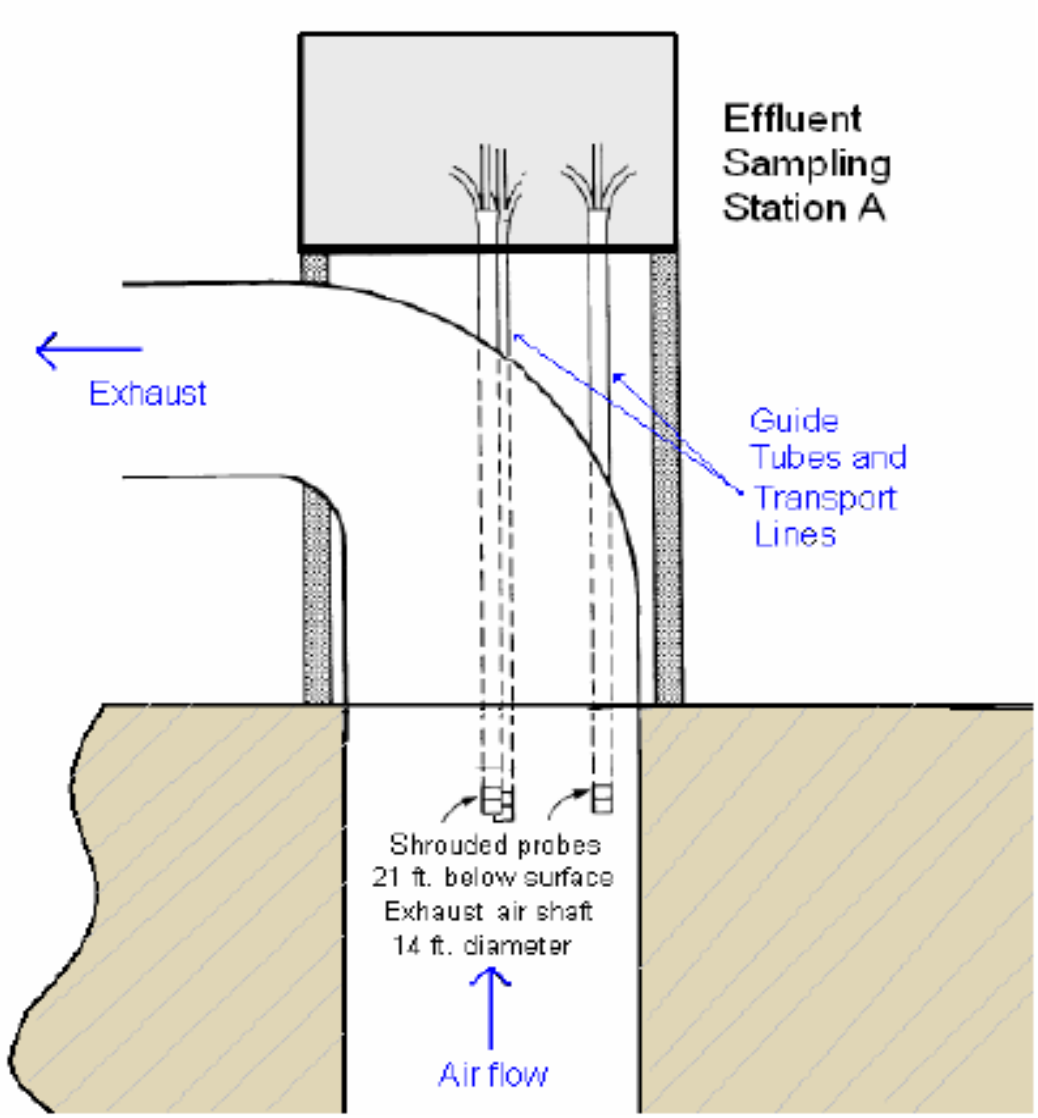


- **Underground repository for transuranic waste**
- **Located in Chihuahuan Desert near Carlsbad, NM**
- **Disposal rooms 2150 feet underground in ancient salt formation**

Effluent Monitoring at Station A for:

40 CFR 191 Subpart A and 40 CFR 61 Subpart H

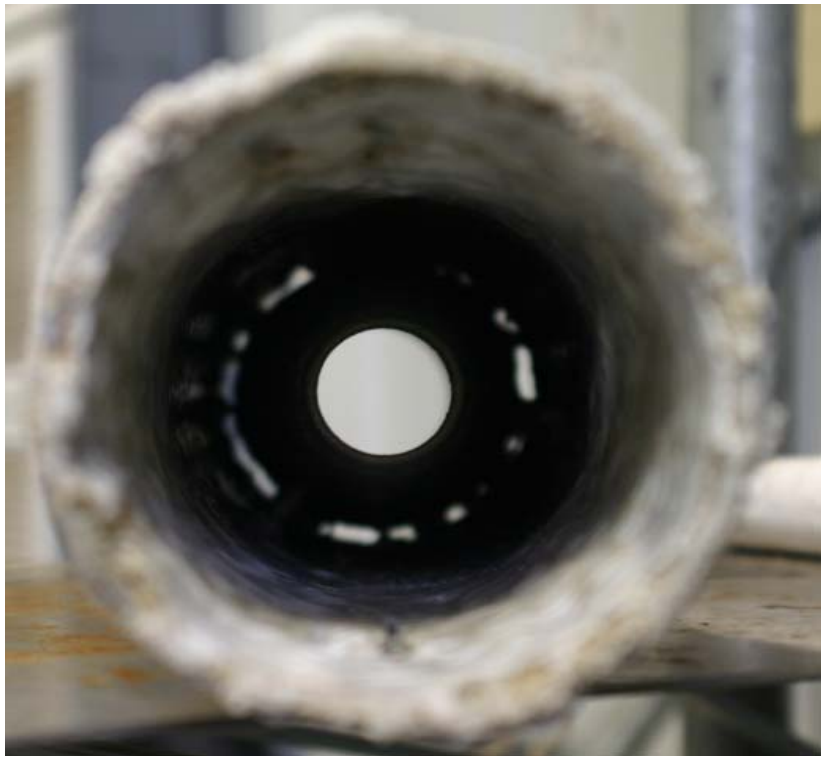




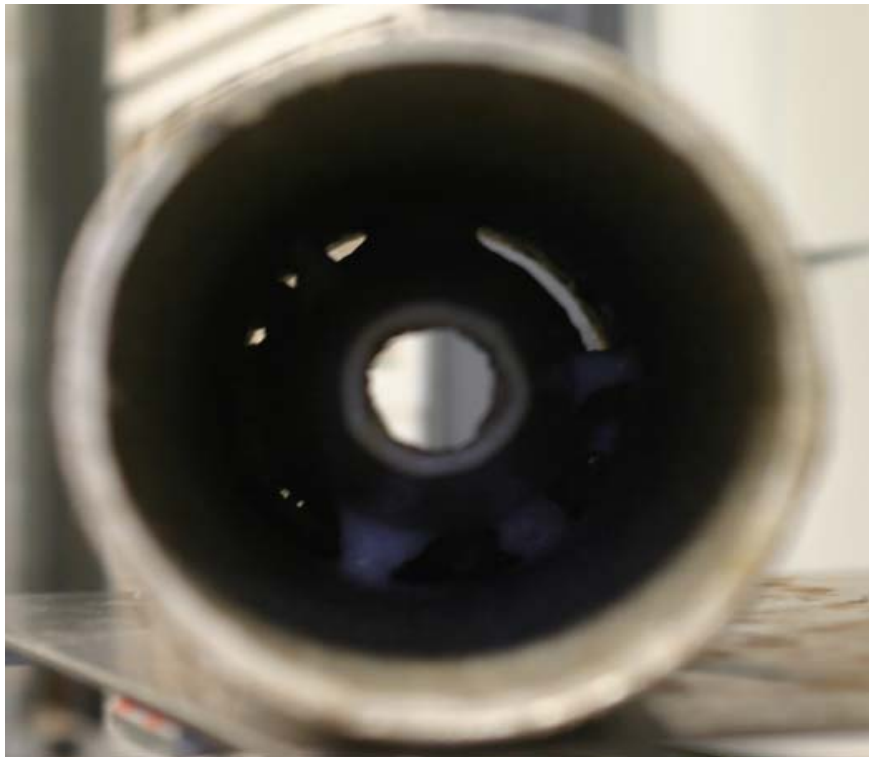
Methods for Calculating the Opening of the "As-Found" Inlet Probe

Photos taken on 6/13/06 before the EPA Annual Inspection :

A-1 Probe



A-3 Probe



Problem Statement:

- No measurements of the “As-Found” inlet probe cross-sectional area opening to assess the pass/fail criteria per PM364005 and WP 12-RE3004.

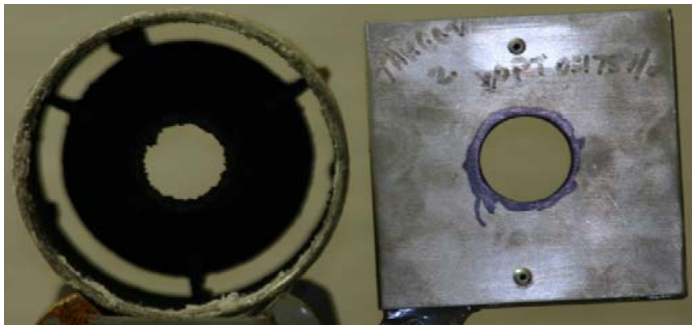
Pass criteria per above procedures:
- Shroud blocked less than 1/3.
- Inlet probe blocked less than 2/3

Test Plan was developed and approved: 8/1/06

Set the “As-Found” shrouded probe on a standard setup such that the plane of the opening (the depth) in the Control is properly aligned with the “As-Found” inlet probe opening. Take photos and compare the “As-Found” inlet probe opening against the Control using 3 different methods.

- Method 1: using Scion Image processing software to compare the pixels in the as-found probe and control.
- Method 2: counting the grids manually.
- Method 3: calculating the average diameter of the probe opening (up to 4 diameter measurements).

How does Scion Image Calculate the Opening Areas?



Original Photo: JPG, BMP,TIFF

Opening 1 Opening 2

Resize photo and save in BMP or TIFF formats

Procedure:

- Open the BMP or TIFF file using Scion Image.
- Options → Threshold
- Analyze → Options → Select “Include Interior Holes”
- Use “Magic Wand” in the Tool Bar to pick the interior hole of Opening 1, then go to “Analyze → Measure”. It gives **19819** pixels.
- Repeat above step and pick the interior hole of Opening 2, It gives **25995** pixels.
- **By comparing Openings 1 to 2, an opening of 76.2 % can be determined.**

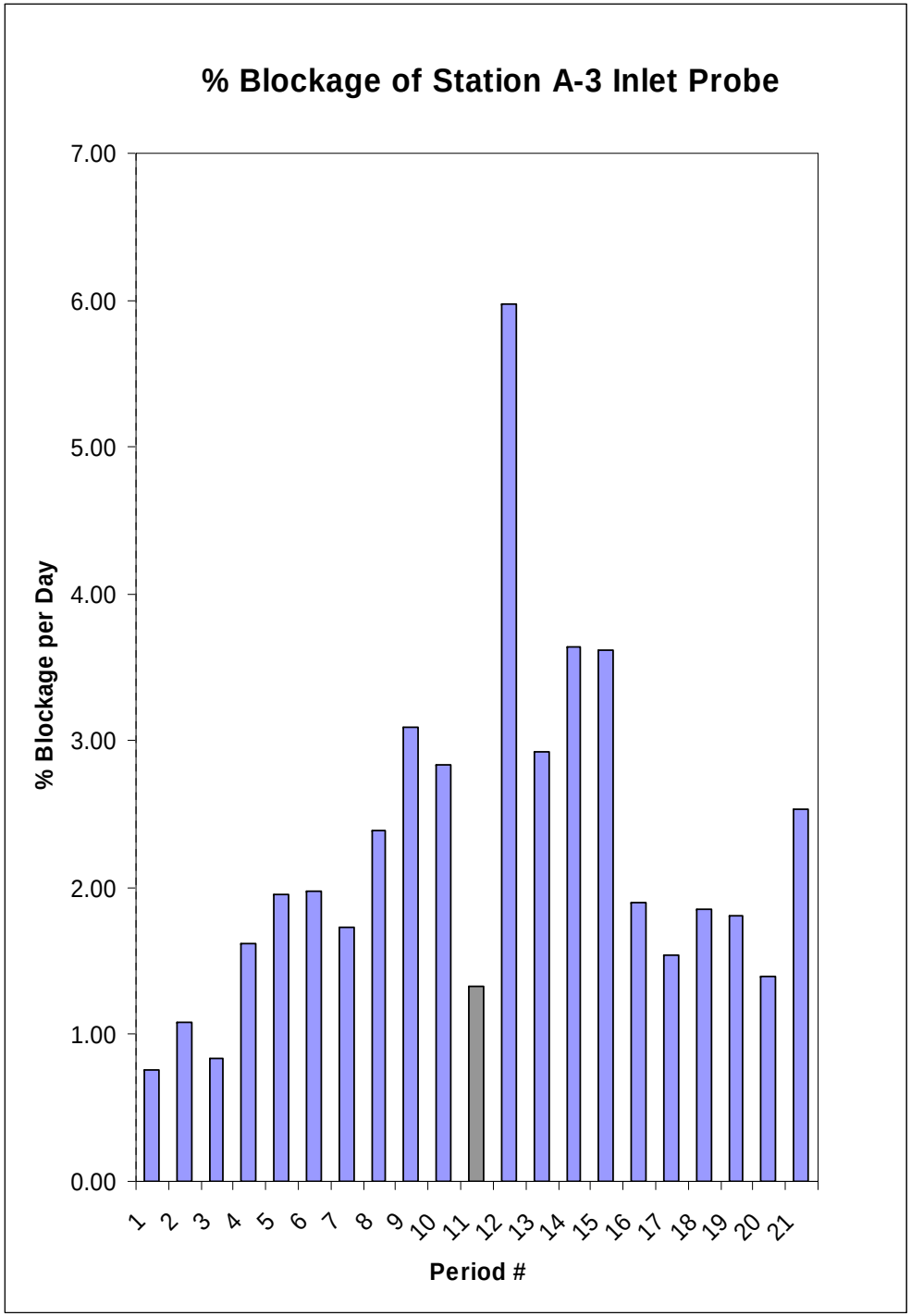
Result Summary for Sample-of-Record (A-3):

Date Probe Pulled	Probe Name	% Opening from Method 1 (IWHE)	% Opening from Method 2	% Opening from Method 3	Time Interval from Previous Probe Pulled (Days)
7/10/2006	A-3	80.3	81.7	76.3	27
8/1/2006	A-3	75.7	78.6	74.4	22
8/14/2006	A-3	Probe was cleaned before photos were taken			13
9/11/2006	A-3	77.1	76.8	75.4	28
10/9/2006	A-3	55.9	55.6	52.2	28
10/24/2006	A-3	70.8	71.6	69.5	15
11/15/2006	A-3	58.0	57.8	54.1	22
11/22/2006	A-3	89.0	86.8	87.9	7
11/27/2006	A-3	89.9	87.1	87.2	5
12/4/2006	A-3	80.2	77.7	77.2	7
12/12/2006	A-3	77.3	78.4	76.3	8
12/18/2006	A-3	90.4	92.9	92.7	6
12/27/2006	A-3	47.4	47.0	44.2	9
1/2/2007	A-3	84.0	83.4	80.0	6
1/8/2007	A-3	78.6	78.9	77.0	6
1/15/2007	A-3	72.6	76.4	74.9	7
1/22/2007	A-3	87.0	86.1	87.2	7
1/30/2007	A-3	87.2	88.0	87.8	8
2/6/2007	A-3	87.5	87.7	86.0	7
2/13/2007	A-3	88.1	87.5	86.5	7
2/21/2007	A-3	88.4	89.0	89.1	8
2/27/2007	A-3	84.4	85.1	84.9	6

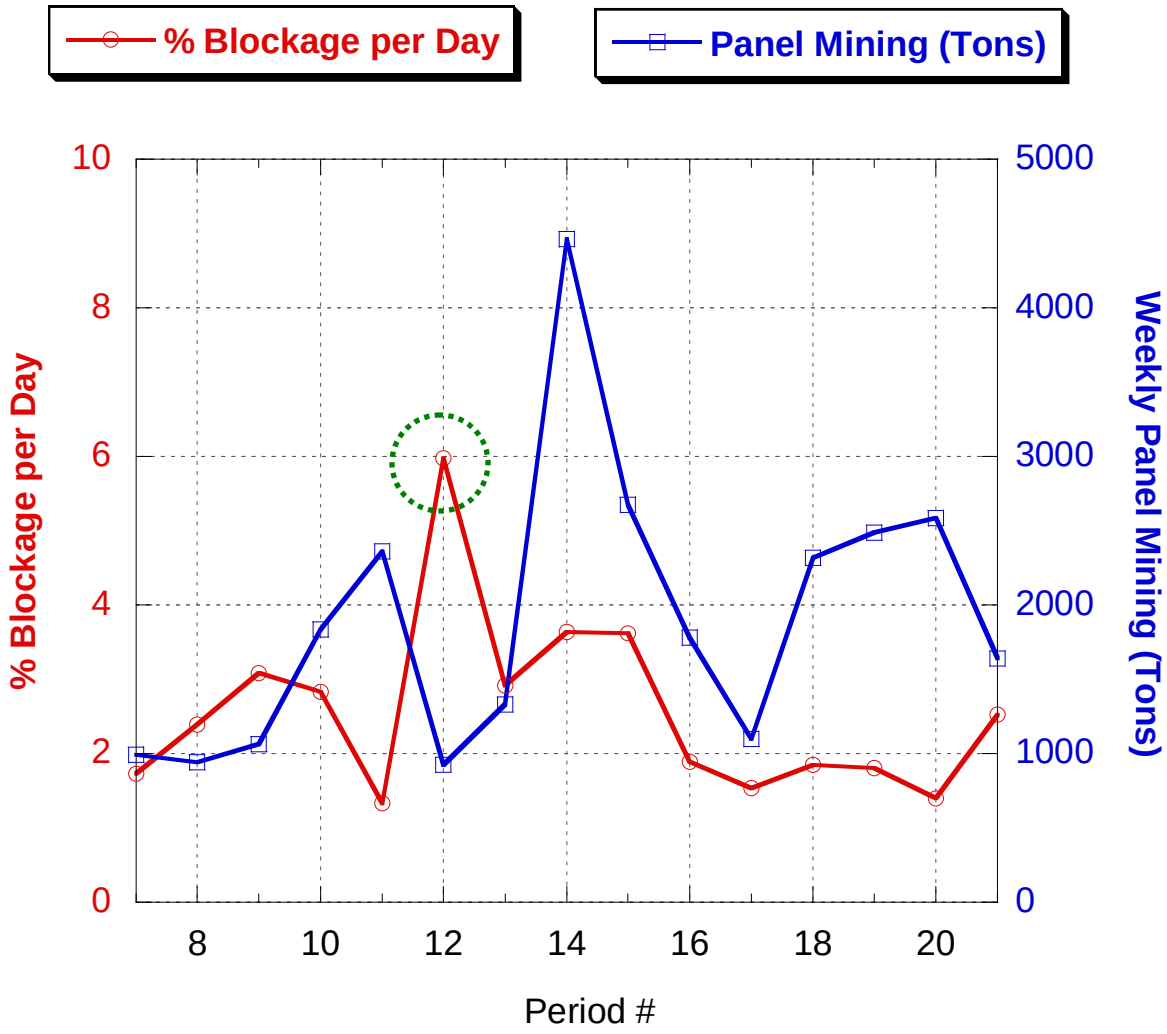
- **All Sample-of-Record inlet probes (A-3) passed the performance criteria.**
- **However, this test plan only addresses the probe inlet and does not apply to the shroud.**
- **The shroud pass/fail determination would be performed by WIPP Effluent Monitoring Improvement Team separately.**

Summary of Three Test Methods

Period #	Date Probe Pulled	Average % Opening from 3 Methods	Standard Deviation (%)	Time Interval from Previous Probe Pulled (Days)	% Blockage per Day
1	7/10/2006	79.5	2.8	27	0.76
2	8/1/2006	76.2	2.1	22	1.08
3	9/11/2006	76.4	0.9	28	0.84
4	10/9/2006	54.6	2.1	28	1.62
5	10/24/2006	70.6	1.0	15	1.96
6	11/15/2006	56.6	2.2	22	1.97
7	11/22/2006	87.9	1.1	7	1.73
8	11/27/2006	88.0	1.6	5	2.39
9	12/4/2006	78.3	1.6	7	3.09
10	12/12/2006	77.3	1.0	8	2.83
11	12/18/2006	92.0	1.4	6	1.33
12	12/27/2006	46.2	1.8	9	5.98
13	1/2/2007	82.5	2.2	6	2.92
14	1/8/2007	78.2	1.0	6	3.64
15	1/15/2007	74.7	1.9	7	3.62
16	1/22/2007	86.8	0.6	7	1.89
17	1/30/2007	87.6	0.4	8	1.54
18	2/6/2007	87.1	0.9	7	1.85
19	2/13/2007	87.4	0.8	7	1.81
20	2/21/2007	88.8	0.4	8	1.40
21	2/27/2007	84.8	0.3	6	2.53
	Total Average	78.2	1.3	11.7	2.23



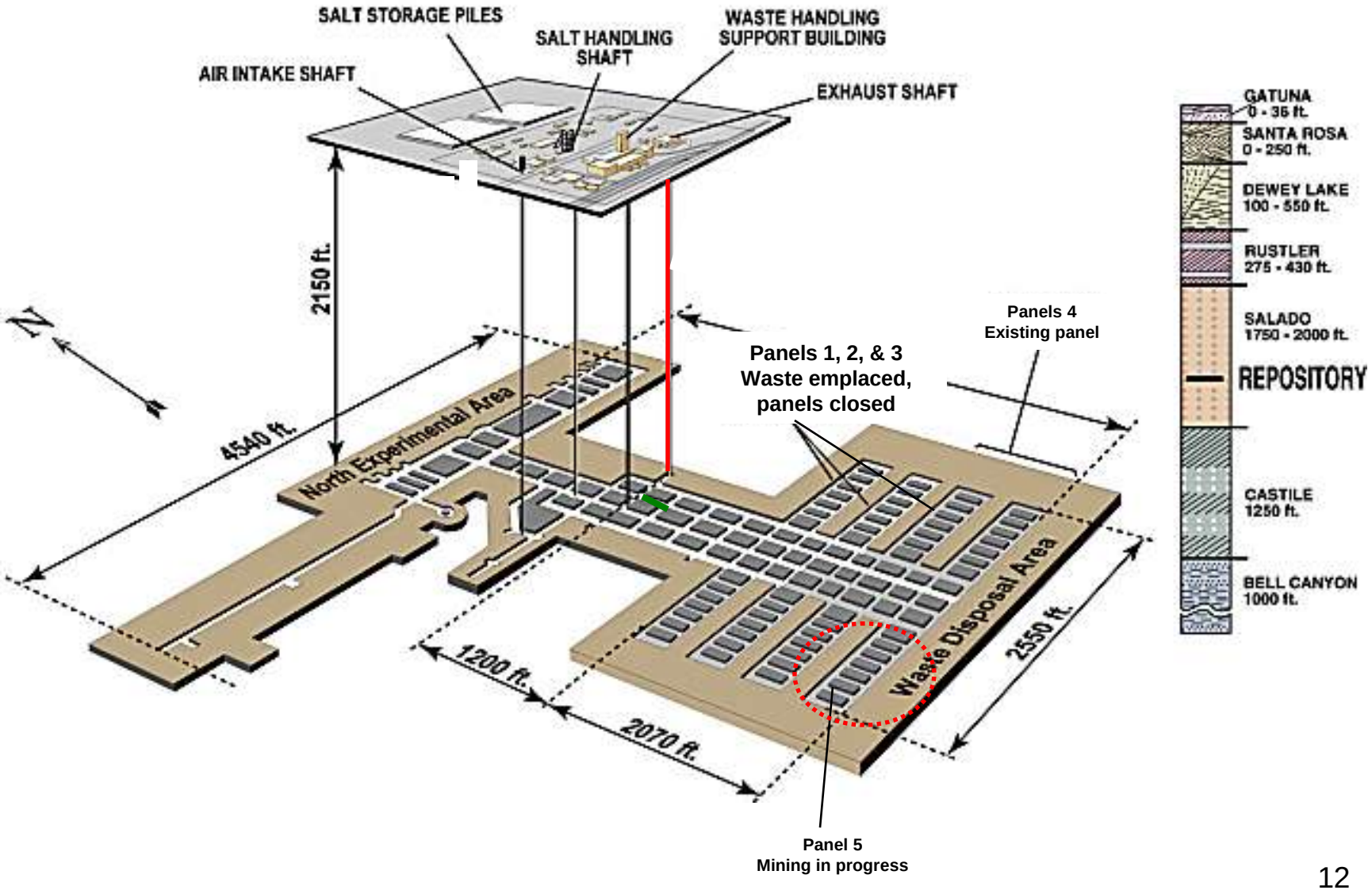
Percent Blockage of Station A Inlet Probe per Operational Day for Each Preventative Maintenance Period



No correlation between the amount of salt being mined at the Panel and the probe blockage rate.

The high blockage rate from period #12 was due to the special maintenance mining activity on E-140 (b/w S-400 and S-700) during the Holiday that was in much closer proximity to the Exhaust Shaft.

WIPP Facility and Stratigraphic Sequence



Discussion:

- The three test methods were very comparable with mean standard deviation of 1.3% among the three methods based on outcomes of 21 cleaning periods.

- Methods 1 (image processing software) is easiest to implement. However, a caution should be taken to ensure that the background light intensity is relatively the same for the opening of “as-found probe” and “the control”.

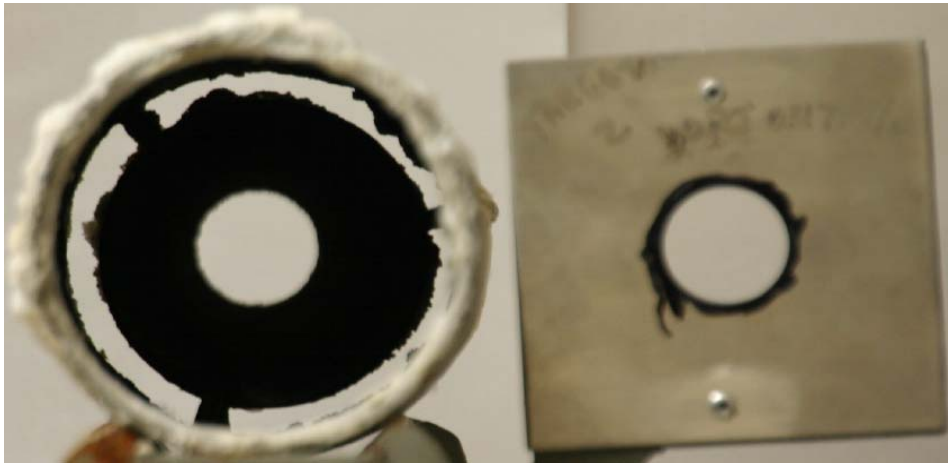
- Higher probe blockage tends to occur in December and January so more frequent probe cleanings are required.

- The results of Methods 2 and 3 served as verification and validation of Method 1 so that using Method 1 as the method-of-choice is defendable.

Caution for Method 1

12/18/06, 6 days interval

A-1 Probe



Method 1: 82.7%

Method 2: 94.4%

Method 3: 90.1%

The background light intensity for the “as-found and control opening” should be similar to avoid an erroneous result.

Methods for Calculating the Opening of the "As-Found" Inlet Probe

Conclusion:

- The three test methods used in calculating inlet probe opening work relatively well and their results are comparable.

- Method 1 (Scion Image software) should be selected as the method-of-choice and Method 3 (average diameter) can serve as an alternative method due to their easy implementation and accuracy.

- Method 2 is not recommended since it is more time consuming and subject to counting errors.

Methods for Calculating the Opening of the "As-Found" Inlet Probe

Recommendation:

- Incorporation of Method 1 (image processing software) as the primary method and Method 3 (average diameter) as the back-up method into PM364005 and WP 12-RE3004 for inlet probe opening calculations.

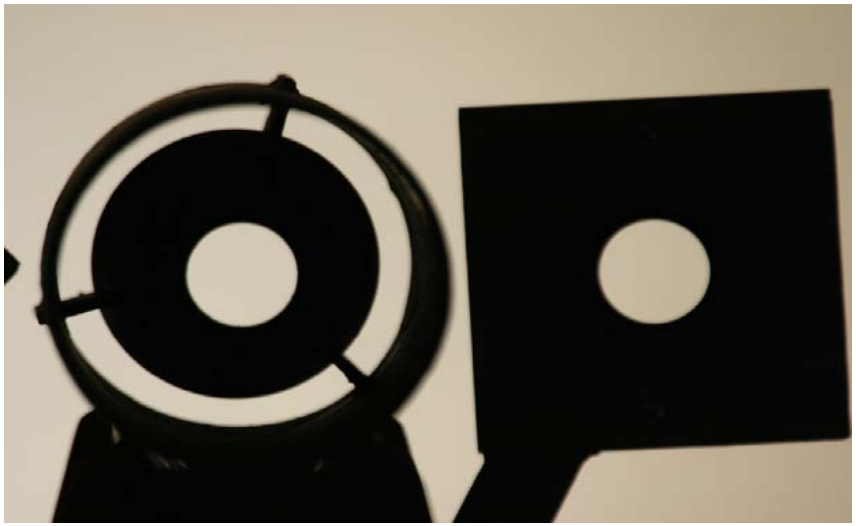
Concurrence by: Manager A _____ _____
Name Signature Date

Concurrence by: Manager B _____ _____
Name Signature Date

Example of As-Found Inlet Probe

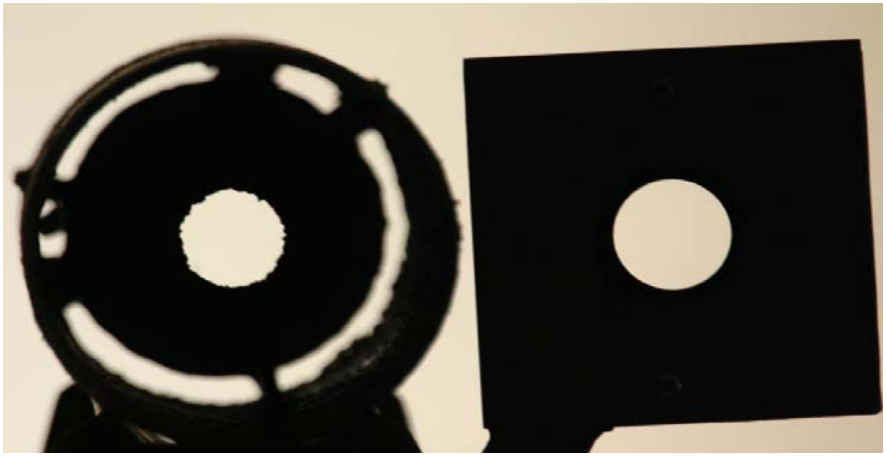
9/11/06, 28 days interval

A-1 Probe



98.0 to 99.3%

A-3 Probe



75.4 to 77.1%

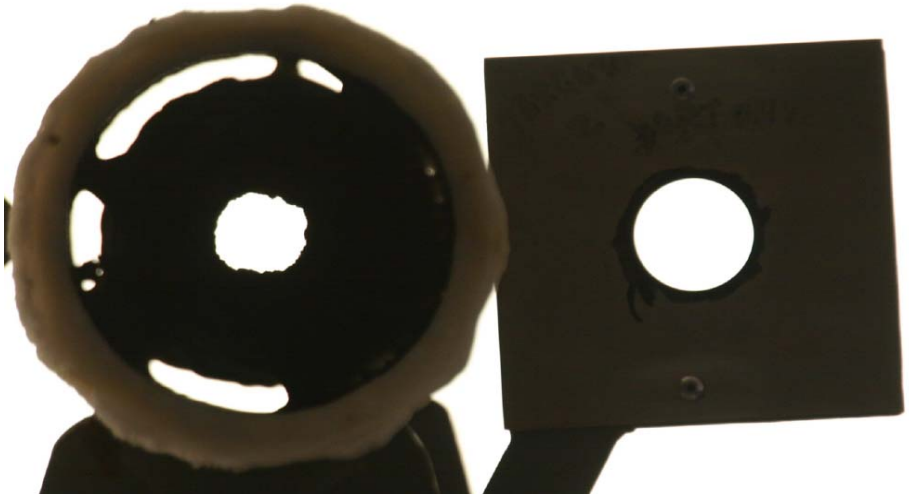
Example of As-Found Inlet Probe

10/09/06, 28 days interval

A-1 Probe

99.2 to 99.7%

A-3 Probe



52.2 to 55.9%

Example of As-Found Inlet Probe

10/24/06,15 days interval

A-1 Probe

96.9 to 98.6%

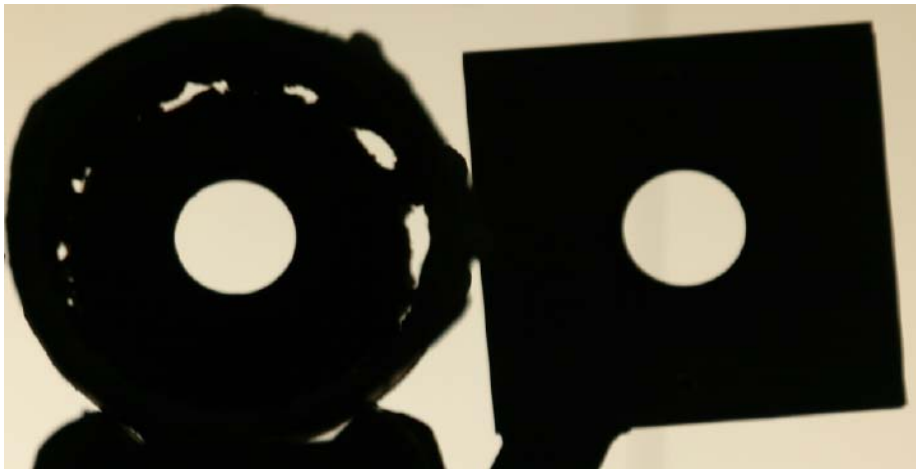
A-3 Probe

69.5 to 71.6%

Example of As-Found Inlet Probe

11/15/06, 22 days interval

A-1 Probe



96.2 to 97.3%

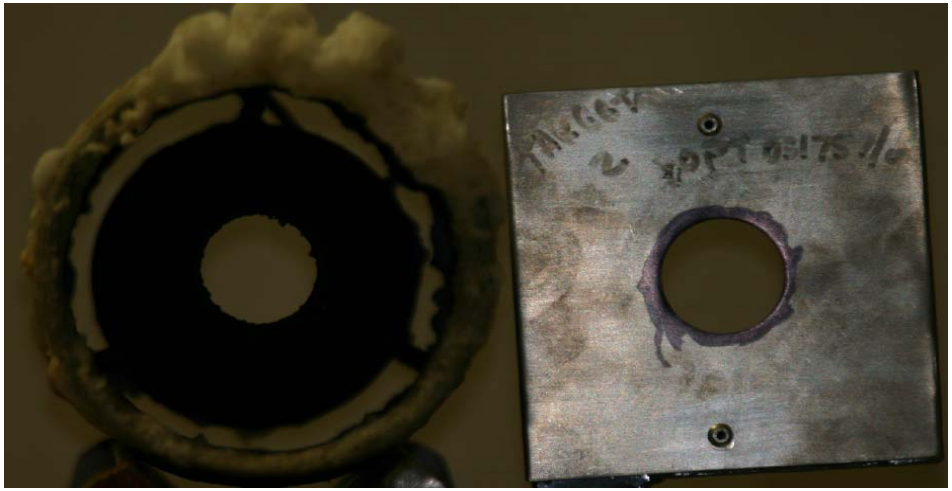
A-3 Probe

54.1 to 58.0%

Example of As-Found Inlet Probe

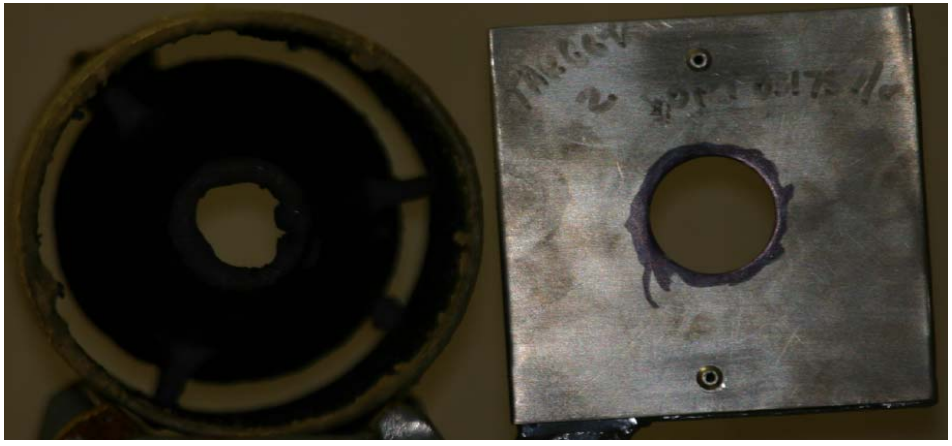
12/27/06, 9 days interval

A-1 Probe



83.1 to 87.0%

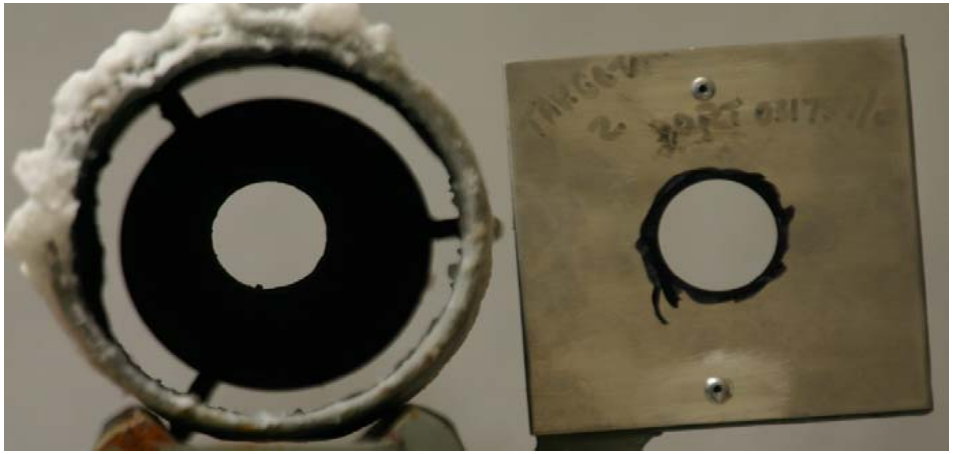
A-3 Probe



44.2 to 47.4%

Example of As-Found Inlet Probe
1/2/07, 6 days interval

A-1 Probe



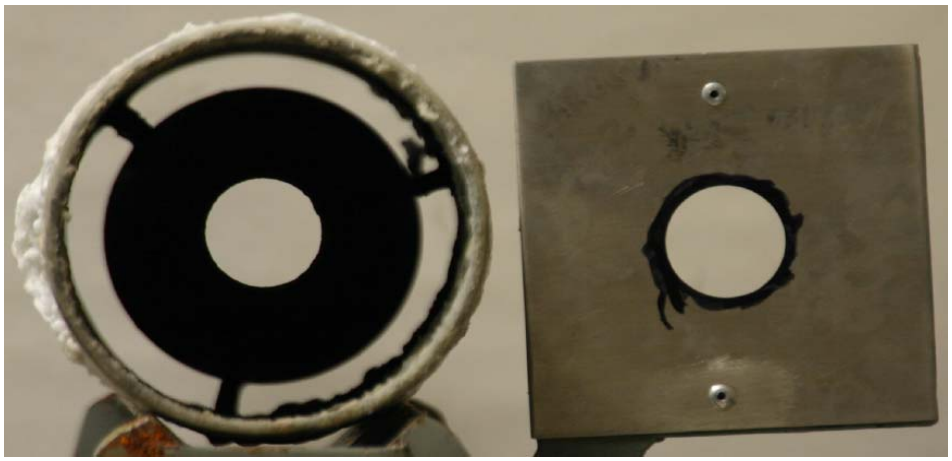
91.7 to 92.1%

A-3 Probe

80.0 to 84.0%

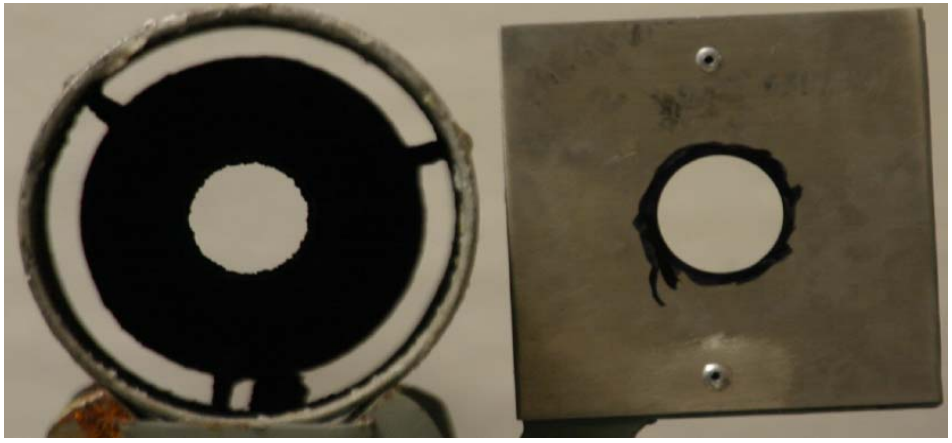
Example of As-Found Inlet Probe
1/30/07, 8 days interval

A-1 Probe



93.7 to 94.0%

A-3 Probe



87.2 to 88.0%