UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

08/22/2023

Dear Mr. Keilholz:

I am writing in response to your submittal dated July 18, 2022, and the additional submittals of September 30, 2021, August 22, 2022, and August 30, 2022, in which you seek the broad approval of an alternative to the certification procedures required for opacity observers under Section 3.2 of Method 9 – Visual Determination of the Opacity of Emissions from Stationary Sources (40 CFR part 60, Appendix A). The U.S. Environmental Protection Agency's (EPA) Office of Air Quality Planning and Standards is the delegated authority for approval/disapproval determinations on any major alternatives to test methods and other compliance determination procedures required under 40 CFR parts 59, 60, 61, 63, and 65.

Background

Method 9 is a measurement technique required by Federal and other environmental rules and regulations to measure the opacity of visible emissions discharged into the atmosphere from stationary sources. It relies on the determination of the plume opacity, in the field, by qualified observers and includes procedures for the training and certification of these observers on the methodology used to conduct the opacity determinations.

Since Method 9 was first promulgated in 1971, observer certification has involved the use of smoke generators in the field to produce a series of white and black smoke plumes at precisely measured opacity levels for the observer certification testing. Observers typically attend classroom instruction beforehand to address the theory and standard practices for opacity determination. During the training, the smoke generator is first used to show the observers a series of white and black practice plumes of known opacities from 0 to 100 percent so they may to practice their skill in assigning opacity levels. Then, under Method 9, the certification testing involves use of the calibrated smoke generator to present the candidate observers a series of 25 unknown plumes each of black and white smoke at random opacities at 5 percent increments between 0 and 100 percent. The candidates must assign opacity readings to the 25 black and 25 white plumes with an error not to exceed 15 percent opacity on any single reading and an average error not to exceed 7.5 percent in either category.

Proposed Alternative Test Method

You are requesting approval, as an alternative test method, of a novel approach for certification of candidate Method 9 observers that relies on the use of a virtual reality (VR) headset. In your proposal this alternative method would replace the in-person "smoke school" as described in Section 3 of Method 9 with a virtual "smoke school". The candidate observer would wear a VR headset to view a demonstration of smoke plume values and then be tested using the same VR headset on their ability to assess the opacity of 25 black smoke plumes and 25 white smoke plumes. All the testing and certification criteria would remain the same as Section 3 in Method 9.

You further explain that the video recordings of the black and white plumes to be displayed on the VR headset during the certification process will be obtained from video recordings taken of a smoke generator that is designed, calibrated, and operated according to section 3.3 of Method 9. At the same time a video recording is made, the opacity data from the transmissometer on the smoke generator will be recorded to the nearest 0.1%. Additionally, the camera used to make the recordings will be positioned according to the Method 9 requirements for an observer. Also, in order to maintain the quality, you provided specifications for the equipment (VR headset, video camera, smoke generator), the procedures (video recording and data storage and retention), and the VR application to be used by this alternative procedure.

Justification

As justification for your proposed alternative method, you note the following potential benefits:

- Consistent and repeatable viewing conditions absent of wind shear, inclement weather, smoke generator malfunctions, operator errors and poor backgrounds.
- More consistent difficulty for candidate observers across test locations and dates.
- Candidate observers can be certified any time of the year, which removes the barrier of scheduling and seasonal smoke school options.
- Candidate observers can certify any time of the day, allowing more shift and rotational workers to be certified.
- More candidates can be certified due to decreased travel, expenses, and scheduling conflicts.
- Increased accessibility in currently underserved areas of the U.S., its territories and other countries that utilize Method 9 and that currently have limited or no Method 9 training options.
- Increased accessibility to community groups.
- Users could potentially view known opacities prior to conducting in-field observations as a refresher between certifications.
- Reduced environmental impact -- smoke is only produced once to create library of plumes and travel to semi-annual smoke schools is no longer necessary.

To support your alternative approach using a VR headset to provide Method 9 demonstration plumes and perform Method 9 observer certification, you submitted a report containing the results of a study that you conducted to evaluate the accuracy of opacity determinations made by observers certified using your proposed alternative method as compared to observers certified according to Method 9. The benchmark data to support the accuracy of Method 9 observers was

reported in January 1975 in the EPA report entitled "Evaluation and Collaborative Study of Method for Visual Determination of Opacity of Emissions from Stationary Sources," Report No EPA-650/4-75-009. In the 1975 study, nine observers were certified according to Method 9 by completing 20 runs (consisting of 25 plumes each) of white smoke and 16 runs (also 25 plumes each) of black smoke for a total of 900 plumes from a Method 9 compliant smoke generator. The observers assigned opacity values to each of the 900 unknown plumes. The range of opacity studied was from just above 0 percent to 40 percent. To determine what extent the observers were able to follow changes in the plume opacity, the generated opacity was subject to change during a run. During the runs, the opacity was either held constant, increased, or decreased according to a test plan. In addition, the number of times the plume opacity was changed, the point at which it was changed and the amount it changed all were varied from run to run so that the observers would not be able to anticipate these changes.

The observer's average opacity determinations for each run (black and white) were compared to the average opacity values for each run as determined by the calibrated in-stack transmissometer installed on the smoke generator. The study assessed the accuracy of Method 9 in terms of the deviation of the observers from the metered opacity. Per EPA-650/4-75-009, "accuracy is measured by the deviation of the observer's determination from the true opacity as measured by the in-stack transmissometer." The mean absolute deviation between the observers' determinations overall and the transmissometer metered data overall was 3.71 percent for the white smoke and 3.33 percent for the black smoke. The results of EPA's 1975 study are presented in Attachment B (Tables B-1 and B-2) for the white and black smoke, respectively.

You note that your study was based on the collaborative study conducted back in 1975 using a smoke generator meeting Method 9 requirements to challenge opacity observers' ability to assign opacity values to unknown plumes. Similar to the 1975 study, nine certified observers completed 20 runs of white smoke and 16 runs of black smoke, all runs consisting of 25 plumes and the observers' average opacity determinations for each run were compared to the average opacity value for each run as determined by the in-stack transmissometer on the smoke generator. The principal difference between the two studies was the nine observers in your study were certified using your proposed VR based alternative to the certification requirements in section 3.2 of Method 9 which are excerpted below:

> *3.2 Certification Procedure. The certification test consists of showing the candidate a complete run of 50 plumes—25 black plumes and 25 white plumes—generated by a smoke generator. Plumes within each set of 25 black and 25 white runs shall be presented in random order. The candidate assigns an opacity value to each plume and records his observation on a suitable form. At the completion of each run of 50 readings, the score of the candidate is determined. If a candidate fails to qualify, the complete run of 50 readings must be repeated in any retest. The smoke test may be administered as part of a smoke school or training program, and may be preceded by training or familiarization runs of the smoke generator during which candidates are shown black and white plumes of known opacity.*

The technical details regarding your proposed alternative method for certification which was used for these nine observers are presented in Attachment A.

You explain that the nine certified observers had no prior knowledge of opacity observation procedures or experience with environmental regulations. The nine observers were then provided an online lecture covering documentation, procedures, and observation techniques for EPA opacity methods and then certified using your proposed virtual smoke school application on a virtual reality (VR) headset.

The candidate observers were shown standard value plumes for white and black smoke via the VR headset and had the option to take practice tests before proceeding to the certification test. Upon successful completion of the VR certification test, a candidate was considered to be certified. You provided the individual observer certification data in Table 1.

Table 1. Observer Data from VR Headset-based Certification

Observer ID Number	Date of Certification	Average Deviation from True Opacity During Certification, %
1	6/2/2022	1.70
2	5/13/2022	3.10
3	4/28/2022	2.00
4	5/3/2022	2.30
5	5/13/2022	3.40
6	5/9/2022	3.80
7	6/13/2022	3.30
8	4/26/2022	1.00
9	5/18/2022	0.80

The nine observers certified on the VR headset then observed 20 runs of white smoke and 16 runs of black smoke (25 plumes per run of both black and white smoke) produced by a smoke generator at an in-person field test. Test conditions during the testing days are presented in Table 2.

Table 2. Weather and Observation Conditions During In-Person Field Test

	Test Dates	
	June 18, 2022	June 24, 2022
Time	9:12 – 11:52 am	9:06 – 11:21 am
Temperature	82 – 86 ºF	76 – 81 ºF
Wind	5 – 10 mph from E/NE	0 – 5 mph from S
Sky Conditions	Start: 10% cloud cover End: 25% cloud cover	Start: 50% cloud cover End: 75% cloud cover
Observer Positioning	Distance – 85 feet Direction – 275º Background – Deciduous tree	Distance – 75 feet Direction - 265º Background – Blue sky/white clouds

Observer determinations were compared to true opacity values as determined by an in-stack transmissometer which met the specifications of Method 9, section 3.3. You report that the mean absolute deviation between the observers' determinations and the transmissometer data was 3.21% for white smoke and 2.29 % for black smoke (see Tables B-3 and B-4 in Attachment B). You also state that the average opacity determination made by observers certified using your proposed VR-based alternative method was 13.5% more accurate for white smoke and 31.2% more accurate for black smoke compared to determinations made by observers certified at an in-person smoke school in 1975 and that these results demonstrate that training and certification using the Virtual Smoke School VR application is equivalent to training and certification from a traditional in person smoke school.

Determination

Based on a thorough review of your submittals including the study report, as well as Method 9 and it's supporting data in EPA-650/4-75-009, we conclude that VR headset-based alternative method for conducting Method 9 plume demonstrations and certification yields observers that are capable of conducting opacity observations with equivalent or better accuracy as observers certified using the existing Method 9 procedures. Therefore, with this letter, I approve the use of the VR headset-based alternative method for conducting Method 9 plume demonstrations and certification as described in this letter and further detailed in Attachment A as an alternative to the procedures of section 3.2 of Method 9 with the specific limitations listed below:

- The procedure described in this letter is not intended to certify Method 9 observers to conduct Method 9 readings at night.
- Other entities besides Virtual Smoke School desiring to conduct Method 9 observer training and certification according to this broadly applicable approved alternative method must:
    - Have a documented certification system that meets all the criteria contained in this determination including the attachment and provide a demonstration to our office; and
    - Have performed and submitted to our office for review and approval a successful demonstration of the VR training system according to EPA-650/4-75-009.

Because this alternative method involves broad application under Method 9, we will post this letter as ALT-152 on the EPA website at *https://www.epa.gov/emc/broadly-applicable-approved-alternative-test-methods.*

If you have any questions regarding this approval or need further assistance, please contact Kim Garnett at (919) 541- 1158 or garnett.kim@epa.gov.

Sincerely,

Steffan M. Johnson, Group Leader
Measurement Technology Group

cc: Kim Garnett, OAQPS/AQAD (garnett.kim@epa.gov)
Gregory Fried, OECA/OC (fried.gregory@epa.gov)
Regional Testing Contacts

Attachment A

Alternative Method for Conducting Method 9 Observer Certification and Training Plume Demonstrations

This document contains an alternative to section 3.2 of Method 9 (40 CFR part 60, Appendix A) and relies in part on use of a smoke generator meeting the requirements of section 3.3 of Method 9. Candidate observers wear a virtual reality (VR) headset to view a demonstration of smoke plume opacity values with the option to take practice tests and are then tested on their ability to assess the opacity of 50 plumes of unknown value, 25 black smoke and 25 white smoke, in order to determine if they can be certified. The administration of the demonstration plumes for training purposes and the certification procedure itself are the only difference between this alternative test method and Method 9.

In order to become certified under this alternative, candidate observers must complete a virtual training course in order to become familiar with background information on Method 9 equivalent to that in the "Visible Emissions Field Manual EPA Methods 9 and 22," Report No EPA 340/1-92-004, December 1992 and "Visible Emissions Evaluation Procedures Course," APTI 325-95-1, January 1995, and to become familiar with the VR headset and its use. Next, a candidate observer will use a VR headset and certification software meeting the requirements detailed in the sections below. The candidate observer will log in to the certification application using unique credentials to allow certification data to be unique to that candidate observer. Upon login, at least four standard values ranging between 0 and 100% opacity will be displayed to the candidate observer. After the standard values are displayed, the candidate will have the option to take practice tests or may begin the certification test for the first smoke color. During the certification test, candidates assign an opacity reading in 5% increments to 25 randomly selected plumes. After completion of the certification test for the first smoke color, the candidate observer proceeds to standard values for the second smoke color and repeats this process. At the completion of each run consisting of 25 black and 25 white readings, the candidate must certify that their answers are their own and the score of the candidate is determined. Candidates who complete the certification test with an average error of less than 7.5% per smoke color and without any single deviation exceeding 15% will be considered certified. If a candidate fails to qualify, the complete run of 50 readings must be repeated in any retest.

Requirements for Creating Black and White Smoke Plume Video Recordings for VR Headset Certification Application

Recordings of black and white smoke to be displayed on the VR headset must meet the following conditions:

- Sun must be within 140° sector behind the camera lens;
- Angle between camera lens and stack exit must be ≤18°;
- A white balance reference must be recorded in each frame;
- Color depth of the source video must be ≥12-bit;
- Video must be recorded in RAW or equivalent visually-lossless codec;
- The source video frame rate must be ≥24 fps;

- Timecode must be recorded per frame;
- Resolution of the source video must be ≥4096 horizontal lines and ≥2160 vertical lines;
- The stack exit must be nominally in the center of the frame during recording;
- The depth of field must be sufficient to ensure the stack exit and plume are in focus and a clear background for the plume.

The smoke generator used to create black and white smoke videos must meet the following conditions:

- The smoke generator must be designed and calibrated according to Method 9, section 3.3;
- Opacity data from the transmissometer must be recorded to the nearest 0.1% at least four times per second. Each recording must have a timestamp with resolution of at least one-tenth of a second.

Processed videos to be used for the certification test on the VR headset must meet the following conditions:

- Audio from the scene must be removed to eliminate mechanical or other auditory hints;
- Visual aids, including Ringelmann charts, must not be visible to the student;
- Resolution must be ≥4096 horizontal lines and ≥2160 vertical lines;
- Video bitrate must be ≥1 Mbps for every 160 lines of horizontal resolution;
- Video frame rate must be ≥24 fps.

Application Requirements for VR Headset Certification

The application on the VR headset used to train and certify students must meet the following conditions:

- Must display at least four opacities between 5% and 100% opacity for each smoke color as part of a standard value demonstration;
- Must provide a practice test of at least five questions per smoke color;
- Students must be shown 5-10 continuous seconds of smoke for each certification plume observation;
- Each video clip must be representative of a single opacity ranging from 0-100%;
- The opacity of the smoke displayed during each test question must be +/- 2.5% of stated value based on a 3-second rolling average of four readings per second;
- Each certification plume video clip must be selected from ≥600 video clips per smoke color with a minimum of 25% of the certification plumes being greater than 50 percent opacity with all opacities from 0-100% represented;
- Each observation must be digitally recorded before proceeding to the next question;
- The probability for receiving the same 50-question test sequence must be greater than one in a million;
- The test must be completed within 90 minutes of initiation;
- Students must certify that their answers are their own;

- To receive certification as a qualified observer, a candidate must be tested and demonstrate their ability to assign opacity readings in 5% increments to 25 different black plumes and 25 different white plumes, with an error not to exceed 15% opacity on any single reading and an average error not to exceed 7.5% opacity per smoke color;
- If a student fails the test, a complete run of 25 black smoke readings and 25 white smoke readings must be repeated.

Application Data Collection, Storage, and Retention Requirements

The following data relating to the VR application must be electronically collected and stored for a minimum of five (5) years:

- Make and model of camera and lens used to record test videos;
- Date and time of video recordings;
- Camera position relative to stack and sun during recording;
- Source video files used to create test videos;
- Transmissometer data during video recording;
- Rolling averages for test videos;
- Student identification;
- Identification of each video clip shown during each certification test;
- Grading results including deviation per reading and total score per smoke color for each certification test;
- Date, start time and completion time of each certification test;
- Application version of the virtual opacity testing software and VR headset firmware and OS version used during test.

VR Headset Requirements

The VR headset used for observer certification and presentation of demonstration plumes for training must meet the following conditions:

- Refresh rate of headset must be $\geq$60Hz;
- Horizontal field of view (FOV) of display must be $\geq$90 Degrees, measured as described by the manufacturer;
- Horizontal pixels per degree (PPD) of display must be $\geq$17;
- Must block ambient light;
- Must respond to the user rotating head left, right, up and down.

Attachment B

Table B-1. Results from 1975 Collaborative Study for White Smoke Deviation for Method 9 Observers

Deviation from Transmissometer - Original EPA Study											
White Smoke											
Run Number	Observer 1	Observer 2	Observer 3	Observer 4	Observer 5	Observer 6	Observer 7	Observer 8	Observer 9	Overall Deviation Per Run	Absolute Deviation Per Run
1	2.8	2	0.8	3.2	0.6	7.4	1	0.6	3	2.38	2.38
2	-3	-4.6	-2.4	-2.6	-5.4	-3	-5.2	-0.8	1.2	-2.87	3.13
3	-0.4	-3.4	-0.6	-0.4	-3.2	-0.6	-2.6	-0.6	0.8	-1.22	1.40
4	3.2	4.4	0	-1.2	-10.2	-1.6	-9.2	1.2	0.2	-1.47	3.47
5	-1.1	-2.7	-0.3	-0.3	-0.9	0.5	-0.5	-0.9	-1.1	-0.81	0.92
6	0.9	-0.1	0.3	1.9	1.1	1.1	1.3	0.3	1.9	0.97	0.99
7	1.2	0.8	-0.6	-0.4	0	0.6	-0.4	0	-0.2	0.11	0.47
8	-2.8	-11.4	-9.4	-9.6	-13.8	-13	-12.6	-6.6	-6.6	-9.53	9.53
9	-2.8	-10	-11.8	-8.8	-5.8	-8	-4.8	-8.4	-9.4	-7.76	7.76
10	-3	-4.8	-4	-4.6	-2.4	-4.6	-3.4	-5.2	-3.8	-3.98	3.98
11	4.3	4.3	6.1	6.5	5.7	4.3	3.3	3.3		4.73	4.73
12	0	-2.2	0	-1.2	-0.6	-2.4	-3.4	-3.4		-1.65	1.65
13	1	-0.2	3.4	1.6	2.4	2.4	-0.3	-0.8		1.19	1.51
14	1.8	3.6	4.6	8.2	4.2	0.8	2.4	1.4		3.38	3.38
15	3.9	6.5	3.1	4.1	5.3	-1.5	-0.5	-3.5		2.18	3.55
16	0.9	-1.9	-0.5	-2.7	-3.7	-13.1	-7.7	-8.1		-4.60	4.83
17	5.8	5.6	7.6	6.4	3.4	1.8	5.6	-0.2		4.50	4.04
18	-7.8	-8	-3.2	-7.2	-9.6	-9.6	-9	-9.8		-8.03	8.03
19	-3.9	-1.7	1.7	-2.3	-1.7	-5.7	-2.9	-7.7		-3.03	3.45
20	-2.2	-4.4	-4.8	-4.6	-5.2	-7.2	-5.4	-6.6		-5.05	5.05
							Absolute Average Deviation-White Smoke:				3.71

Table B-2. Results from 1975 Collaborative Study for Black Smoke Deviation for Method 9 Observers

Deviation from Transmissometer - Original EPA Study											
Black Smoke											
Run Number	Observer 1	Observer 2	Observer 3	Observer 4	Observer 5	Observer 6	Observer 7	Observer 8	Observer 9	Overall Deviation Per Run	Absolute Deviation Per Run
1	-10.6	-14.6	-13.0	-11.8	-16.0	-13.6	-13.4	-13.2	-9.6	-12.87	12.87
2	-3.4	-1.2	-0.8	-0.4	-0.2	-3.2	0.4	-2.4	1.2	-1.11	1.47
3	-6.0	-5.8	-3.4	-2.0	-3.8	-5.2	-2.8	-4.2	-3.0	-4.02	4.02
4	-2.4	-5.6	-4.4	-0.4	-2.8	-0.4	0.0	0.2	-3.0	-2.09	2.13
5	-4.9	-0.9	0.3	1.7	0.5	-0.3	0.7	0.7	0.1	-0.23	1.12
6	-6.4	-10.8	-10.2	-11.4	-7.2	-10.4	-11.2	-11.2		-9.85	9.85
7	2.6	0.0	1.0	0.0	-0.6	1.0	0.2	1.4		0.70	0.85
8	-4.4	-3.6	-4.2	-3.4	-7.6	-3.8	-6.0	-5.8		-4.85	4.85
9	-5.0	-7.4	-1.2	-1.4	-6.2	-2.8	-6.4	-2.6		-4.13	4.13
10	-1.6	-2.8	0.2	0.4	-2.0	-1.2	-1.8	0.0		-1.10	1.25
11	0.6	0.2	-0.8	3.0	-0.8	5.0	-0.2	1.2		1.03	1.48
12	1.0	-11.2	-3.0	1.2	1.2	3.0	1.8	0.4		-0.70	2.85
13	1.0	-2.4	2.0	3.6	1.2	3.6	-0.4	-0.8		0.98	1.88
14	-1.2	-1.0	2.4	2.4	1.0	2.6	-0.6	-0.4		0.65	1.45
15	0.2	-2.6	0.4	5.6	1.0	1.8	1.0	0.8		1.03	1.68
16	-0.2	-2.0	1.0	2.0	0.8	2.2	-0.2	-2.4		0.15	1.35
							Absolute Average Deviation-Black Smoke:				3.33

Table B-3. Results from Virtual Smoke School Study for White Smoke Deviation for Method 9 Observers

Deviation from Transmissometer - VR Certification Study											
White Smoke											
Run Number	Observer 1	Observer 2	Observer 3	Observer 4	Observer 5	Observer 6	Observer 7	Observer 8	Observer 9	Overall Deviation Per Run	Absolute Deviation Per Run
1	-0.2	6	-2.2	3.2	-1.4	-5.8	-5.4	3	-4.4	-1.80	3.51
2	1.6	5.6	-2.6	10.2	-1.8	3	0.4	3.2	-2.8	2.03	3.47
3	7.6	6	1.4	4.4	1	2.2	6.6	-0.6	2.6	2.70	3.60
4	6.6	3.8	-1	3.4	-2.8	1.4	7.2	0	-2.2	1.17	3.16
5	8.8	6.8	-0.8	7.2	2.6	-0.8	9.8	0.6	-1	3.07	4.27
6	5.4	4	0	1.2	1.2	0.6	1.8	1.2	1.6	1.27	1.89
7	6.2	5	-3.8	6.4	2.8	-3.8	7.8	4.8	-0.4	2.93	4.56
8	3.4	0.6	-3	4.6	-2.8	-2.6	2.8	0.6	-3	-0.07	2.60
9	3.8	2.6	-6.6	2	1.2	-9.2	5.6	0.6	-3.4	-0.53	3.89
10	7.8	4	-0.2	6.8	7.6	0.4	10.6	2.6	2.2	5.03	4.69
11	0.4	-0.2	-3.6	-0.2	1.8	-1.44	4.6	-1	-1.8	0.33	1.67
12	0	1.4	-3.2	2.6	6.6	-2.6	4.8	1	-2.6	1.63	2.76
13	-0.4	1	-3.4	0.6	3.8	-0.36	5.8	-1.6	-3.8	0.74	2.31
14	-0.2	0.8	-3.2	1.6	3.4	-4.4	6.2	-0.4	-4.8	0.27	2.78
15	-0.4	-0.2	-2.76	2	6.2	-5.6	5.6	3.2	-1.8	1.60	3.08
16	2	-1.8	-1.4	3.6	-1.6	-4	2.4	0.6	1.2	0.37	2.07
17	4.2	10.2	0.2	2.6	8.6	-0.36	4.8	2.2	0.8	3.11	3.77
18	5.4	2.2	-1.4	2.8	6.2	-2.8	8.8	1.8	-0.4	2.73	3.53
19	4.8	-0.4	-3.4	2.2	3	-8.8	4.8	-2.2	-5	-1.00	3.84
20	5	4	-1.6	1.6	4.4	-2.16	4.6	2.2	-0.2	1.74	2.86
										Absolute Average Deviation-White Smoke:	**3.21**

Table B-4. Results from Virtual Smoke School Study for Black Smoke Deviation for Method 9 Observers

Deviation from Transmissometer - VR Certification Study											
Black Smoke											
Run Number	Observer 1	Observer 2	Observer 3	Observer 4	Observer 5	Observer 6	Observer 7	Observer 8	Observer 9	Overall Deviation Per Run	Absolute Deviation Per Run
1	-6.2	-2.4	2	-1.2	0	6.2	0.4	3.4	3.56	2.06	2.82
2	-2.8	-1.6	-2.6	-0.6	-0.6	1.6	-2	-0.4	-0.8	-0.47	1.44
3	-10.8	0.8	-5	-2.4	-0.2	-3.4	0.8	1.4	-5	-1.47	3.31
4	-9.8	-0.6	-4.4	-2.6	-2.2	-0.8	-0.6	-0.6	-1.8	-1.43	2.60
5	-7.4	-0.2	-2.4	-2.6	-1.2	-2.6	1	-0.4	-1.2	-1.17	2.11
6	-5.2	1	0	1.2	1.4	-2.4	5.2	3	2.2	1.77	2.40
7	-4.8	-2.4	-1.8	-1.8	-1.6	-4	1.6	-0.6	1.4	-0.83	2.22
8	-7.8	-0.2	-2.6	0.2	1.2	-3	3.4	2.4	-0.8	0.57	2.40
9	-7.2	-0.4	-3.6	-0.6	0	-4.2	2.6	1	-0.2	-0.23	2.20
10	-2.4	0.8	-1.2	0.4	-1	-1.6	3.2	1	1.4	0.57	1.44
11	-6.4	1	0	3	2.2	-2.4	5	1.4	0.6	1.63	2.44
12	-3.2	2.6	-1.88	-0.4	1.6	-2.6	6	1	1.12	1.12	2.27
13	-5	1.6	-4.2	-1	-1.8	-4.4	5	-0.6	0.8	-0.33	2.71
14	-3.2	0	-3.8	-2	-2.2	-2	1.6	0.8	0.2	-0.60	1.76
15	-0.6	1.4	-3	-0.8	4.6	-1	6.6	1.4	2.6	2.23	2.44
16	-6.6	-0.8	-3.84	-1.2	0.8	-3.8	0.8	0	-0.4	-0.63	2.03
										Absolute Average Deviation-Black Smoke:	**2.29**