WHITE PAPER

Answering Your Questions about ANSI/ASHRAE Standard 199

By Rick Kreczmer

camfil
AIR POLLUTION CONTROL

The new ANSI/ASHRAE Standard 199-2016, Method of Testing the Performance of Industrial Pulse Cleaned Dust Collectors, is the first to provide a methodology for comparing performance results based on true dust collector operating conditions. What is covered under the standard? How can it best be applied to make informed dust collection decisions? This white paper will answer these and other important questions.

Answering Your Questions about ANSI/ASHRAE Standard 199

By Rick Kreczmer

The recently published ANSI/ASHRAE Standard 199-2016, Method of Testing the Performance of Industrial Pulse Cleaned Dust Collectors, fills an important information gap that will help operators and specifiers of dust collection systems to compare and evaluate equipment with much greater accuracy. This white paper will address 10 key questions on how Standard 199 differs from previous test standards, how it measures dust collector performance, and how readers can best apply this new methodology in concert with other regulations and standards to make more informed decisions.

Full-scale test rig in the Camfil APC laboratory has been built in accordance with Standard 199 specifications. It is used both in the company's internal testing and for customer assistance.

1. Why has this standard been developed?

The dust collection industry has for many years lacked an appropriate test standard to measure the effectiveness of the filter elements used in a dust collection system. Until now, dust collection equipment users have had to rely on air filter test standards such as those developed by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) to measure filter efficiency in HVAC system environments.

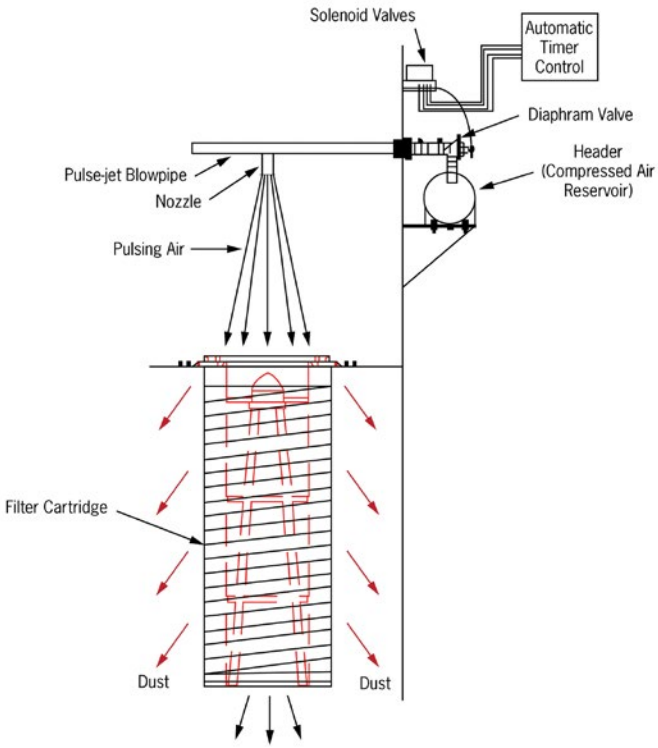
One such standard is ANSI/ASHRAE Standard 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size, which uses the Minimum Efficiency Reporting Value or MERV system to measure air filter efficiency. This system is based on a scale from 1 to 16, with MERV 16 being the highest efficiency. Developed for the HVAC filter market, ASHRAE 52.2 provides a useful means of comparing filters; however, it does not take into account the way a dust collector operates – i.e., it pulse-cleans filters periodically when a dust cake builds up. Standard 199 is the first to provide a methodology for comparing performance results based on true dust collector operating conditions – analyzing not only how well the filters clean, but also how the collector performs as a whole.

2. What types of dust collectors are covered under Standard 199?

The standard applies to "bag, cartridge, or envelope industrial dust collectors that recondition the filter media by using a pulse of compressed air to discharge the dust cake from the filter media while the air cleaning device remains on line". It provides a standardized method of testing performance of these collectors from inlet to outlet, accurately portraying the dynamics of this equipment in multiple filter arrangements vs. single filter initial efficiency methodologies like MERV.

3. How is the test performed?

Testing under Standard 199 includes a total of six stages that challenge the dust collector in the same way that a real-life application would. It takes into account that filters will load with dust and then be periodically cleaned using different modes of pulse cleaning. All tests are performed with an inlet loading of 1 gr/ft3 using calcium carbonate as the test dust. No more than 25 percent of the media in the dust collector will be pulsed at one time. The test stages are as follows:



Schematic of typical pulse cleaning system used in an industrial dust collector.

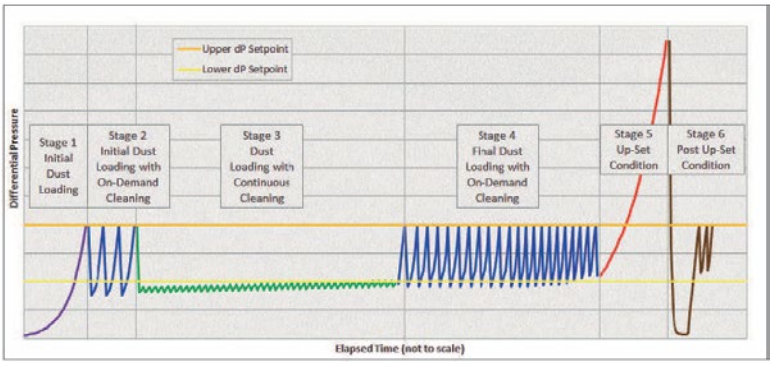
A. Conditioning

Stage 1: Initial Dust Loading: This stage loads dust to the collector at the specified rate to a predetermined differential pressure, with no pulse cleaning. Once differential pressure has been reached, the test proceeds to the next stage.

Stage 2: Initial Dust Loading with On-Demand Cleaning: Once the initial dust loading stage is complete, on-demand pulse cleaning is initiated while maintaining airflow and dust feed. The cleaning interval is determined by high and low differential pressure set points provided by the manufacturer of the dust collector.

On-demand cleaning conserves compressed air while keeping the filter pressure drop in a good workable zone, allowing adequate airflow from the dust-generating process. Field experience has shown that most applications can use on-demand pulsing to conserve compressed air for the owner of the equipment.

Stage 3: Dust Loading with Continuous Cleaning: This stage follows the initial on-demand cleaning, using continuous pulse cleaning while maintaining airflow and dust feed. This stage lasts for 24 hours or until the predetermined maximum differential pressure has been reached, whichever occurs first.



ANSI/ASHRAE Standard 199 Figure 4.1 – Schematic showing sequence of test stages.

With continuous cleaning, as the name implies, the cleaning system is always engaged. Filters will clean at specified time intervals (generally every 10-15 seconds). Continuous pulsing is typically used for tough applications with heavy loading where on-demand is not a good fit, such as thermal spray, plasma cutting or light paper dust.

B. Performance Test

Stage 4: Final Dust Loading with On-Demand Cleaning: This second, longer on-demand stage follows the continuous cleaning stage, while maintaining airflow and dust feed. Cleaning is determined by high and low differential pressure set points provided by the dust collector manufacturer.

C. Recovery test

Stage 5: Up-Set Condition: This stage is designed to simulate dust collector performance in an up-set condition. Dust feed is maintained, but pulse cleaning is stopped. This stage continues until differential pressure reaches the predefined maximum, usually 10 inches of water gauge. At this point, dust feed is stopped.

Stage 6: Post Up-Set Condition: After up-set condition has been reached, airflow is reduced to 25 percent of specified value. Continuous pulse cleaning is initiated and continues for 10 complete cycles. The system is then returned to specified airflow and differential pressure is measured. Dust feed is then restarted and final measurements are performed. This stage is designed to replicate the process commonly known in the industry as “downtime cleaning”.

It is important to note that as filters are cleaned, emission levels will fluctuate. The shock of compressed air used for pulse cleaning allows some dust to pass through the filtration media.

The pressure drop will rise when cleaning is paused and fall when cleaning is active. This directly affects pressure drop in the system and is also the main driver for energy consumption. Filters with inherently higher pressure drop will consume more energy due to higher pulsing/ compressed air usage and higher electrical power needed for the fan motor to overcome the additional static in the system.

4. What performance parameters are measured under Standard 199?

Emissions: The test measures not only the initial emissions, but emissions through the life of the test. This is important because the compressed air shock will allow dust to pass through the media. Emissions will be measured in milligrams per cubic meters of air (mg/m^3).

Pressure drop: A filter with a high dust-holding capacity and good dust release characteristics will require less frequent cleaning and maintain low pressure drop throughout the life of the filters.

Compressed air usage: This will also vary depending on the self-cleaning abilities of the filters. The better the cleaning characteristics, the less compressed air will be needed. Compressed air can cost anywhere from 18 to 30 cents per 1000 cubic feet of air, based on statistics from the U.S. Department of Energy.

Energy savings will be directly related to pressure drop and compressed air usage, since both have a significant impact on energy consumption. As noted, less frequent pulsing saves on compressed air usage

and the associated electrical costs. A lower pressure drop filter, in conjunction with a variable frequency drive (VFD) as used on the Standard 199 test rig to maintain a constant airflow, will further save on electrical energy and help extend the life of the filters.

Emission reading: This reading includes penetration through the whole system and measures:

PM1: particulate mass less than 1 µm as determined by photometric measurement in accordance with US EPA 40 CFR Part 50.

PM2.5: particulate mass less than 2.5 µm as determined by photometric measurement in accordance with US EPA 40 CFR Part 50.

PM10: particulate mass less than 10 µm as determined by photometric measurement in accordance with US EPA 40 CFR Part 50.

See Appendix on pages 12-14 to view the test report template from ANSI/ASHRAE Standard 199.

5. What must dust collection equipment manufacturers do to comply?

Standard 199 is voluntary, not mandatory, so it will be up to individual dust collector and filter manufacturers to develop an internal plan for compliance.

Using a cartridge dust collector with four high efficiency filters, the Camfil APC test rig feeds dust into the collector under conditions specified in Standard 199.

Some manufacturers of dust collection equipment may opt to install a lab in-house where they can design, build and test collectors to meet the new standard. However, for third-party verification, units should be sent to independent laboratories to confirm in-house results.

It may take some suppliers several years to get on board, due to limited test facilities and the cost involved in commissioning independent testing. Some smaller suppliers may find these costs to be prohibitive. Another development that may impact the market is the potential involvement of the International Organization for Standardization (ISO), which is currently looking at adopting the standard. If this happens, it will impact equipment suppliers and customers worldwide.

Also, ISO is currently rolling out a new test standard for air filters for general ventilation (ISO 16890). It is expected to become the new global standard for testing and classification of air filters. It shifts the focus on filtration performance to the classes of particulate recognized by leading environmental groups, including

Pharmaceutical processing facilities like this one are among those most likely to be impacted by Standard 199.

the World Health Organization. Filter efficiencies will be determined based on particulate matter size classes PM1, PM2.5 and PM10. Use of these parameters will make it easier to select the right filter for a specific application. Though the new standard does not specifically target dust collection filtration, some industry experts see a potential link between ISO 16890 and ANSI/ASHRAE Standard 199.

6. What industries will be impacted the most?

Standard 199 has the potential to help equipment operators in all sectors to make more informed dust collector purchasing decisions; however, it will have the most impact in industries and applications with stringent emission control requirements. This includes pharmaceutical processing, mining, some areas of metalworking, and other applications where EPA, OSHA or other regulatory emissions compliance is critical.

Any company involved in processes with stringent contaminant threshold limits in the work environment, or a PM 1, 2.5 or 10 requirement, should be interested in the results of this testing. It will allow them to make better assessments of the technology they are considering to control their dust generating processes.

7. What questions should I ask my dust collection supplier?

Has the supplier's equipment been tested under Standard 199?

As noted above, suppliers are not required to use the new standard: Participation is voluntary; and it will take time for some companies to get up to speed, if they plan to participate at all. Ask where the supplier stands in the process. If your supplier does not offer Standard 199 test data, it may limit your ability to make informed equipment decisions.

Does the supplier operate an in-house test lab for Standard 199 testing?

Any supplier who has installed an in-house Standard 199 test rig has demonstrated a strong commitment to the program. A company-operated lab enables the manufacturer to conduct in-house simulations to optimize the design of products under development, as well as to improve the performance of existing products.

Does the supplier commission independent testing?

Even if in-house test facilities are available, a conscientious supplier will also commission independent testing to verify results. Independently certified results are preferable to test reports from a company that relies solely on self-certification.

Has the supplier specified the same filters for my application that were tested under Standard 199?
Users of dust collection equipment should verify that the filter elements used in the testing are the same that they will receive when ordering the dust collector. Some companies may test with their best elements, but switch to less costly and lower performing elements when packaging the collector. The same could be said for changing to untested elements. The system will undoubtedly not attain the same results.

Is the supplier's testing confined to new dust collector models, or have older models also been tested retroactively?
If a dust collector operator is concerned with an existing collector's emissions performance in a critical application, it may be worthwhile to ask the manufacturer if the older model has been tested in accordance with Standard 199. This type of testing is not required under the standard but may be implemented by some suppliers.

Standard 199 will most often be employed during the planning and specification stage of a new dust collection system. The remaining questions and answers provide some general guidelines for integrating Standard 199 into your overall dust collection plan.

8. How can I best apply Standard 199 to the design of my new dust collector?

Standard 199 will provide a very useful tool for reviewing comparative results between different dust collectors and filters – on emissions, pressure drop, compressed air consumption and energy. This data creates the building blocks for evaluating total cost of ownership (TCO) of a new dust collector.

TCO is like life-cycle costing: It helps you determine what it really costs to operate your dust collector over time by calculating the three areas of cost associated with this equipment:

- **Energy** – the amount of energy required to operate the dust collector from day to day, including electrical costs and compressed air usage.
- **Consumables** – the items that are replaced periodically throughout the life of the equipment. Filter replacement can be a major cost in dust collector maintenance; and although Standard 199 cannot directly predict the service life of a filter, the comparative data on pressure drop can shed light on which filter elements may last longest.
- **Maintenance and disposal** – the time it takes to service the equipment and the costs of disposing of the consumables. Again, this relates closely to filter service life.

Cutaway view of a pulse cleaned cartridge-style dust collector.

A reputable equipment supplier should have the capability to perform a TCO calculation, inputting the data from the Standard 199 test report combined with other data that is unique to your application. The TCO evaluation will ultimately save you money, time and energy by ensuring the most cost-effective equipment choice.

9. Should I use Standard 199 in conjunction with other filter test standards?

Until 199 test reports become more widely available, it's likely that equipment specifiers will sometimes continue to compare the MERV rankings or other efficiency ratings of different filters. The MERV scale provides a good indicator of a filter's initial efficiency; however, it does not measure pressure drop, emissions while pulsing, energy performance or the other parameters that are part of Standard 199 testing.

10. What other rules and standards do I also need to consider when designing a dust collection system?

It is important to understand that Standard 199 does not measure all aspects of dust collection design and performance. Other areas to consider include:

Combustible dust: Combustible dust hazards exist in a great many manufacturing environments and must also be evaluated. Readers are urged to become familiar with the recently published *NFPA 652: Standard on the Fundamentals of Combustible Dust*, which introduces the concept of Dust Hazard Analysis (DHA), a new simplified methodology targeted toward factories involved in more basic processes involving simple dust collection systems.

Combustible dust explosion hazards must also be evaluated when designing a dust collection system. Photo shows a controlled explosion staged to test how this collector will hold up in a combustible dust event.

NFPA 652 is now the starting point for defining a combustible dust and its hazards. Its purpose is to clarify the relationship between the shared standards and the industry-specific standards such as NFPA 484 for metals, NFPA 664 for wood, NFPA 655 for sulfur, and NFPA 61 for agricultural and food processing. These standards require that a facility processing or handling combustible dust perform a hazard analysis and risk assessment for each operation that handles combustible dust. OSHA enforces these standards through its Combustible Dust National Emphasis Program (NEP).

A hazard analysis is the first thing the OSHA inspector will ask for if he or she discovers combustible dust in your facility. As part of this analysis, your dust should undergo explosibility testing to determine its combustible and explosive properties. Explosibility testing is essential in analyzing the best type of dust collection system for an application as well as the explosion protection or prevention devices to use on the dust collector and related components.

Hex chrome exposure: Hexavalent chromium – also known as hex chrome or Cr(VI) – is a carcinogenic substance produced in a variety of industrial processes, e.g. during welding or other types of "hot work" on stainless steel and other metals that contain chromium. In May 2006, OSHA published a new rule for hex chrome exposure which reduced by tenfold the permissible level of exposure in the workplace. The current Permissible Exposure Level (PEL) is just 5 micrograms per cubic meter of air time-weighted average (TWA) in an 8-hr shift. Facilities impacted by this rule must perform air monitoring as required by OSHA and will need to incorporate dust collection equipment with very high filtration efficiencies to meet the stringent threshold.

OSHA is not the only group concerned with hex chrome emissions. In 2011, the U.S. EPA issued a National Emission Standard for Hazardous Air Pollutants (NESHAP) Rule 6x. The rule encompasses all manufacturing processes using materials that contain 0.1% by weight cadmium, chromium, lead, or nickel – or 1.0% by weight manganese, which is virtually a universal component of welding wire. Simply stated, there can be no visible emissions (zero opacity) from these processes. If a metalworking facility opts to exhaust hex chrome or any of the other classified pollutants outdoors, they will be need to put strict emission monitoring and engineering controls in place to comply with Rule 6x.

Dust collector designed for silica dust capture to meet OSHA's stringent new silica rule.

Silica emissions: OSHA has issued a new silica rule, effective June 2016, that updates regulations established in 1971. It features a lower limit for worker exposure to harmful respirable crystalline silica dust as well as more stringent measures to monitor compliance. Silica dust turns up in a wide range of processes and applications, including abrasive blasting processes in construction, maritime work and general industry; cement production; pottery, structural clay, stone and concrete products manufacturing; asphalt

pavement manufacturing; foundry production; electronics manufacturing; production of abrasives, paints, soaps, and glass; shipbuilding; filtration in food and beverage production; and hydraulic fracturing.

If your facility has a respirable silica dust hazard, you need to become familiar with the new OSHA rule, how to achieve compliance, and the specific role of dust collection as a proven and reliable engineering control strategy.

Industry-specific emission requirements: Some industries including pharmaceutical, chemical and mining require close attention to Threshold Limit Values (TLVs) for specific contaminants used in their products. Established by the American Conference of Governmental Industrial Hygienists (ACGIH), the term TLV is defined as the airborne concentration of a substance below which workers are believed to be protected while exposed to the substance daily for 8-hour periods. For dust, mist and fumes, TLV is stated as milligrams per cubic meter (mg/m3) of surrounding air. Emissions readings from Standard 199 test reports can assist in selecting the equipment best suited to the application.

# # #

*Rick Kreczmer has held numerous positions with Camfil APC in the U.S. and Europe, and currently serves as director of aftermarket. Camfil APC is a global manufacturer of dust, mist and fume collection equipment and is part of Camfil, the largest air filter manufacturer in the world. For further information, contact 1-800-479-6801 or 1-870-933-8048; email **filterman@camfil.com**; website **www.camfilapc.com**.*

References

American Conference of Governmental Industrial Hygienists (ACGIH), 1330 Kemper Meadow Drive, Cincinnati, Ohio 45240; www.acgih.org.

- *TLV®/BEI® Guidelines*

American Society of Heating, Air-Conditioning and Refrigeration Engineers (ASHRAE), 1791 Tullie Circle, N.E. Atlanta, GA 30329; www.ashrae.org.

- ANSI/ASHRAE Standard 199-2016, *Method of Testing the Performance of Industrial Pulse Cleaned Dust Collectors*
- ANSI/ASHRAE Standard 52.2, *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*

International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland; www.iso.org.

- ISO 16890-1: Air filters for general ventilation -- *Part 1: Technical specifications, requirements and classification system based upon particulate matter efficiency (ePM)*

National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169; www.nfpa.org.

- NFPA Standards 61, 484, 652, 654, 655 and 664

Occupational Safety & Health Administration (OSHA), 200 Constitution Avenue, Washington, DC 20210; www.osha.gov.

- OSHA 29 CFR Parts 1910, 1915, and 1926 Occupational Exposure to Respirable Crystalline Silica; Final Rule (2016)
- OSHA Combustible Dust National Emphasis Program (Reissued) – Directive Number: CPL 03-00-008; effective date March 11, 2008
- OSHA Standard on Hexavalent Chromium (OSHA Standard 3373-10), 2009

U.S. Department of Energy, 1000 Independence Ave., SW, Washington, DC 20585; www.energy.gov.

- Compressed Air Systems: *Determine the Cost of Compressed Air for your Plant*

U.S. Environmental Protection Agency (EPA), 1200 Pennsylvania Avenue, N.W., Washington, DC 20460; www.epa.gov.

- NESHAP Nine Metal Fabrication and Finishing Area Source Categories 40 CFR part 63 subpart 6x

Appendix

See pages 12-14.

Appendix

Test report template from ANSI/ASHRAE Standard 199

Company Logo		Report No.	
		Review 12-16-2014	
Company Address		Date:	Page:
Company Address		12/14/2014	1 of 3

Requestor Information

Requestor	ASHRAE 199 Review Committee

Device Under Test - Test Conditions

Pulse Cleaned Dust Collector Information		Filter Information	
Manufacturer	Equipment Manufacturer	Manufacturer	Sample
Product Name	Equipment Product Name	Product Name	Canister
Tested Airflow (CFM)	1760	Part Number	Sample PN

Performance Summary (Last 4 hours of Stage 4)

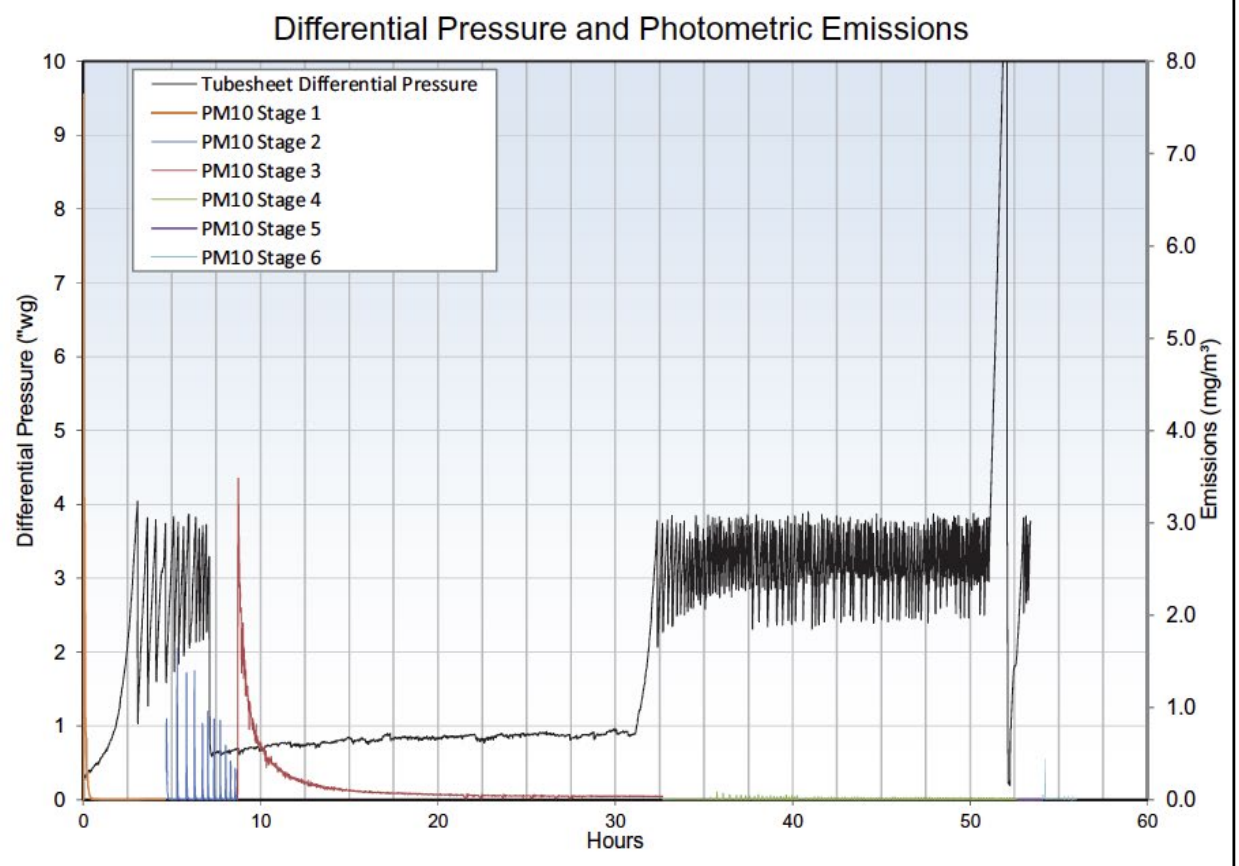
Emissions[1] (mg/m^3)	Differential Pressure Average[2] ("wg)	Air Consumption[3] ($ft^3/1000ft^3$)
Not Available	**3.14**	**0.078**

[1] Average PM_{10} emissions

[2] Average of tubesheet differential pressure

[3] Compressed air usage rate (cubic feet of compressed air per 1000 cubic feet of cleaned air)

Full Test Summary



Disclaimer: Actual dust collector performance may vary depending upon multiple factors. See page three for full details.

Company Logo		Report No.	
		Review 12-16-2014	
Company Address		Date:	Page:
Company Address		12/14/2014	2 of 3

Requestor Information

Company	Your Company Name
Address	Your Address
Phone Number	Your Phone Number
Contact & Email	ASHRAE 199 Review Committee / Your e-mail

Device Under Test

Collector Information				Filter Information	
Manufacturer	Equipment Manufacturer			Manufacturer	Sample
Serial Number	146577-001-1			Part Number	Sample PN
Product Name	Equipment Product Name			Product Name	Canister
Pulse Clean System (PCS) Information				Media Type	Synthetic
No. Pulse Valves	4	Valves Pulse/cycle	4	Media Area (ft^2)	256
PCS Volume (ft^3)	0.18	Stated Interval (min)	1	No. of Filters	4
Initial PCS Pressure (PSI)	100	Actual Interval (min)	1	Additional Info	ASHRAE 199 Test run #2
Post Pulse PCS Pressure (PSI)	40	Stated Duration (ms)	150		
Compressed Air/Pulse (ft^3)	0.73	Actual Duration (ms)	100		
Compressed Air/cycle (ft^3)	2.92				

Test Conditions

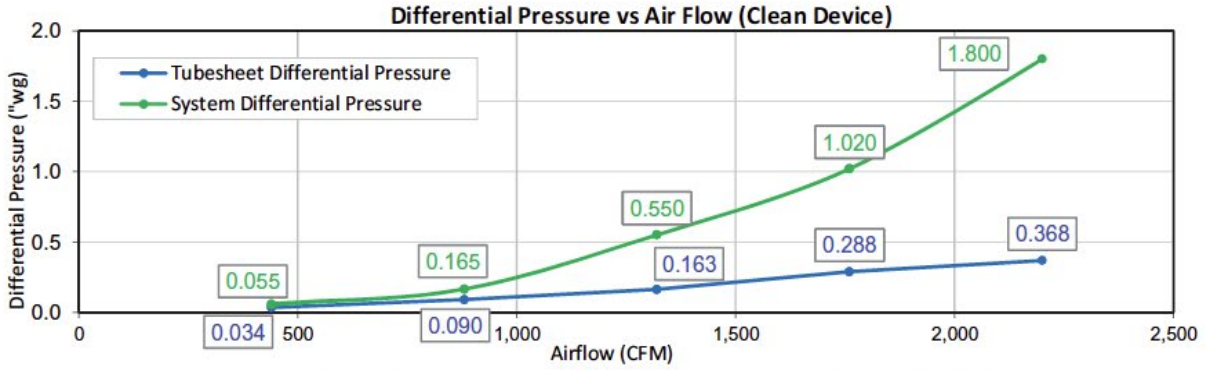
Ambient Lab Conditions				Requestor Variables - Set by Customer	
Temperature (min|max|avg) (°F)	70.0	90.0	86.9	Tested Airflow (CFM)	1760
Rel. Humidity (min|max|avg) (%RH)	39.0	52.0	42.5	High / Low Set Points ("wg)	2.5 / 3.75
Baro. Pressure (min|max|avg) ("Hg)	2.53	29.74	29.56	Up-Set Max ΔP ("wg)	10
Test Dust					
Calcium Carbonate				Concentration ($grain/ft^3$)	1

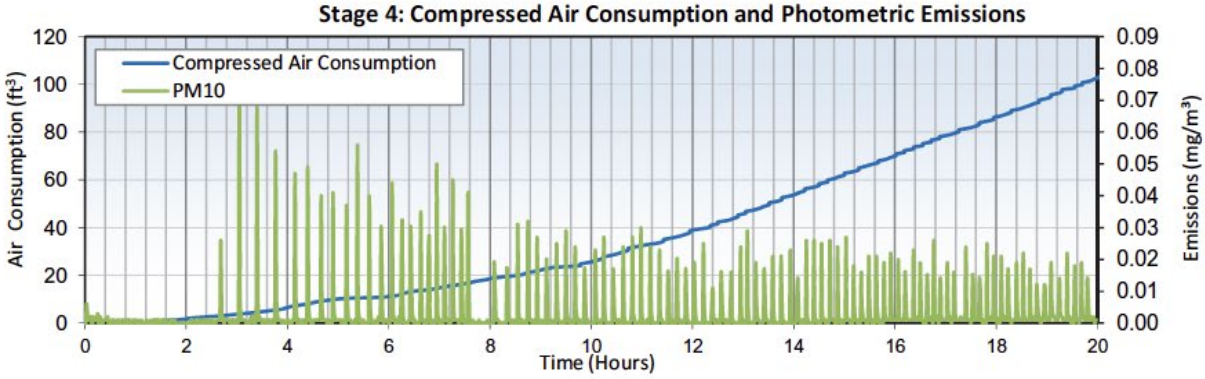
Test Results

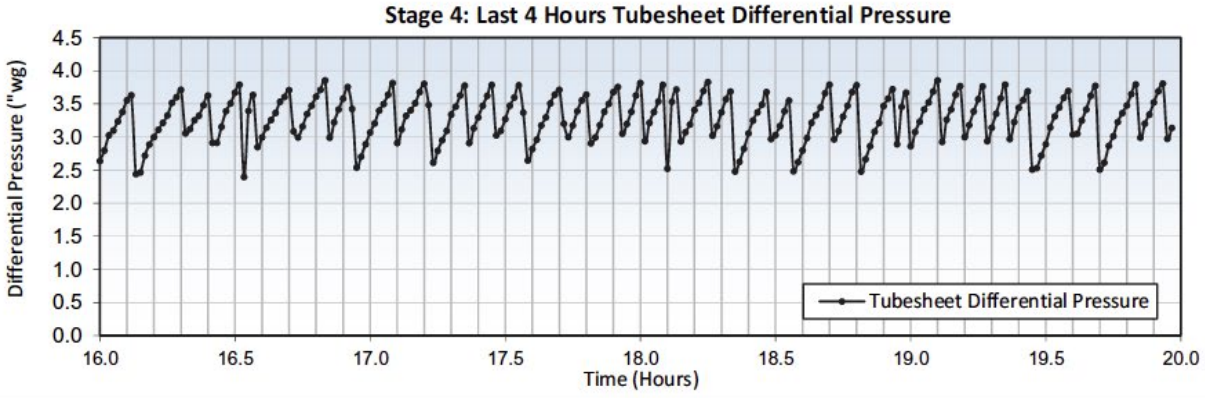
	Initial Dust Loading	Initial On-Demand Cleaning	Continuous Cleaning	Final On-Demand Cleaning	Up-Set Condition	Post Up-Set Condition
Stage	**1**	**2**	**3**	**4**	**5**	**6**
Duration (hrs)	3.08	4.00	24.00	20.73	1.02	1.30
Dust Fed (lbs)	46.50	60.32	361.91	312.65	15.33	17.59
No. of Pulses	-	8	86400	149	-	41
Total Air Usage (ft^3)	-	6	63032	109	-	30
Gravimetric Eff. (%)	88.27%		98.83%	99.41%	99.41%	-
PM_{10} Avg (mg/m^3)	0.122	0.070	0.151	0.003	0.001	0.010
$PM_{2.5}$ Avg (mg/m^3)	0.122	0.070	0.151	0.003	0.001	0.010
PM_1 Avg (mg/m^3)	0.122	0.070	0.151	0.003	0.001	0.010

Cumulative Data		Filter ΔP Data	
Total Test Duration (hrs)	54.1	Initial Filter ΔP ("wg)	0.29
Total Dust Fed (lbs)	814.3	Avg. Pressure ("wg) Stage 3	0.91
Total Number of Pulses	86598		

Company Logo		Report No.
		Review 12-16-2014
Company Address		Date: 12/14/2014 / Page: 3 of 3
Company Address		







Comments