

Visible Emission Management Forget the School, Use the Tool

The Digital Opacity Compliance System
Third Generation (DOCS III):

USEPA Alternative Method 082
Visible Emission Management

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Opacity Globally Accepted Nuisance Emission Measurement People Complain About What they See and Smell



**World Bank Requires, <20% Opacity Guarantee for Payment
ASTM D7520-16, used by World Bank: Opacity Measurement
Thousands of Projects, located in nearly every country
% Opacity is the
Nuisance Emission Measurement Indicator.**



Opacity Monitoring History

- 1800-1974 – Opacity used to optimize combustion sources and determine the nuisance level of air emissions
 - 1968 Federal Government/Industry Panel Publish AP-40 Opacity legally established as measure.
 - 1970 EPA Published NAAQS, and national Opacity measure
 - 1971 EPA proposes 10% Opacity limit on Portland Cement
 - 1974 Reference Method 9 published in New Source Performance Standard, Opacity measurement.
- 1975 to 2000 – Reference Method 9 is written into the vast majority of Clean Air Agency Regulations, City and County Ordinances throughout the US and developing countries and the measurement to the Maximum Visible Emission Allowed.
- 2007 - ASTM Workgroup to meet Technology Transfer Act requirement for EPA to use consensus standards, Creates the Digital Camera Opacity Technique D7520
 - 2009 - ASTM D7520-09 approved and published
- 2012 February – EPA Office of Air Quality Planning and Standards published US EPA Alternate Method 082 (ALT 082), **Broadly Applicable Standard:**
 - Digital Camera Opacity Techniques (DCOTs) can be used “**in lieu of Method 9**”, for all subparts of 40 CFR 60, 61 and 63

***US EPA ALT 082 Broadly Applicable Standard
Most Credible Evidence Today***

***Opacity can be used by All Enforcement Agencies in
US to act, against a pollution source.***



Evolution of DOCS III Continued

- 2012 to Present – Fugitive Dust Applicability
 - Applicable to fugitives per 40 CFR 60 Subpart ooooo October 2012
- 2015- EPA opinion “Any Creditable Evidence” rule of Clean Air Act, DCOT Most Credible
 - Applicable to all Source types “a picture says a thousand words”.
- 2015- FerroAlloy NESAP defines DCOT as BACT, and mandates for Process Fugitive Emis.
- 2016 – ASTM D7520-16 Approved Applicable to all Opacity Sources
 - Digital Camera Opacity Technique (DCOT) Applicable
 - Stationary, Mobile, Fugitive
- 2017 – FerroAlloy NESHAP final reconsideration ruling DCOT is BACT for Opacity.
- 2018 – DOCS II Flare Watch Development begins expanded background, auto detect
- 2019 – DOCS II Heavy Diesel Inspection and Maintenance Full Speed Opacity Monitoring
- 2020 – Auto-Detect released to production clients for Flare Watch and HD Diesel ID
- 2020 – Heavy Diesel Inspection and Maintenance Toll Integration
- **2021 – Community Monitoring and Educational Tools**
- **2021 – Reflection/Refraction/Rayleigh/Mie, Scattering principles used to speciate Opacity into PM Concentration within the Plume.**
- **2022 – Neighborhood Wide Area Scanning Opacity Monitor**
Reporting % Opacity and concentrations of PM <3 , $3-9$, >9
DOCS III Monitors Opacity from Feet to Miles Away



Opacity Based Monitoring

Regulatory Compliance, Community Conservation



Observation Analysis

Software As a Service

Observation Analysis



MPG/JPG
VEE Process



MPG/JPG
VEE Manage



Obs.
Event
Trans
for
Analysis



Onsite Observation Switch
Archive Storage

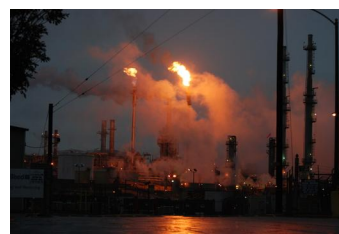
Community Monitoring Pollutant Tracing



Electronic Complaints

Image	Opacity	Coordinates	Camera and Weather Information
	10	33° 05' 12.00" N -111° 55' 12.00" W	Camera: MyWeather Center Camera Pro-2000-011 Altitude: 1011 Weather: 72 Wind: 10 Humidity: 72 Bar: 30.00
	10	33° 05' 12.00" N -111° 55' 12.00" W	Camera: MyWeather Center Camera Pro-2000-011 Altitude: 1011 Weather: 72 Wind: 10 Humidity: 72 Bar: 30.00
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	10	33° 05' 12.00" N -111° 55' 12.00" W	Camera: MyWeather Center Camera Pro-2000-011 Altitude: 1011 Weather: 72 Wind: 10 Humidity: 72 Bar: 30.00
	10	33° 05' 12.00" N -111° 55' 12.00" W	Camera: MyWeather Center Camera Pro-2000-011 Altitude: 1011 Weather: 72 Wind: 10 Humidity: 72 Bar: 30.00

Electronic VEE Reports





DOCS II Community Empowerment

Neighborhood, Watch Monitor

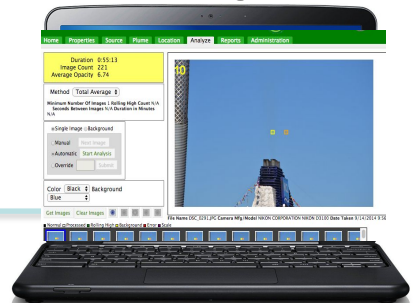
Community Controlled

Independent third-Party Review

Capture



Remotely Controlled Geo Referenced w/Google/NOAA



Receive Validated Digital Report

Each Monitor Circular Scans for Opacity, 1/2 Mile Radis, to measure Opacity and it's Speciated PM Concentration



Review Submit Emission Events

VISIBLE EMISSION OBSERVATION FORM		Date		Time		Wind		Temp		Humidity		Pressure		Altitude	
Location	City/County	Station	Lat	Long	Alt	Dir	Spd	DBP	DBP	DBP	DBP	DBP	DBP	DBP	DBP
Condition	Category	Observed	Observed	Observed	Observed	Observed	Observed	Observed	Observed	Observed	Observed	Observed	Observed	Observed	Observed
Method	Scan	Scan	Scan	Scan	Scan	Scan	Scan	Scan	Scan	Scan	Scan	Scan	Scan	Scan	Scan
Color	Back	Back	Back	Back	Back	Back	Back	Back	Back	Back	Back	Back	Back	Back	Back

Image	Opacity	Coordinates	Camera and Weather Information
	10	34.2101, -118.1511	Date Taken 1/24/2010 10:33:40 AM Camera M3iModel Canon/Canon-PhaseDuo 011 Wind Speed 0 Wind Humidity 72 Wind Dir 40 Wind Bulk Temp 40
	10	34.2101, -118.1511	Date Taken 1/24/2010 10:34:00 AM Camera M3iModel Canon/Canon-PhaseDuo 011 Temperature 57 Wind Speed 0 Wind Humidity 72 Wind Dir 40 Wind Bulk Temp 40
	5	34.2101, -118.1511	Date Taken 1/24/2010 10:34:10 AM Camera M3iModel Canon/Canon-PhaseDuo 011 Wind Speed 0 Wind Humidity 72 Wind Dir 40 Wind Bulk Temp 40
	10	34.2101, -118.1511	Date Taken 1/24/2010 10:34:20 AM Camera M3iModel Canon/Canon-PhaseDuo 011 Temperature 57 Wind Speed 0 Wind Humidity 72 Wind Dir 40 Wind Bulk Temp 40
	5	34.2101, -118.1511	Date Taken 1/24/2010 10:34:30 AM Camera M3iModel Canon/Canon-PhaseDuo 011 Temperature 57 Wind Speed 0 Wind Humidity 72 Wind Dir 40 Wind Bulk Temp 40
	10	34.2101, -118.1511	Date Taken 1/24/2010 10:35:00 AM Camera M3iModel Canon/Canon-PhaseDuo 011 Temperature 57 Wind Speed 0 Wind Humidity 72 Wind Dir 40 Wind Bulk Temp 40
	5	34.2101, -118.1511	Date Taken 1/24/2010 10:35:10 AM Camera M3iModel Canon/Canon-PhaseDuo 011 Temperature 57 Wind Speed 0 Wind Humidity 72 Wind Dir 40 Wind Bulk Temp 40
	10	34.2101, -118.1511	Date Taken 1/24/2010 10:35:20 AM Camera M3iModel Canon/Canon-PhaseDuo 011 Temperature 57 Wind Speed 0 Wind Humidity 72 Wind Dir 40 Wind Bulk Temp 40

30 % Opacity
PM < 3m @ 20%
PM 3-9m @ 35%
PM > 9m @ 45%
VOC Present

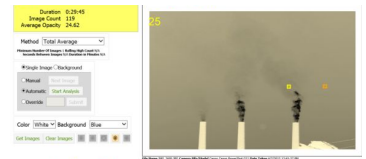
How DOCS III Works

- An image or images of the emission source are captured by a Certified Camera Operator, credential for the Neighborhood watch, 6th Grade Class
- The images are uploaded to the “Cloud” where they are acquired by a Certified Analyst who identifies the Regions of Interest Credential for High School Graduation
- DOCS II then applies algorithms to the Regions of Interest and calculates the opacity of each image and the average, based on the selected rule, e.g. 6 min. avg., 3 min. avg.
- Opacity calculated is then converted speciated PM
- DOCS II generates a VEE report with speciated PM
- Data Owner accepts/rejects the draft VEE report
- DOCS II generates final VEE report and archive record with Opacity and Speciated PM

Uses Light Scatter Filters to find Opacity and PM



Water



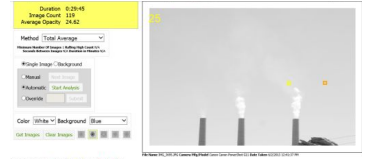
PM >9=45



PM 3-9=35



PM <3=20



Inexpensive, Simple, Fast, Reliable, Repeatable



Community Air Protection Program

- Uses Promulgated Nuisance Emission Measure Opacity as base
 - Enables Regulators with Actionable Information
 - Defines the Source and the PM emission.
 - Wide Area Scanning Line of Sight for 1 mile.
 - Scans Fence lines for Nuisance Emissions
 - Measures Distance to plume LiDAR embedded
 - Measures Temperature Plume
 - Day and Night
- Stationary Sources
 - Permitted with Opacity limits, require other compliance monitoring
 - Over 10,000 Stationary Sources monitored by DOCS
- Mobile Sources
 - Monitor for High Emitters at speed,
 - Vehicle Counts cars, trucks, trains, planes, ships
- Fugitive Area Sources
 - Larger sources farms and agriculture
 - Largest category of undocumented air pollution
 - Includes Wood Smoke and other unpermitted sources
- Natural Area Sources (spikes during event)
 - Great Dust Storm and Forest Fire Pictures
- Security and Surveillance Enabled
 - People/Animal detection
 - Automated perimeter search

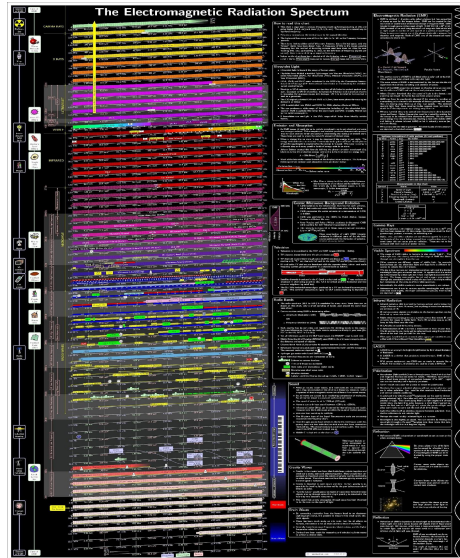


Opacity/PM/VOC

Cameras Document Light Scatter humans can not see

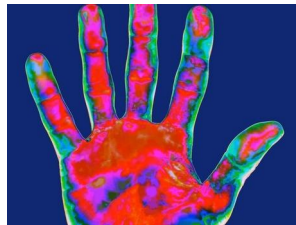
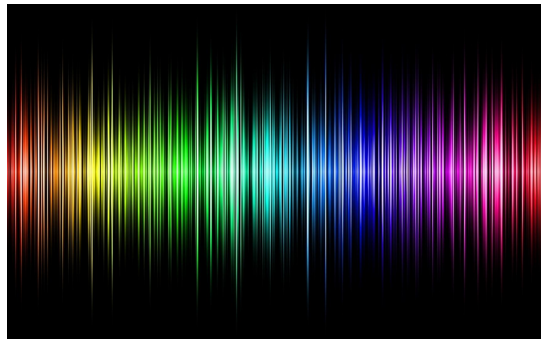


Energy/Intensity Level, humans can not feel

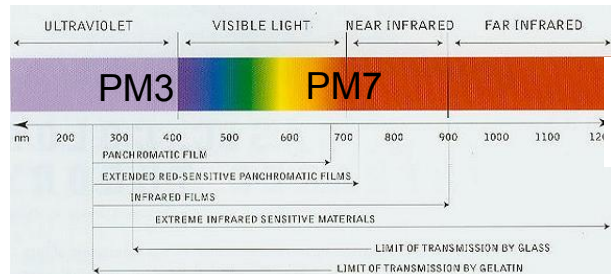


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VISIBLE EMISSION OBSERVATION FORM		Image	Height	Coordinates	Camera and Weather Information
Plant Name	Unit Name		10	30.000000, 110.000000	Camera: Wiggilshot Canon/Canon PowerShot G11 Wind Direction: 0 Wind Speed: 0 Temperature: 27 Humidity: 75 Wind Speed Range: 0-5
Plant Name	Unit Name		10	30.000000, 110.000000	Camera: Wiggilshot Canon/Canon PowerShot G11 Wind Direction: 0 Wind Speed: 0 Temperature: 27 Humidity: 75 Wind Speed Range: 0-5
Plant Name	Unit Name		10	30.000000, 110.000000	Camera: Wiggilshot Canon/Canon PowerShot G11 Wind Direction: 0 Wind Speed: 0 Temperature: 27 Humidity: 75 Wind Speed Range: 0-5
Plant Name	Unit Name		10	30.000000, 110.000000	Camera: Wiggilshot Canon/Canon PowerShot G11 Wind Direction: 0 Wind Speed: 0 Temperature: 27 Humidity: 75 Wind Speed Range: 0-5
Plant Name	Unit Name		10	30.000000, 110.000000	Camera: Wiggilshot Canon/Canon PowerShot G11 Wind Direction: 0 Wind Speed: 0 Temperature: 27 Humidity: 75 Wind Speed Range: 0-5
Plant Name	Unit Name		10	30.000000, 110.000000	Camera: Wiggilshot Canon/Canon PowerShot G11 Wind Direction: 0 Wind Speed: 0 Temperature: 27 Humidity: 75 Wind Speed Range: 0-5
Plant Name	Unit Name		10	30.000000, 110.000000	Camera: Wiggilshot Canon/Canon PowerShot G11 Wind Direction: 0 Wind Speed: 0 Temperature: 27 Humidity: 75 Wind Speed Range: 0-5
Plant Name	Unit Name		10	30.000000, 110.000000	Camera: Wiggilshot Canon/Canon PowerShot G11 Wind Direction: 0 Wind Speed: 0 Temperature: 27 Humidity: 75 Wind Speed Range: 0-5
Plant Name	Unit Name		10	30.000000, 110.000000	Camera: Wiggilshot Canon/Canon PowerShot G11 Wind Direction: 0 Wind Speed: 0 Temperature: 27 Humidity: 75 Wind Speed Range: 0-5
Plant Name	Unit Name		10	30.000000, 110.000000	Camera: Wiggilshot Canon/Canon PowerShot G11 Wind Direction: 0 Wind Speed: 0 Temperature: 27 Humidity: 75 Wind Speed Range: 0-5



Temperature delta's humans can not feel

Between Selected ROI's
 30 % Opacity
 PM < 3m @ 20%
 PM 3-9m @ 35%
 PM > 9m @ 45%
 VOC Present



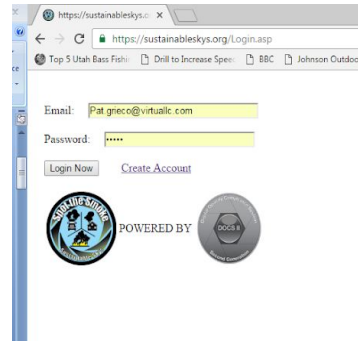
Spot the Smoke Air Quality Complaint System

People Complain About What They See and Smell, Nuisance Emissions

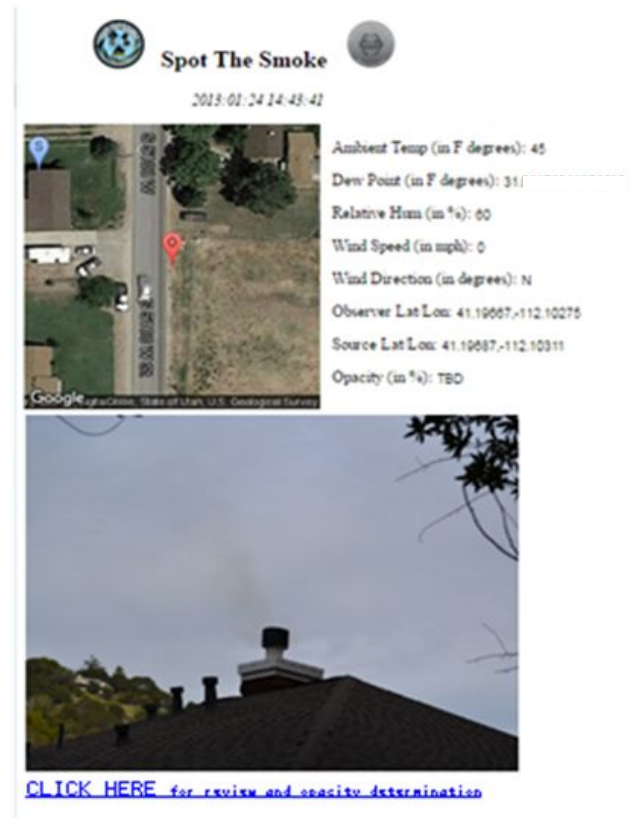
Load App



Log In or Create an Account



Submit to create a Draft Report
Submit Draft for Opacity Analysis
Receive Final Report



Take or Attach an Existing Picture



Touch the Screen to Indicate Where you are looking



Building Community Air Monitoring Infrastructure

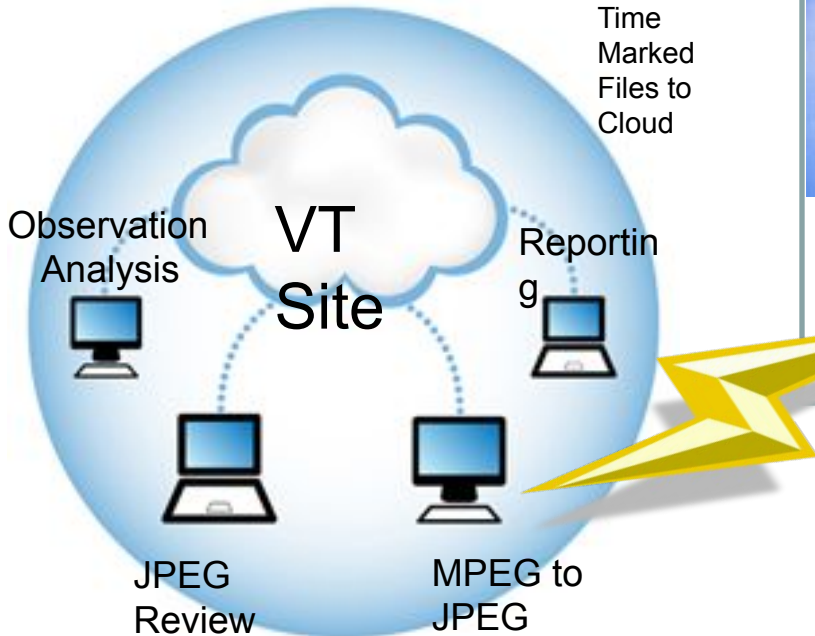




Flare Monitoring System with Opacity Event



Convert to JPEG every 15 seconds
During marked event times
and display for observation cut down



Time
Marked
Files to
Cloud

Flare Site
 Roof Mounted
 Intrinsic all weather
 Internet Protocol Cam

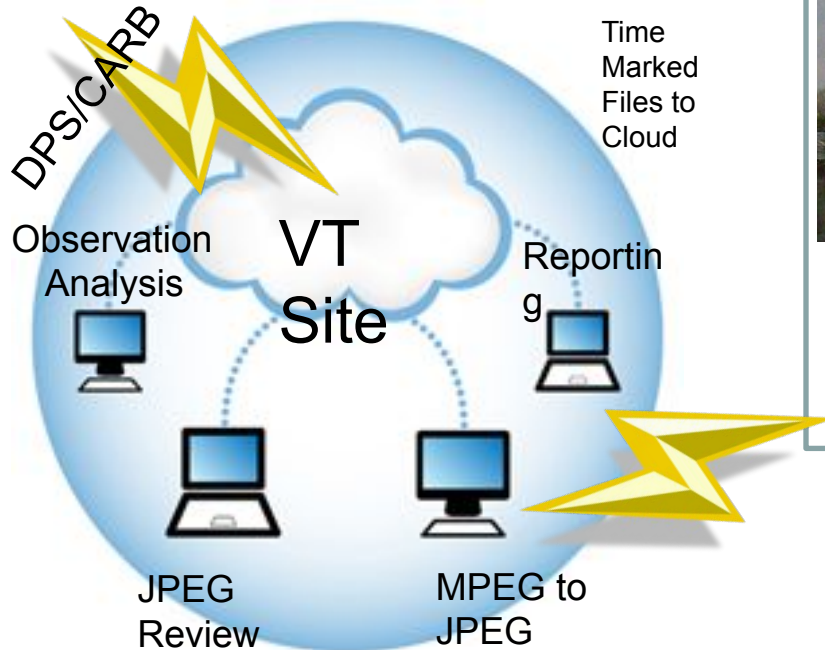
Local copy of MP4 "video files" mirrored
 high-capacity drives, Archived monthly
 Time marked by "Control Operators log"
 for events or detections against known
 backgrounds

Remote copy of MP4 "video files"
Control Operators log, Mark Event times.
Cuts MP4 into (1) JPG/15 seconds
Extracts JPG sets (Observations)
Runs screening on Observations
Marks observations JPG w opacity.
Generates Monthly and Semi Annual report.



Heavy Duty Vehicle Emissions Enforcement

Convert to JPEG every 15 seconds
During marked event times
and display for observation cut down



Enforcement Site

Local Mounted all Weather IP Cam



Local copy of MP4 "video files" mirrored high capacity drives, Archived monthly
Time marked by "Control Operators log" for events.



Remote copy of MPEG "video files"
 Plate/Transponder number tag to images.
 MP4 into JPG at set interval (reduce storage)
 Opacity Analysis on high image (smoke > 5%)
 Creates Violation Record (Image, Opacity, Plate/Trans)
 Transmits Violation record to ??? For enforcement
 Automated Enforcement Close out
 Generates monthly follow up report