An Alternative to EPA Method 9

AFRL

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Overview

- Current method
- Problems with current method
- Proposed Method
- Progress

Current Method

- EPA method 9 opacity measurement
- Smoke School
  - In-stack instruments / transmissometer
  - Recurring training
    - Visual estimation of opacity every 15 seconds
    - Training valid for six months
    - $350 per student / loss of man days & travel rqmts (105 man days at Hill AFB alone)

Current Method

- "Ringleman" Number
  - Calibration run
  - Observers must estimate the opacity
    - 25 Black; 25 White
    - Within +/-7.5% for an individual reading
    - Absolutely correct 26% of the time
    - Samples range from 0 to 100% at 5% increments

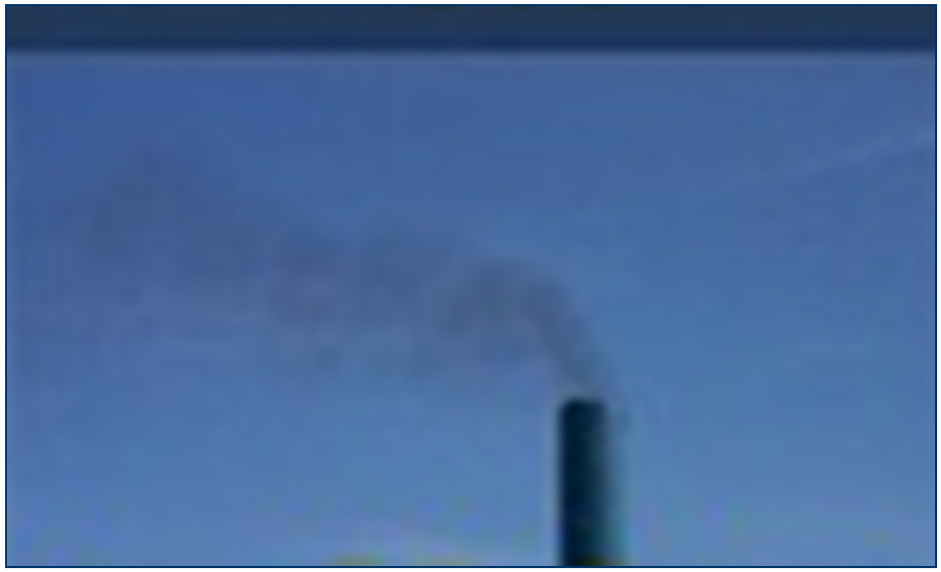
Problems with current method

- Smoke school is doing the best job possible with the current technology
- Not reproducible results
  - No Historical record
  - Expert testimonies needed
    - unsupported by technical documentation

Problems with current method

- Seems Subjective
  - Permitted values currently range from 20-30 %
  - Humans have difficulty differentiating between 15%; 20%; 25% etc.
  - Two experts can be correct when one says 20% the other says 30%
  - Fines based on estimates of opacity may range up to $10,000 per day

Problems with current method



Smoke reader A = 20%

B = 30%

Problems with current method

- Regulated at the lowest detection levels
  - No longer working with “black” emissions
  - Human is expected to differentiate between modestly gray and slightly grayer
  - Human is also expected to differentiate between steam and particulate emissions

Need for a change

- Technology has moved forward
  - Higher resolution devices available
  - Commercially available hardware
  - Scientific approach available

Proposed Method

- Digital technology
  - Near real time image processing
  - COTS cameras
  - Highly portable

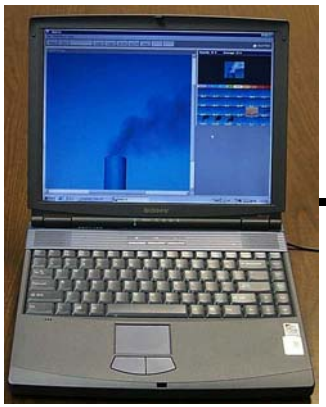
Proposed Method

- Objective Measurements
  - Permanent pictures
  - Reproducible results
  - Algorithm protects integrity of pictures

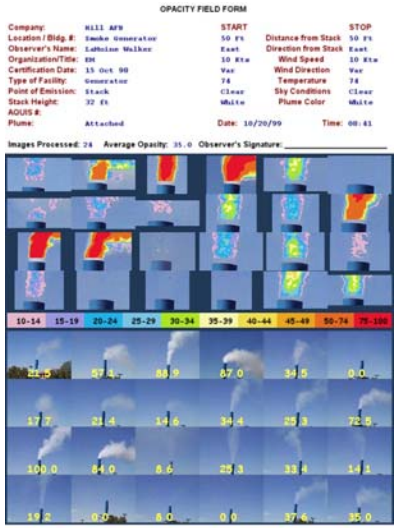
The Process

Dust Processing Displayed for Immediate Action

Photographs Taken Using Kodak DC265 Digital Camera



Commercial Computer Used to Processes Images With SCIENTECH Proprietary Software. Sofgtware Determines Opacity, Displays Results

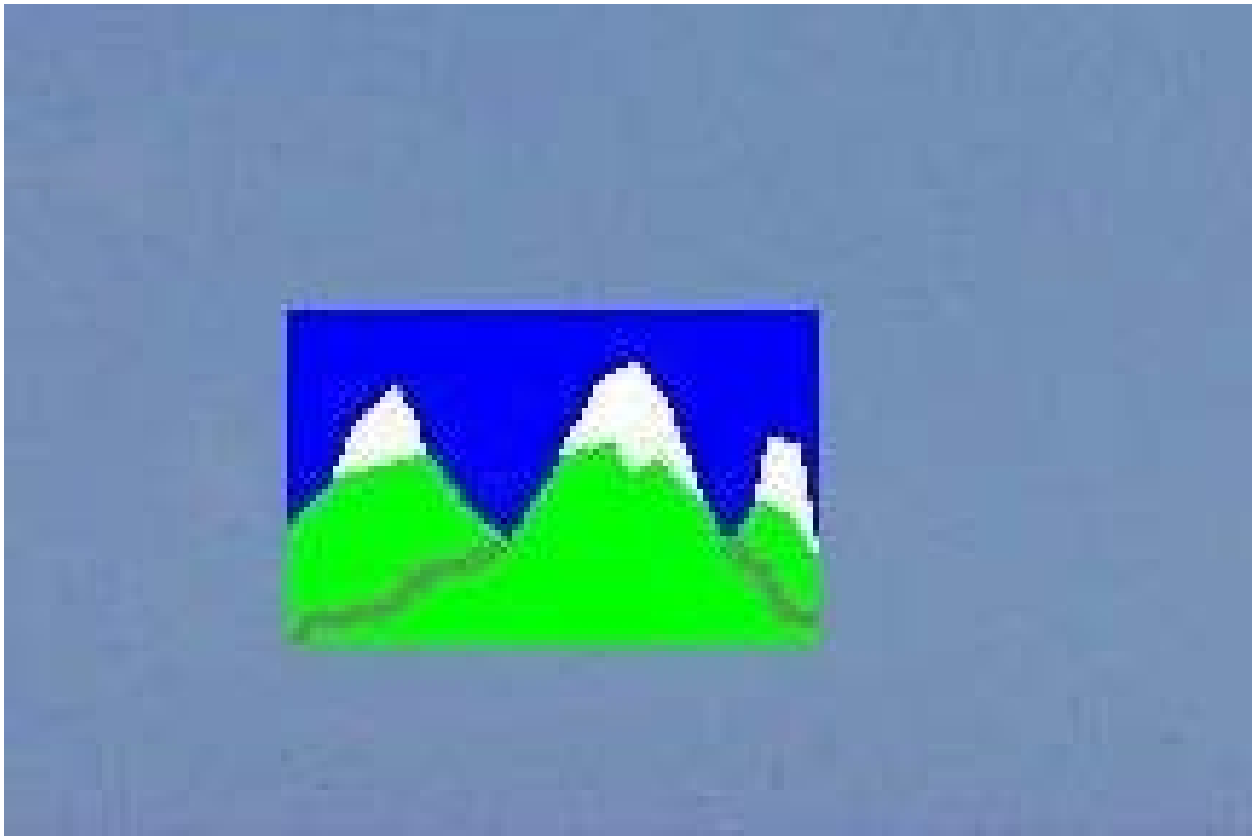


Method 9 Results Displayed, Can Be Printed, Stored on Disk

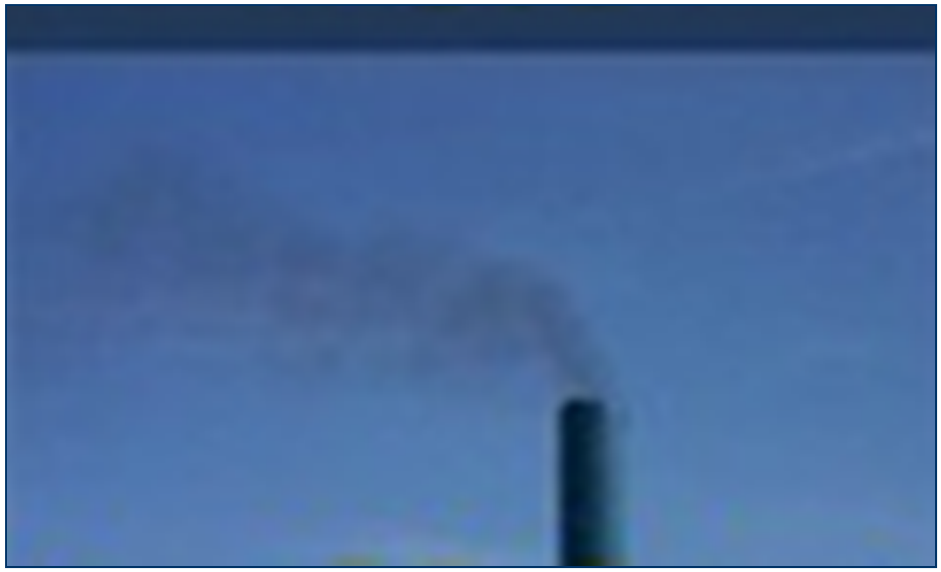
If computer is taken to the field site, Method 9 can be done in 10 min-- from set up to final report.

Proposed Method

Proposed Method



Problems with current method



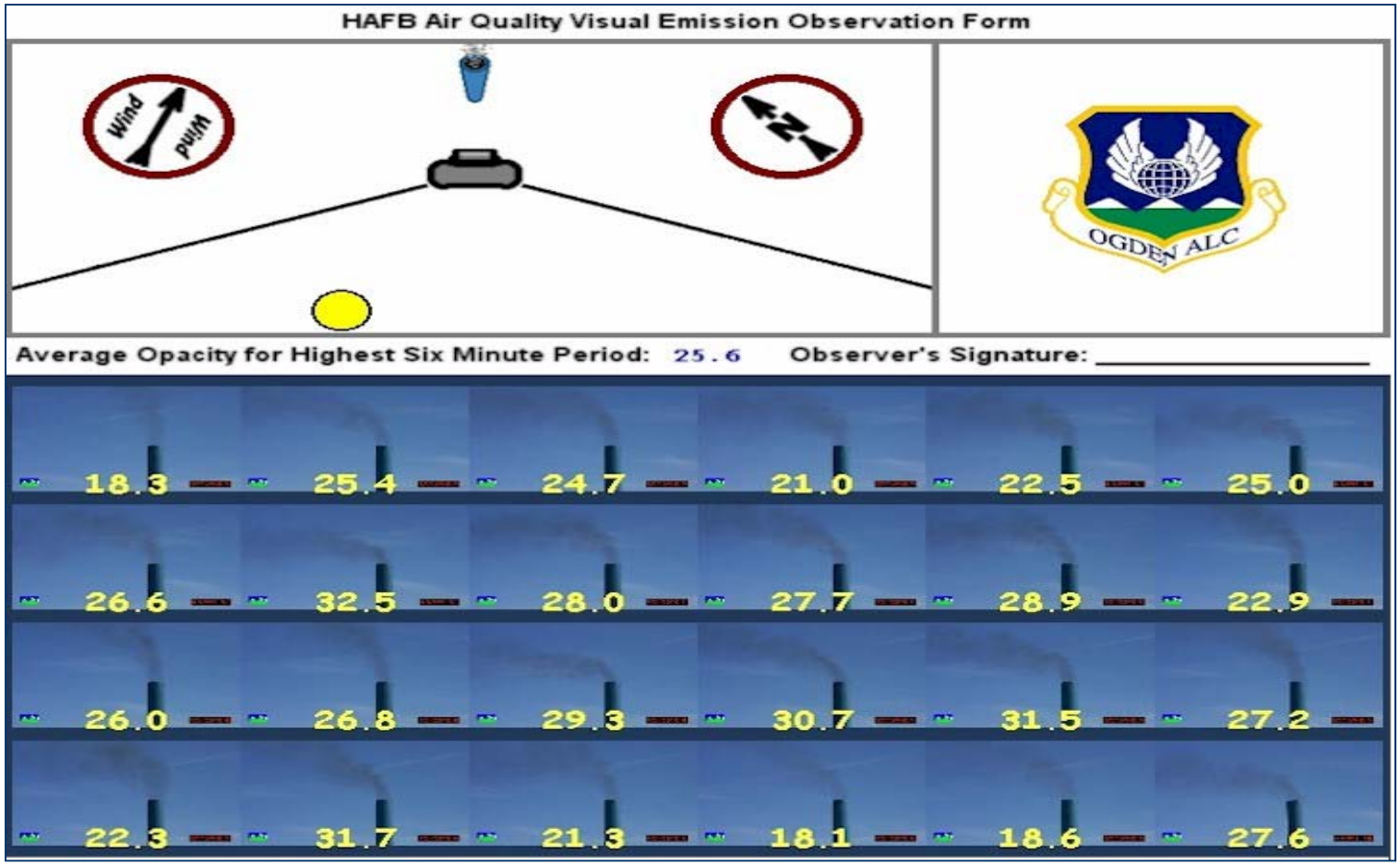
- Smoke reader A = 20%
  B = 30%

Problems with current method

- Both are correct
  - If the allowable opacity is 25% there is a problem
  - If the limit is 30% operations can continue
- What is it really by our method??

Proposed method

Proposed method



Proposed method

- Level of testing
  - 4 or 5 sites throughout the continental US
    - Pacific Northwest
    - High Desert
    - Southern US
    - Mid West
  - 3 Testings per year -- all seasons
  - 3 Days of testing per site

Potential Savings

- DoD currently spends 6.9 million dollars on annual smoke school training
- Return on investment ~ 3 years
- Avoid fines / maintain compliance
- Avoidable future litigation costs

Previous Investments

- Feasibility study, sponsored by SCIENTECH, providing 10K to Space Dynamics Lab
- Concept development and demonstration funded through NASA. 8 Month effort 80K
- Prototype development through AFRL 32.5K
- Hill AFB 44K camera validation

Statistical Summary of Utah Smoke School vs DOCS Evaluation

Smoke Color / Measurement Approach	Opacity Range	Average Percent Deviation	Number of Samples	99% Confidence Interval
Black – DOCS	0 – 100%	6.58	2357	6.1 – 7.0
Black - Observers	0 – 100%	7.45	280	6.0 – 8.8
White – DOCS	0 – 100%	10.08	2410	9.5 – 10.7
White - Observers	0 – 100%	8.55	282	7.1 – 10.0
Black – DOCS	0 – 60%	5.70	1972	5.3 – 6.1
Black - Observers	0 – 60%	5.82	225	4.5 – 7.1
White – DOCS	0 – 60%	6.7	1900	6.2 – 7.2
White - Observers	0 – 60%	8.17	224	6.6 – 9.8
Black – DOCS	0 – 40%	5.44	1759	5.0 - 5.9
Black - Observers	0 – 40%	4.77	194	3.5 – 6.1
White – DOCS	0 – 40%	5.90	1689	5.4 – 6.4
White - Observers	0 – 40%	7.39	199	5.7 – 9.0

Interim Results of Utah Measurements

<u>Method 9 requires 7.5% or less opacity deviation for certification</u>

Black Plumes (2357 plumes evaluated) - Passed

•Average DOCS opacity deviation of 6.58% vs 7.45% certified readers

White Plumes (2410 plumes evaluated) – Failed

•Average DOCS opacity deviation of 10.08% vs 8.55% for certified readers

White Plumes in 0 – 60% Opacity Range - Passed

•Average DOCS opacity deviation of 6.70% vs 8.17% for certified readers

DOCS Field Vehicle Alaska Trip – Near Healy AK

DOCS Field Crew – Pipeline Pump Station #7

Healy AK Coal Fired Power Plant

Williams Power Plant Near Fairbanks

Anchorage Municipal Sludge Incinerator

Conclusion

- Current method
- Problems with current method
- Proposed Method
- Progress

Bottom Line

- EPA -- Senior scientists endorsement
  - “Anticipate,with successful demonstration and validation of techniques, approval for national use”