Data Quality Issues with Detonation Product Monitoring

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Global Demilitarization Symposium
17 May 2007

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Monitoring OD Events

Advantages

- Simulation is unnecessary
- Sufficient atmospheric O_2 available for afterburning
- Issues of scale can be addressed
- Shrapnel interactions with surfaces is not an issue

Disadvantages

- Harsh sampling environment
  - Instrumentation often does not survive test event
- Substantial sample dilution
  - Dilution increases with time
- Inhomogeneous plume
- Mobile plume (sample)

Monitoring Contained Detonations

Advantages

- Better control of variables
- Produce stationary, homogeneous plume
- More time to collect sample
  - Lower detection limits
- Limited dilution volume
- Protection of sampling instrumentation

Disadvantages

- Limited energetic size
- Requires correction for leaks
- Shrapnel issues
  - Cased/uncased ordnance
  - Extraneous contributions from wall collisions
- Blank may not be representative

Sampling Approaches

Past Approaches

- Minimized assumptions about the sample
- Designed for sample constraints
  - Development intensive
  - Validation questionable

≤ 5 min sampling time

Current Approaches

- EPA validated methods
  - Standardized QA/QC
  - Methods validated for stack emissions may not be applicable to monitoring detonation products

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≥ 20 min sampling time

Comparison

Detonation Process	EPA Sampling Methodology
Instantaneous emission process – Chemistry is over in ms to s	Methods developed and tested on continuous emission sources – 20 min sampling period
Information desired is total quantities emitted	Generates an average of concentrations during the sampling interval

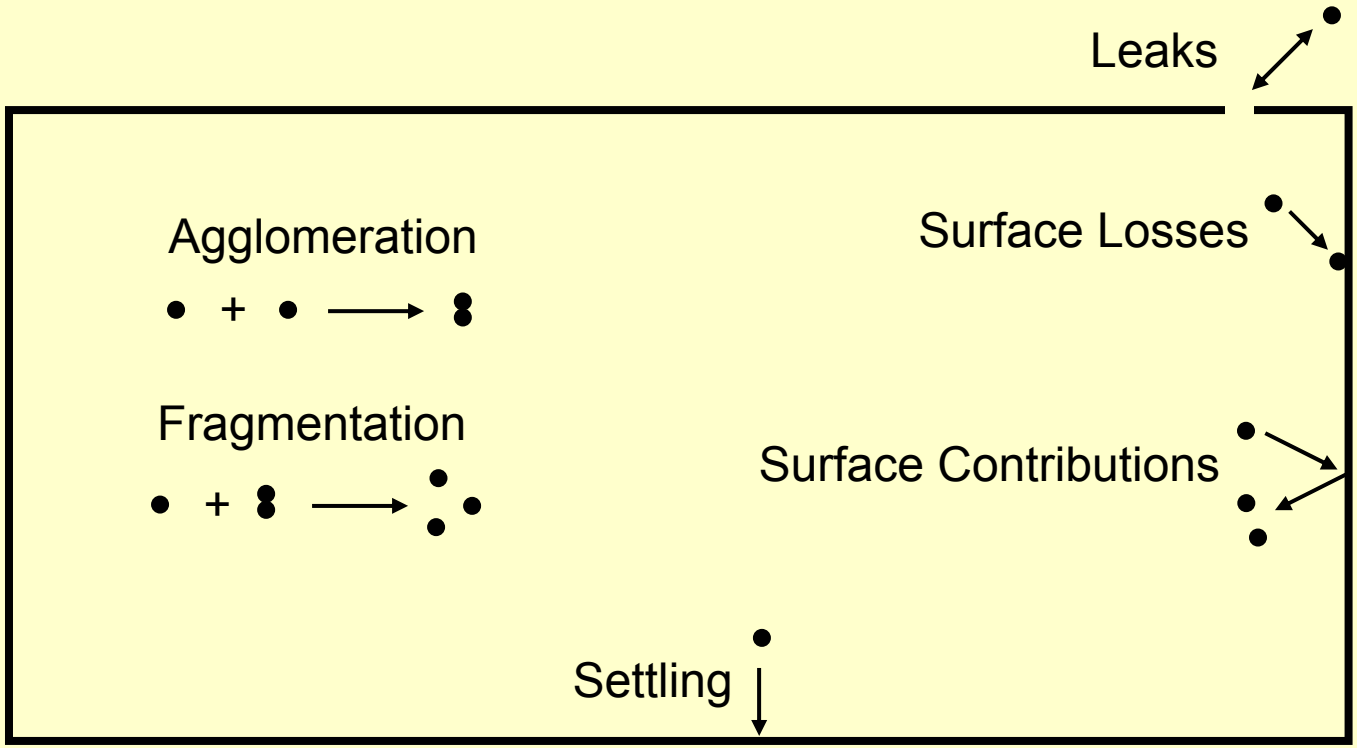
Assumptions Necessary for the Application of EPA Methodology to Contained OD Monitoring

- Static (unchanging) sample during the sampling interval
- Contained detonation process is representative of OD treatment event
  - Same Products
    - Scaleable
  - No extraneous contaminants

Static Sample Assumption

- Use particulates to illustrate the issues
  - Many other analytes of interest are affiliated with the particulates
- Atmospheric sampling requires analytes to remain suspended in the air.
  - If it is not in the chamber air we are not measuring it

Processes that Alter Atmospheric Particulate Distributions in Chamber Studies

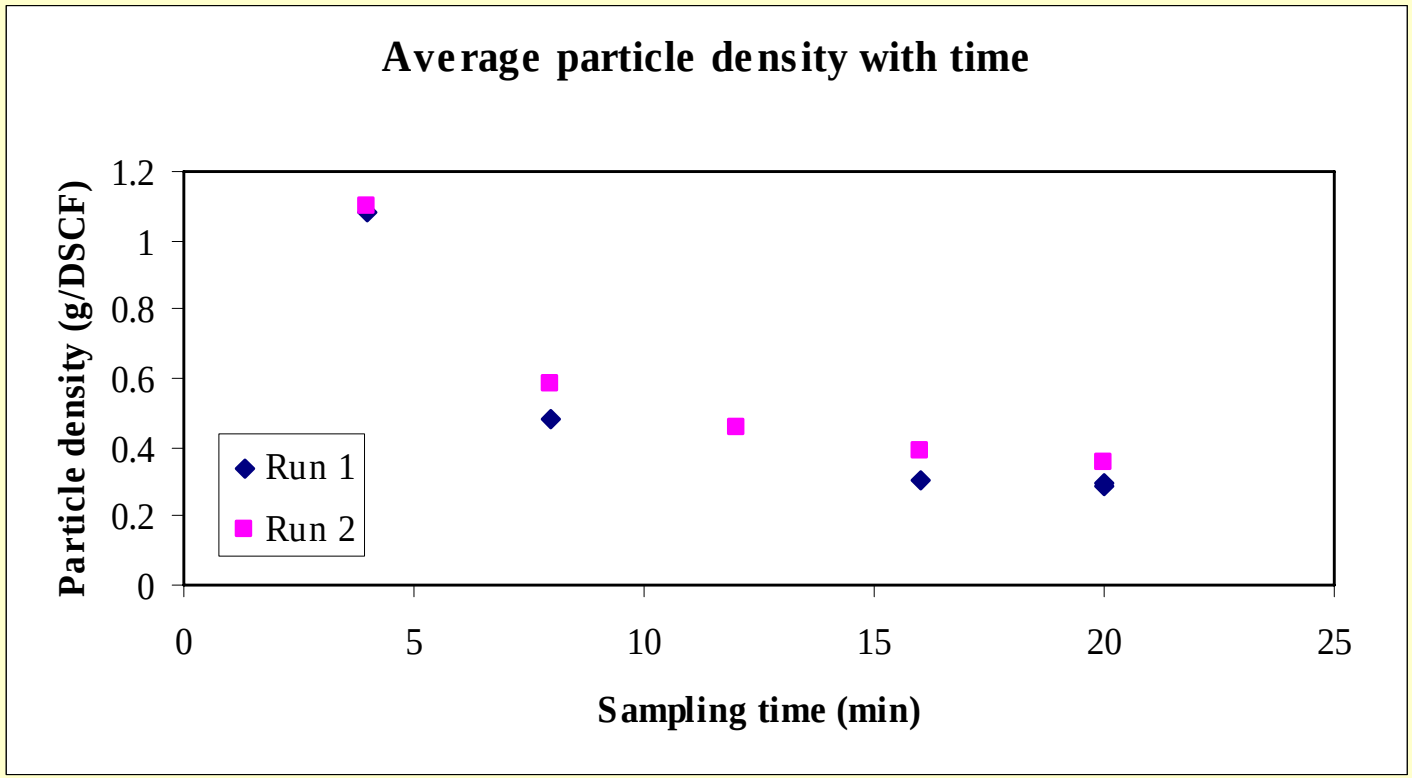


- Settling usually predominates in a static sample
- Other losses may predominate when stirred to minimize settling

Experimental Confirmation of Particle Losses

- Experiment designed to determine if the losses are significant
- Detonate cased ordnance in a contained chamber
- Wait 3 min for settling of large particulates
- Used a blower to stir the chamber air
- Measured TSP (total suspended particulates) for varying time periods
- Calculated and plotted average particle density over the sampling period
  - Total mass of particles collected on filter divided by the volume of air passed through the filter

Experimental Confirmation of Particle Losses



- Results: Average concentration of particulates at 20 min sampling period is roughly 1/3 of measured average at a 4 min sampling interval

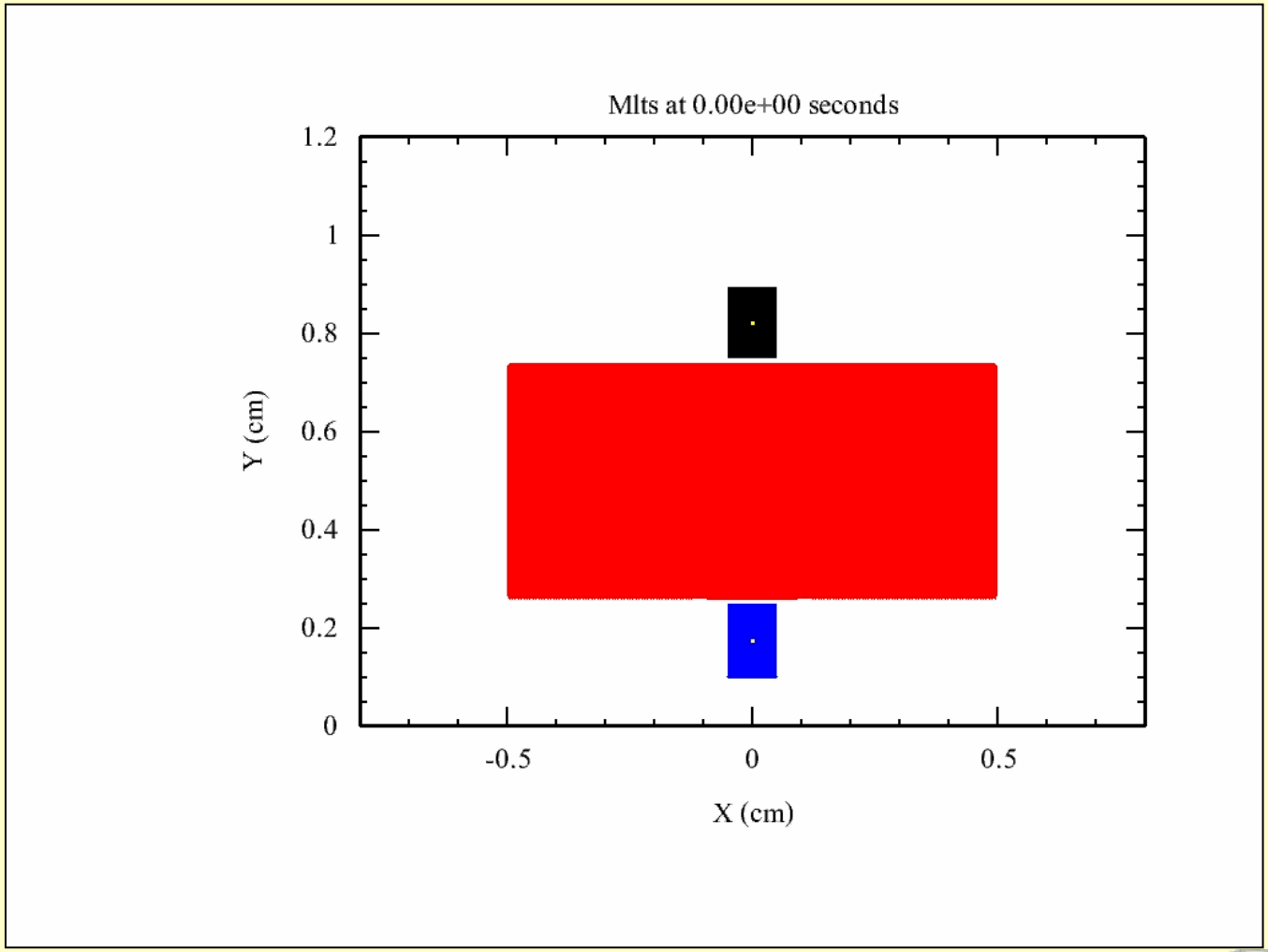
- Test needs to be rerun monitoring only $PM_{10}/PM_{2.5}$

NAVAIR

CD/OD Representative Assumption

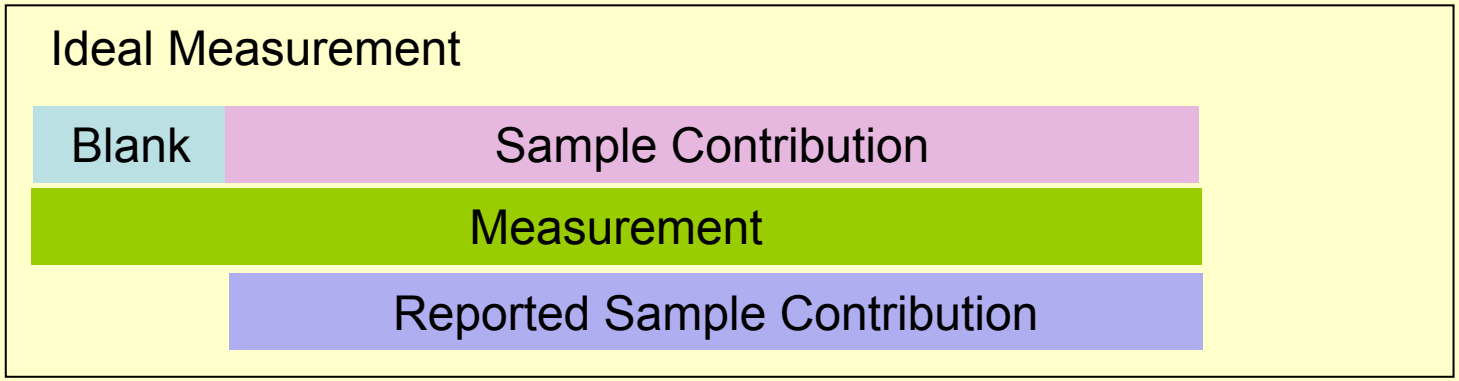
Phenomenon	**OD**	**CD**
Reaction scale effects	✔	-
Cased ordnance	✔	-
Entrained soil	✔	-
Wall effects: adsorption, catalysis, and thermal retention	-	✔
Multibodied collisions (needed for reformation products, i.e. PAH, PCB)	Very Low	Higher
Chamber surface contributions	-	✔

Wall Effects Involving Shrapnel



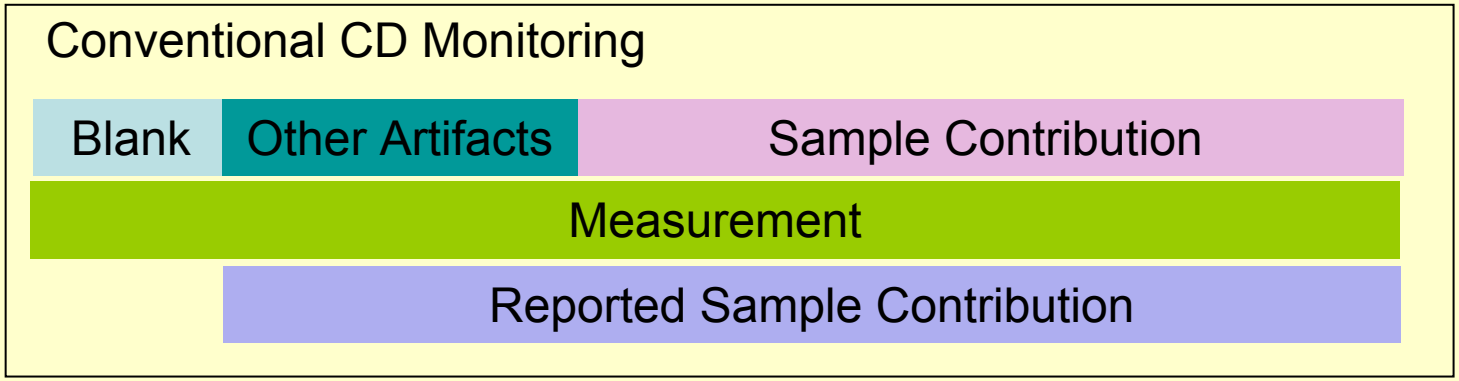
Observed Impact Sites
Brass on Steel Walls

Artifact Elimination



- Blanks are used to eliminate contributions in the sampled matrix that are not present as a result of the tested item.

Contained Detonation Blanks



- The conventional approach to collecting blanks is to pass an equivalent volume of air through the trapping media without detonating ordnance
  - These samples do not include materials knocked from surfaces by the detonation shock wave
  - Additional material knocked from surfaces as a result of shrapnel collisions are also not included in these blanks
- The result is an overestimate of emissions

Conclusions

- Underlying assumptions for EPA sampling methodology to monitor contained detonations are not necessarily applicable to OD emissions monitoring
  - The static sample assumption results in an *under-estimate* of emissions
  - Most causes for failure of the CD assumption result in an *over-estimate* of emissions

What Now?

- Continue to ignore these issues
- Apply a “fudge factor” to current data
- Regenerate all emission factor data with better, relevant sampling methods
- Modify all current and future monitoring efforts to accurately quantify OD emissions
  - Shorter sampling times with similar detection capabilities
    - Validation is needed for shorter sample time technologies to demonstrate data quality
  - Approaches need to be developed to compensate for errors caused by the assumption that CD is representative of OD