SOF/DIAL Inter-comparison Project Proposal

TERC Science Advisory Committee Meeting
October 23, 2007
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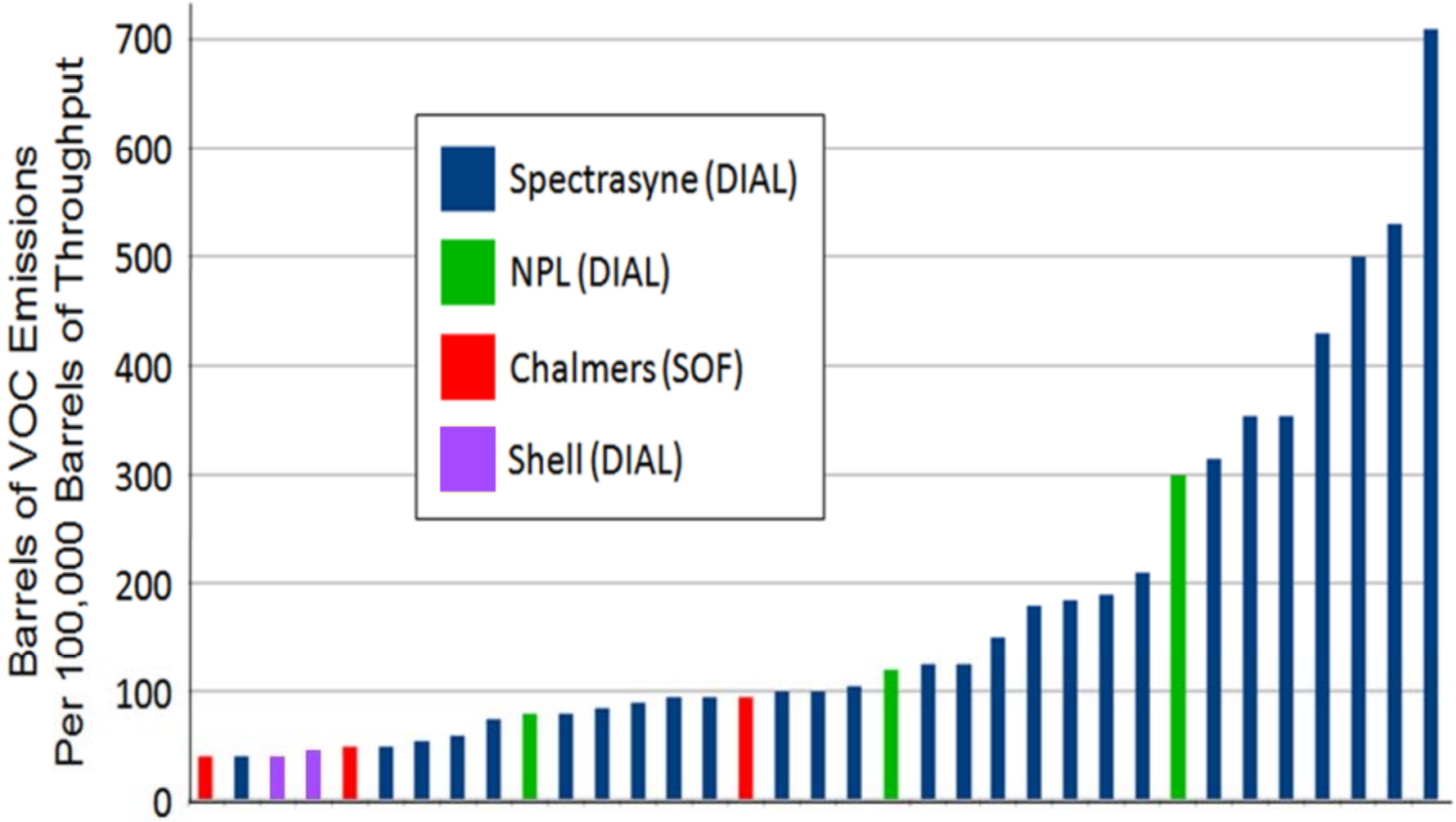
$250K

35 Refinery Measurement Surveys Since 1988



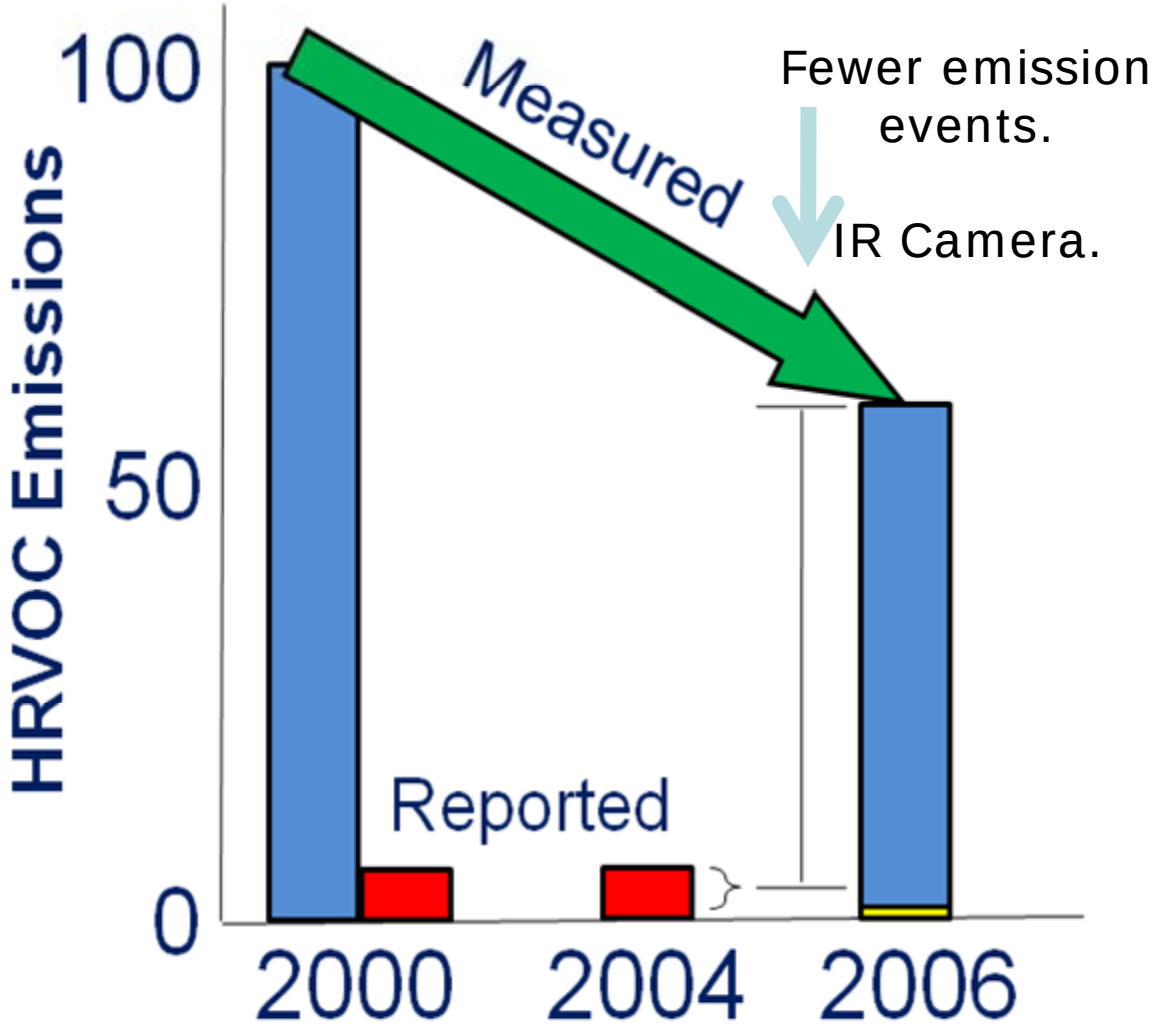
Each bar represents the overall VOC emissions measurements at a refinery.
Each refinery measurement survey typically takes two weeks to complete.

Annual Emissions for Refineries OK? CONCAWE: "No." Shell Sweden Refinery

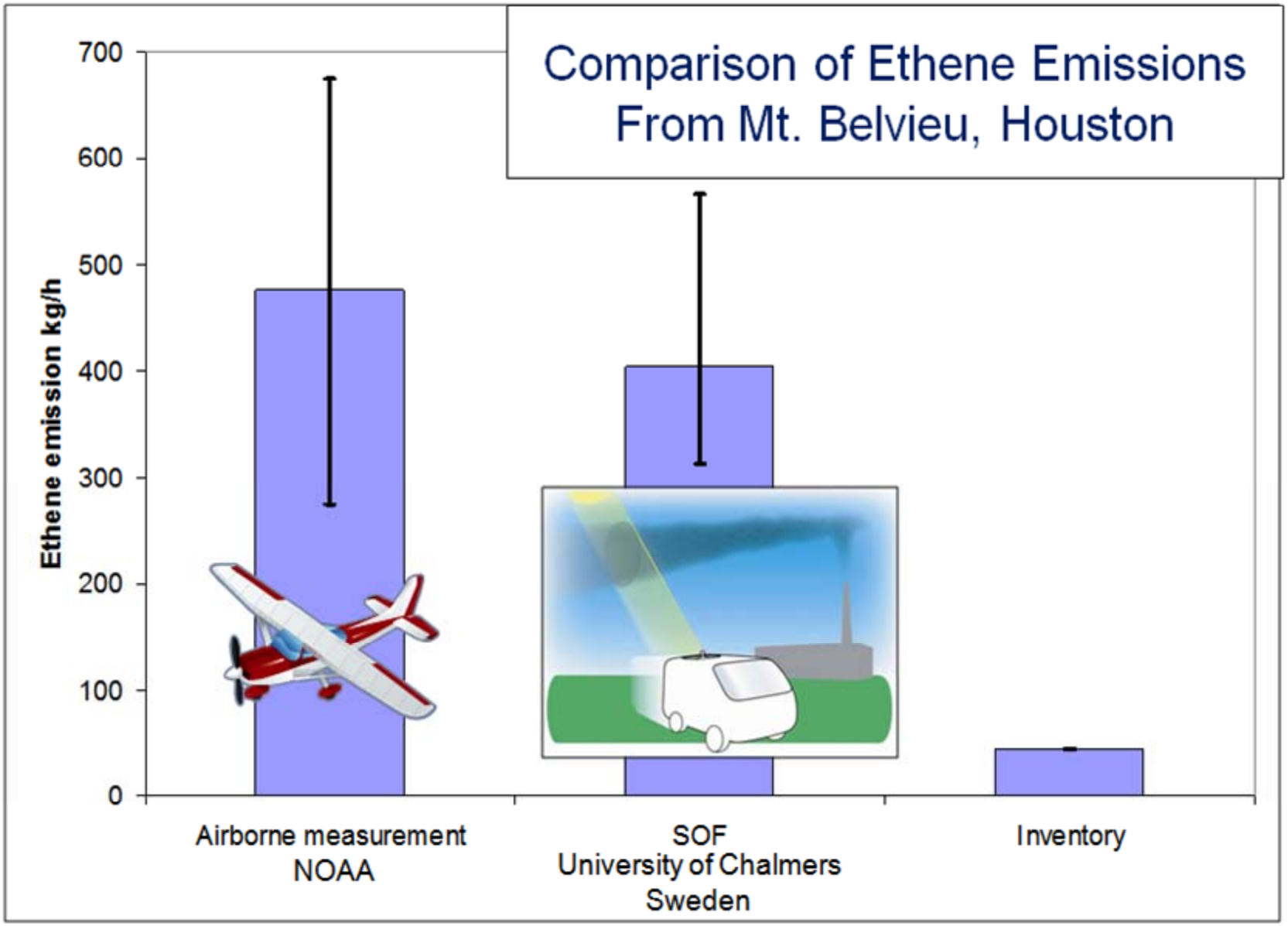
TexAQS 2006 Rapid Science Synthesis

1. HRVOC (ethene) Emissions dropped 40% between 2000 and 2006.

2. In 2006 HRVOCs were still 10-50 times higher than reported in 2004.



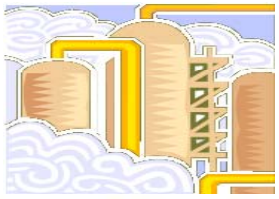
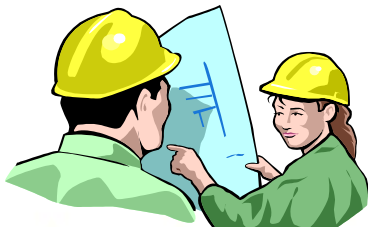
TexAQS 2006 – Aircraft & SOF



Underestimated Emissions Inventories

The estimating techniques used by chemical engineers to calculate and report VOC emissions from refineries and chemical plants are off by more than an order of magnitude and have been that way for more than 20 years.



Presented to the Houston Area American Institute of Chemical Engineers, Greater Houston Partnership's Clean Air Committee, the 101st AWMA Conference in Portland, the Texas Senate Natural Resources Committee and many others.

What is at Stake?

This issue is bigger than Houston, bigger than Texas…

1. Point Source EI's as a Basis for Policy
2. BACT/MACT Credibility How can you know what the best VOC control strategies are if your emissions inventories are off by a factor of 10 for over 20 years?
3. Permits & Control Strategies for…
   a. Ozone
   b. Air Toxics
   c. Greenhouse Gases
4. Cap and Trade Programs

I.E., billions of dollars all over the world.

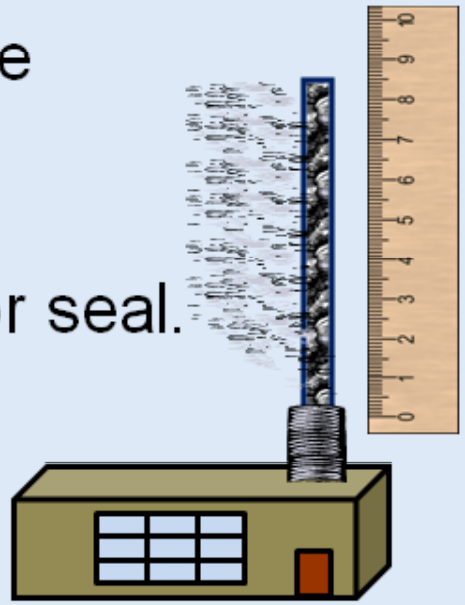
2-D Measurements Are Required

Inspection, Testing and Maintenance
- Was it done? Was it done right?

Equipment Failure
- A crack or hole in a pipe, vessel or seal.

Operator Error
- A bleeder valve left open.

Model defaults don't reflect Reality
- Vapor pressure on crude tanks often inaccurate.



These are the fatal flaws of emission factors.

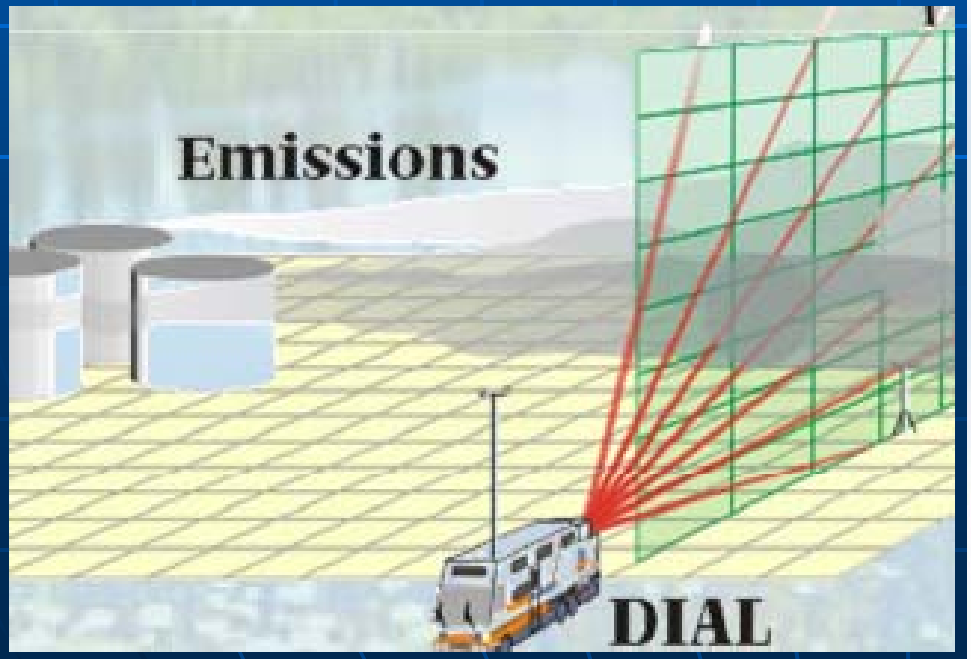
Measurements are the only way to know if you are off by a factor of 10 in your estimates.

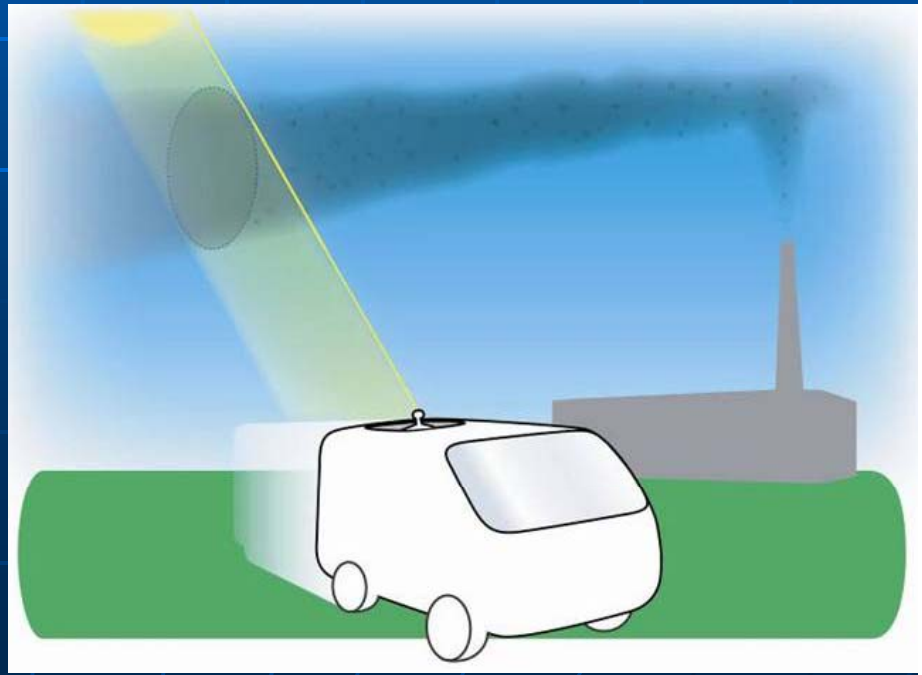
Measuring will save some and lose some money.

If the Greenest Refineries Go Bankrupt, We All Lose.

Inter-comparison of Solar Occultation Flux (SOF) and Differential Absorption LIDAR (DIAL) for VOC measurements

Johan Mellvist, Chalmers
Bernhard Rappengluck, UH





Why

- Measurements, (specifically by SOF for Houston) indicate that the emission inventories are underreporting VOCs by a factor 5-20.
- There are today two main techniques (SOF and DIAL) for conducting full surveys of VOC emissions from industrial facilities
- The SOF and DIAL techniques have not been intercompared. There is also a need for further validations and more documentation of both techniques (QA-QC, reviewed papers) .
- To better understand the pros and cons of the techniques there is a need for an outside review of the techniques. The best way to achieve this is by an instrument inter-comparison.
- This project will provide better insight into the DIAL and SOF techniques to outsiders and make it easier to judge the reliability of the measurements, of use when planning measurements strategies

Experience

- SOF (Chalmers/FluxSense) 40 individual surveys since 1998
- DIAL (National Physics laboratory, Shell global solution and Spectrasyne). More than 100 individual surveys since 1989

Validation conducted so far

- DIAL
  - Downwind measurements of a know emission source of methane,
  - Comparison to VOC emission from a petrochemical plant, obtained by standard point sampling and dispersion-modeling
  - DIAL concentration measurement compared against absorption tube samplers and in a long absorption tube

- SOF
  - Tracer releases of SF6 from tanks
  - Controlled releases of VOCs from tanks and pipes
  - Comparions to two other techniques (tracer gas, and FID)
  - Comparison to airborne measurements

JM1

Slide 11

JM1 for instance whether the standard point sampling measures the emissions correctly and The validation experiments have not been published to our knowledge so it is difficult to judge the representativemness of this work from the outside,
. whether the methane measurements is representative for measurements in a complex areas such as a refinery.
Hence, there is definitely a need of more validation excercises, in real measurement situations, and ideally various methods should be compared against each others both for real industries but also in controlled gas releases.
Johan Mellqvist, 10/22/2008

Quasi-comparison

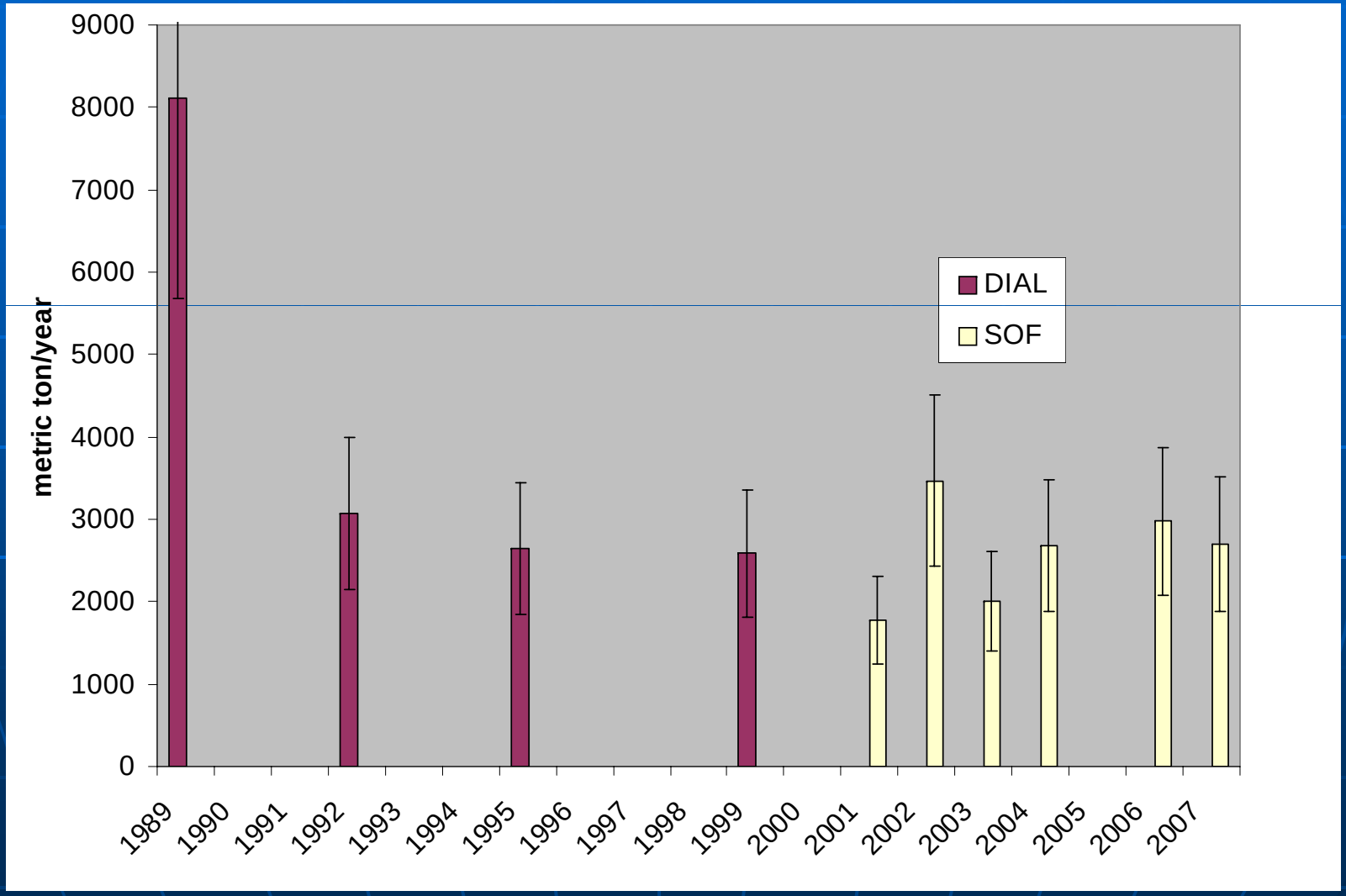
- DIAL and SOF have been applied at three Swedish light oil refineries, although not at the same year. It appears that the techniques yield similar results within at least 50% for alkanes.
- The techniques have also been applied at 2 heavy oil refineries. Here the DIAL, operated by Spectrasyne, measured higher values for the same sources, such as crude oil tanks and bitumen pipes. The SOF values were supported by two other techniques .

JM2

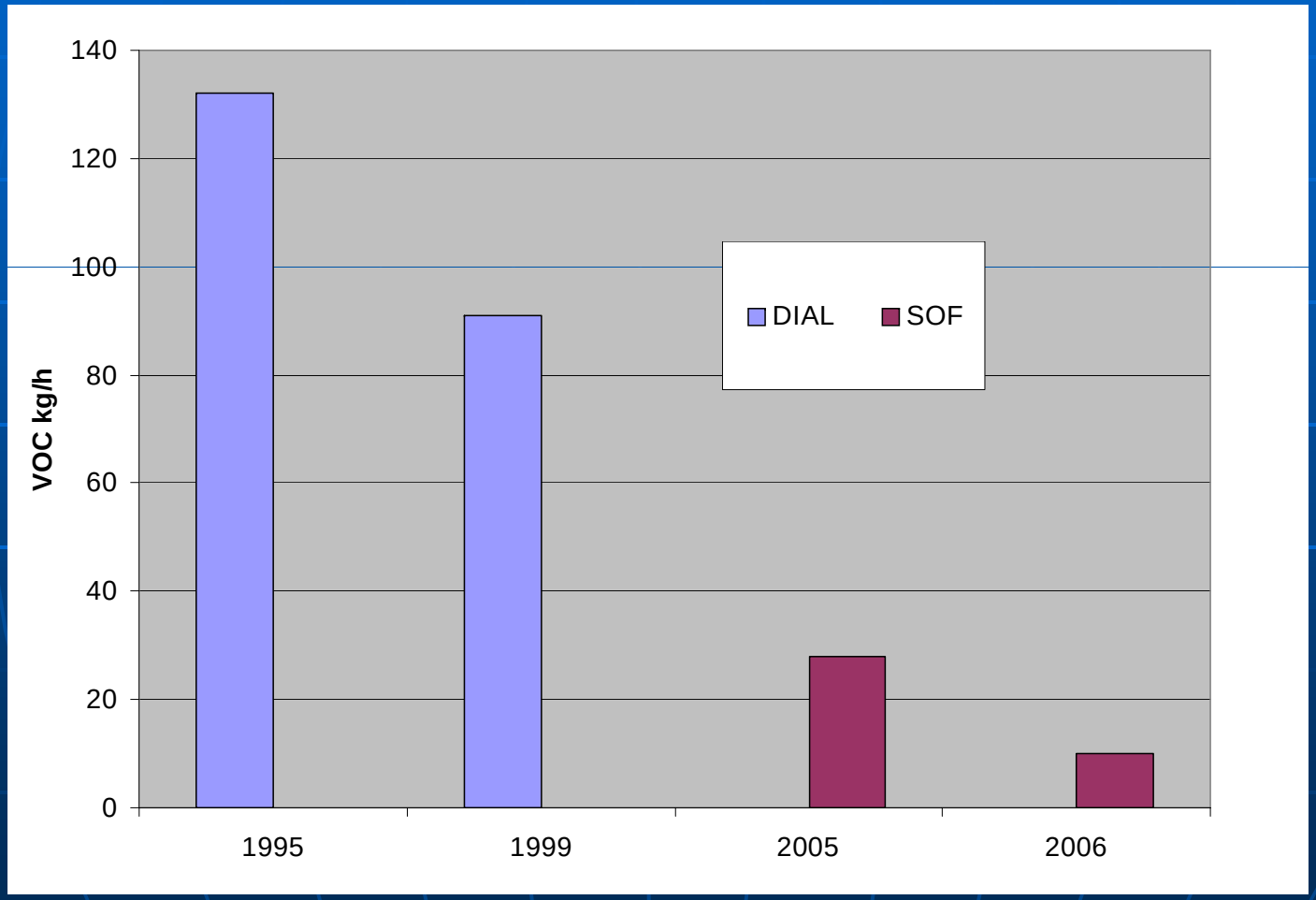
Slide 12

JM2 for instance whether the standard point sampling measures the emissions correctly and whether the methane measurements is representative for measurements in a complex areas such as a refinery.
Hence, there is definitely a need of more validation excercises, in real measurement situations, and ideally various methods should be compared against each others both for real industries but also in controlled gas releases.
Johan Mellqvist, 10/22/2008

VOC emissions measured by DIAL and SOF from refinery A with 5 Mton throughput (i.e. emissions corresponds to ~0.05% of throughput)



VOC emissions measured by DIAL and SOF from a heavy oil refinery in Sweden



Project

- SOF measurements will be conducted at the same time as DIAL for a period of 4-6 weeks at a facility in the Houston area
- Tracer releases will be used to test/demonstrate the ability of SOF vs. DIAL to quantify VOCs.
- An IR Camera (City of Houston) will be used in conjunction with the SOF measurements. Identify and report on any significant findings, either detection or non-detection of VOCs when the instruments are used simultaneously.
- A detailed QA QC protocol will be developed for SOF that meets EPA requirements.
- An extensive review of the two technologies and a comparison of the results will be conducted by an independent PI.
- Budget 250 k$ (measurement 225 k$ 25k$ review)
- In addition, yet not mentioned, we also want to add a tracer FTIR method (TCT), within the same budget and canister sampling for detailed speciation during part of the measurements

Parameters to compare

	DIAL	SOF
Sensitivity/precision		
Specificivity		
Overview		
Uncertainty		
Plume height information		
Cost		

Additional measurements by mobile FTIR and tracer gas (The time correlation tracer (TCT) method) performed from the SOF vehicle.