

*Texas Commission on  
Environmental Quality  
(TCEQ)  
Differential Absorbption Lidar  
(DIAL) Project*

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*Summer 2007  
Texas City, Texas*





## *Project Objective*

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- Compare DIAL measurements with emissions calculated using traditional EPA emission factors and calculation techniques for sources that are difficult to measure (DTM)
- Improve emissions inventory (EI) data
- Not a compliance project
- Not an EI comparison project



## *Project Status*

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- The final report has been submitted to EPA Region 6



## *Site Cooperation*

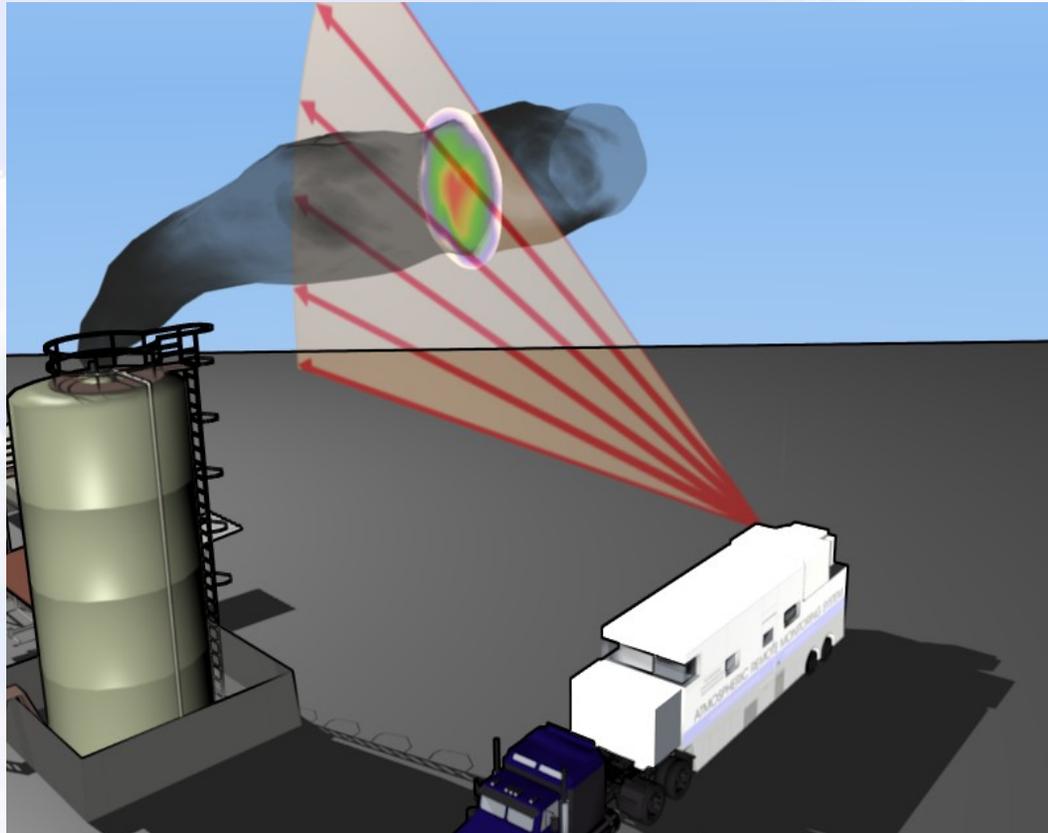
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- Cooperation from BP Texas City and Oil Tanking during this project was considerable
- Good site access for DIAL measurements
- Adequate process data for most sources
- Company LDAR staff support



# *DIAL Schematic*

- Vertical scans enable plume mapping
- Flux calculations from combining integrated concentration with simple wind field to determine wind mass (flux)
- Remote source measurement





## *DIAL Limitations*

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- Lack of official established validation protocols
  - EPA is attempting to develop best practice guidance for DIAL measurements
- Dependent on accurate wind measurements
- Complicated equipment and data analysis
  - Expensive
  - Limited equipment and contractors



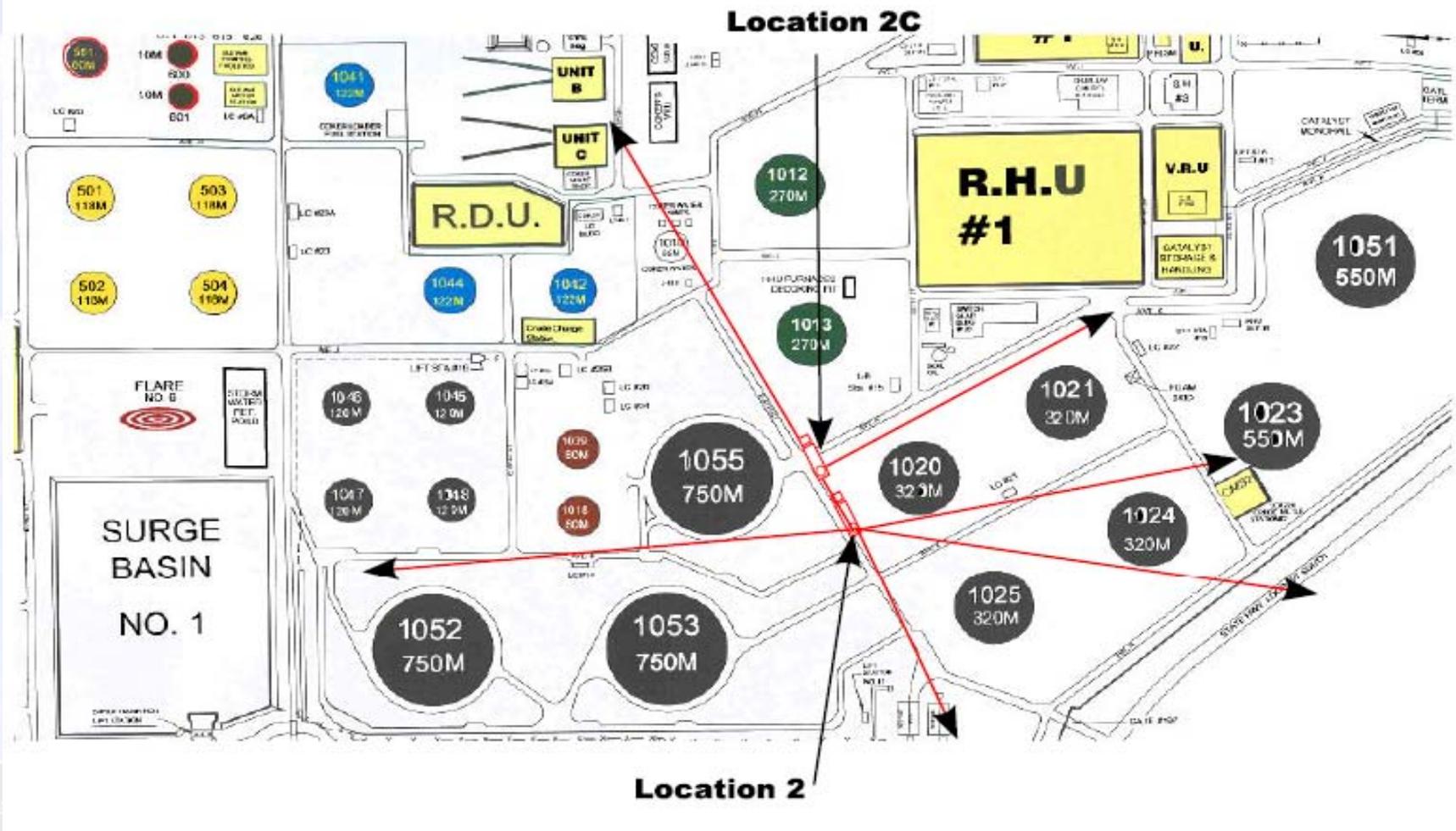
## *Crude Storage Tanks Observations*

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- Strong VOC odors were present when the infrared (IR) camera team was on top of the crude tanks
- Hydrocarbon vapors were seen by the IR camera coming from the rim seals of some of the crude tanks
- Potential upwind impact from wastewater area
  - Due south of the crude tanks



# DIAL Location for Crude Tanks Measurements





## *Crude Tanks Information*

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- Emissions measurements with DIAL were more than 5 times the hourly tank emissions estimated using AP-42 emission factors
- Possible explanations for discrepancy
  - Entrained gas vapor in the crude oil
    - Propane, butane, etc.
  - Single crude oil parameter default in TANKS program of Reid Vapor Pressure (RVP) 5
  - Crude oil reduction factor of 0.40 in TANKS program



## *Finished Gasoline Storage Tanks Observations*

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- No VOC odors were present when the IR camera team was on top of the gasoline tanks
- Very small amounts of hydrocarbon vapor were seen by IR camera coming from the rim seals of the gasoline tanks
- DIAL measurements at the gasoline tank area were impacted by emissions from ground flare
- Ambient temperature was very hot (around 100 degrees F) during DIAL measurements





## *Finished Gasoline Tanks 501 - 504*

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DIAL measurements (5.28 lb/hr) were approximately the same as emissions estimated using AP-42 emission factors (6.82 lb/hr)



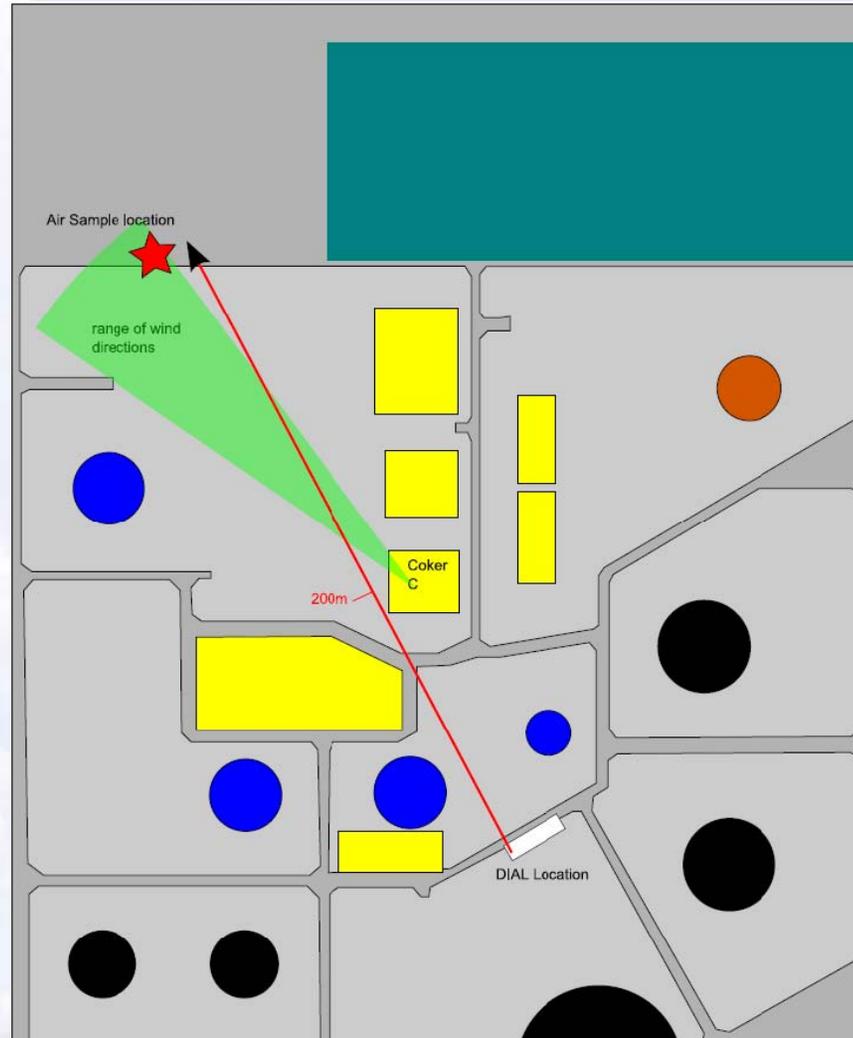
## *Coker Information*

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- Coker Design
  - 4 product cuts with overhead vapor sent to a **vapor recovery unit (VRU) or into the refinery fuel gas system**
- Coker furnace heats coker feed to 920° F
- The coker was on a 20 hour cycle
- The coker is a refinery process unit with expected fugitive VOC emissions



# *DIAL Location During Coker Benzene Measurements*





## *Coker Benzene Measurements*

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- DIAL benzene measurements
  - Measured during last six hours of the coking cycle including the decoking process
- DIAL measurements were at or **below** detection limits for benzene during most of the coking cycle
- Air samples were taken downwind of the coker during the decoking process
  - Tube measurements 1.33 ppb
  - Canister measurements <2.0 ppb



## *Coker Benzene Measurements cont.*

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- DIAL measured 1.5 to 2.1 lbs/hr of benzene emissions during the **decoking** process
- No background benzene emissions detected by DIAL
- The coker unit measured in the Alberta DIAL study was **not** vented to an abatement device and resulted in high VOC and benzene measurements
- All cokers in Texas are controlled by an abatement device



# FLARES

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- DIAL measured emissions from two flares
- The temporary flare
  - The steam assisted temporary flare was burning a byproduct hydrogen/VOC stream normally sent to a unit that was in turnaround status
- The steam assisted ultra cracker (ULC) flare
  - Recently built emergency/process flare
- Both flares are in highly reactive VOC (HRVOC) service and by TCEQ rule are equipped with flow monitors and HRVOC speciation equipment



## *Temporary Flare Observations*

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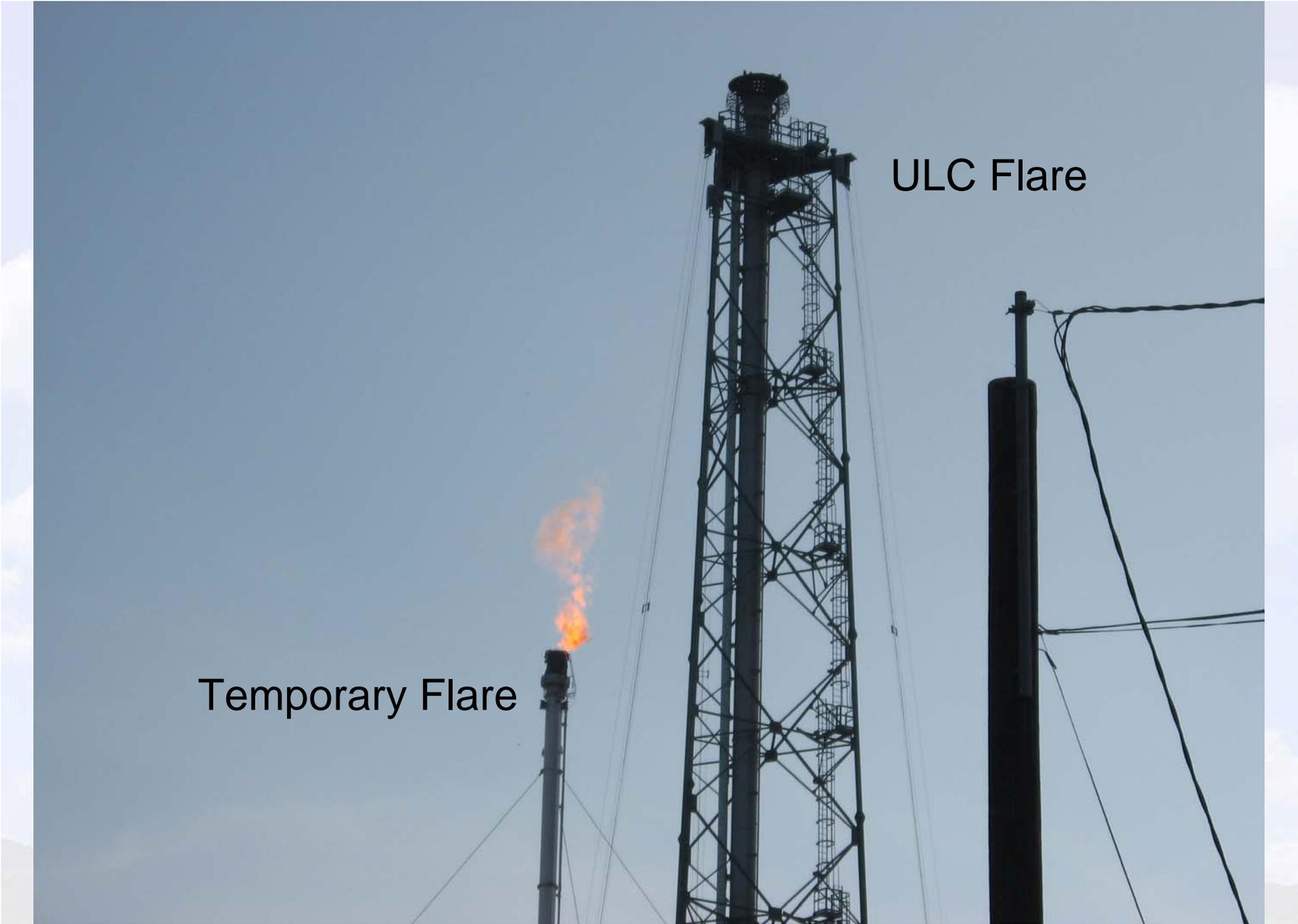
- A large flame was visible in the daylight during the measurement period
- A high volume of 80% hydrogen waste gas was going to the flare



## *Temporary Flare DIAL Measurements*

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- Emissions measured downwind of the temporary flare on August 11
  - 1 to 15 lbs/hr when measured by DIAL



ULC Flare

Temporary Flare



## *ULC Flare Observations*

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- Large emergency flare handling routine process gases
- No visible flame from the flare in daylight
- A small flame was visible at night
- The BTU value and velocity were within the requirements of 40 Code of Federal Regulations Part 60.18 (40 CFR 60.18)



## *ULC Flare DIAL Measurements*

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- DIAL measured high VOC emissions from the ULC flare on August 11
- DIAL measured 88 to 326 lbs/hr
  - Inferred measurement made by subtracting out isolated emissions from the temp flare
  - The ULC flare could not be isolated during the measurements on August 11



## *Wastewater Treatment Area*

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- DIAL measurements on August 2
  - Limited DIAL scans of wastewater area
- Downwind of wastewater area secondary and tertiary effluent treatment facilities
  - Average DIAL emissions rate 30 lbs/hr
- Downwind of oil/water separator
  - Average DIAL emissions rate 7 lbs/hr
  - No hydrocarbon vapor seen by the IR camera in the separator areas



# *DIAL Technology Validation Techniques*

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DIAL measurements closely agreed with:

- Canister and tube samples
- Ultraviolet differential optical absorption spectroscopy (UV-DOAS) measurements
- Inline gas calibration cells provided by the refinery for propane, pentane, and benzene
  - Benzene
    - Actual 1000 ppm
    - DIAL prediction  $900 \pm 70$  ppm



# Project Conclusions

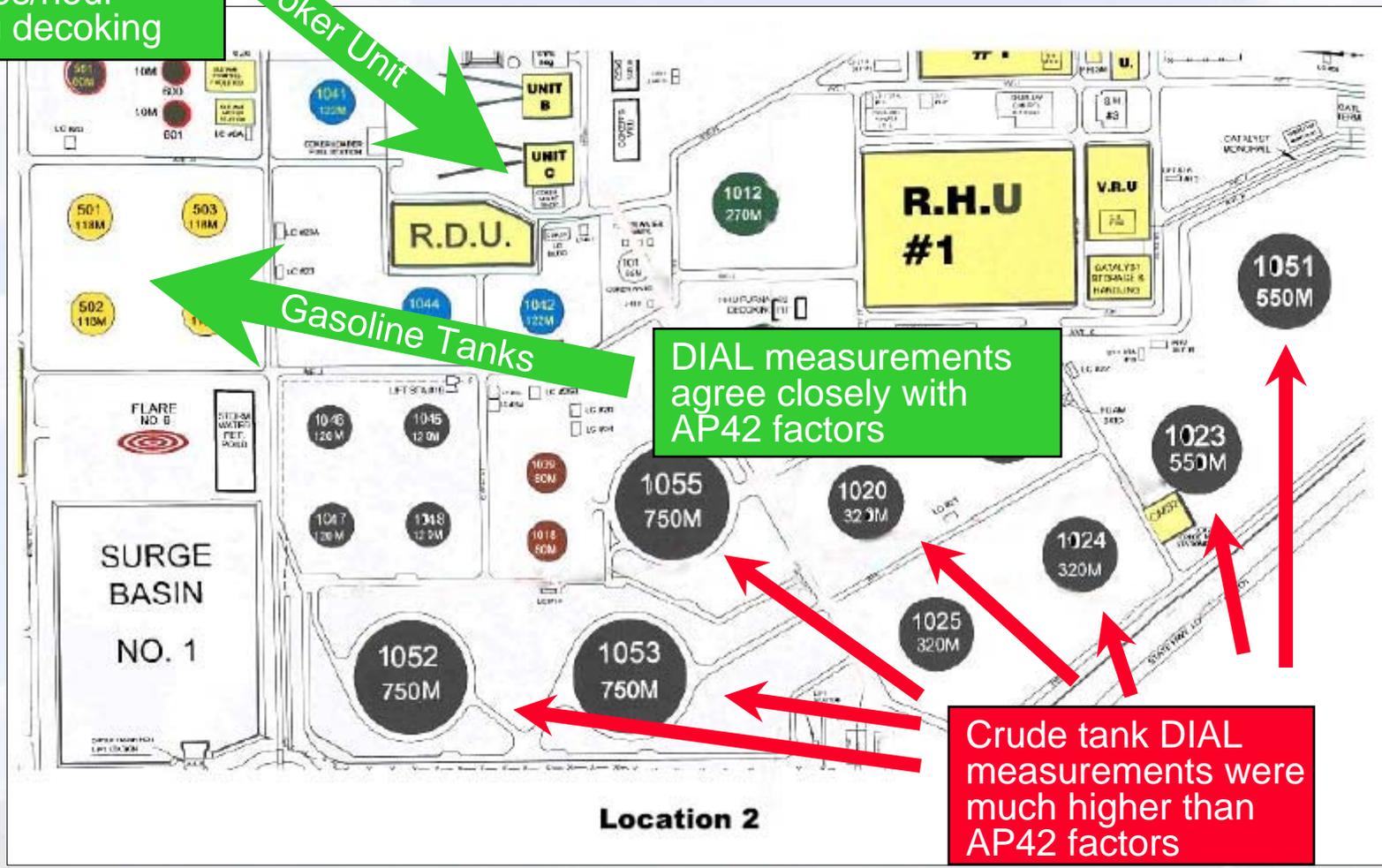
Coker benzene measurements <2.1 lbs/hour during decoking

Coker Unit

Gasoline Tanks

DIAL measurements agree closely with AP42 factors

Crude tank DIAL measurements were much higher than AP42 factors





## *Potential Storage Tank Emissions Determination Improvements*

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- Recommend EPA update TANKS program
  - Evaluate crude oil factor
  - Improve chemical parameter default data for crude oil and mid-refined products
  - Expand chemical defaults to accurately account for hot products
  - Account for butane slip when making winter gas
  - Consider effects from internal mixing



## *Potential Storage Tank Emissions Determination Improvements*

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- Recommend EPA address potential significant issues with TANKS program for heated tanks
  - TANKS program is difficult to use with heated tanks and tanks with hot products
  - Limited information on vapor pressures at elevated temperatures
  - Cutter stock effects on vapor pressures
- Visible IR hydrocarbon plumes are regularly seen from heated storage tanks by TCEQ staff



## *Potential Storage Tank Emissions Determination Improvements*

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- Do not allow TANKS defaults for chemical parameters for certain liquid types
  - Require actual vapor pressure and other physical property parameters to be input into TANKS program for crude and mid-refined products with vapor pressures that vary



## *Potential Storage Tank Emissions Determination Improvements*

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- Require actual storage tank design inputs into TANKS program
  - Do not allow average settings or design defaults
    - Tank design should be available for TANKS program data input
- Heated storage tanks
  - Require actual vapor pressure at the correct storage temperature for heated tanks and tanks with hot products



## *Contact Information*

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