

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

***Summer 2007
Texas City, Texas***

EX. 5524-000030-CRK

Chief Engineer's Office •

Russ Nettles

• April 7, 2010



Project Objective

- 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

- The final report has been submitted to EPA Region 6



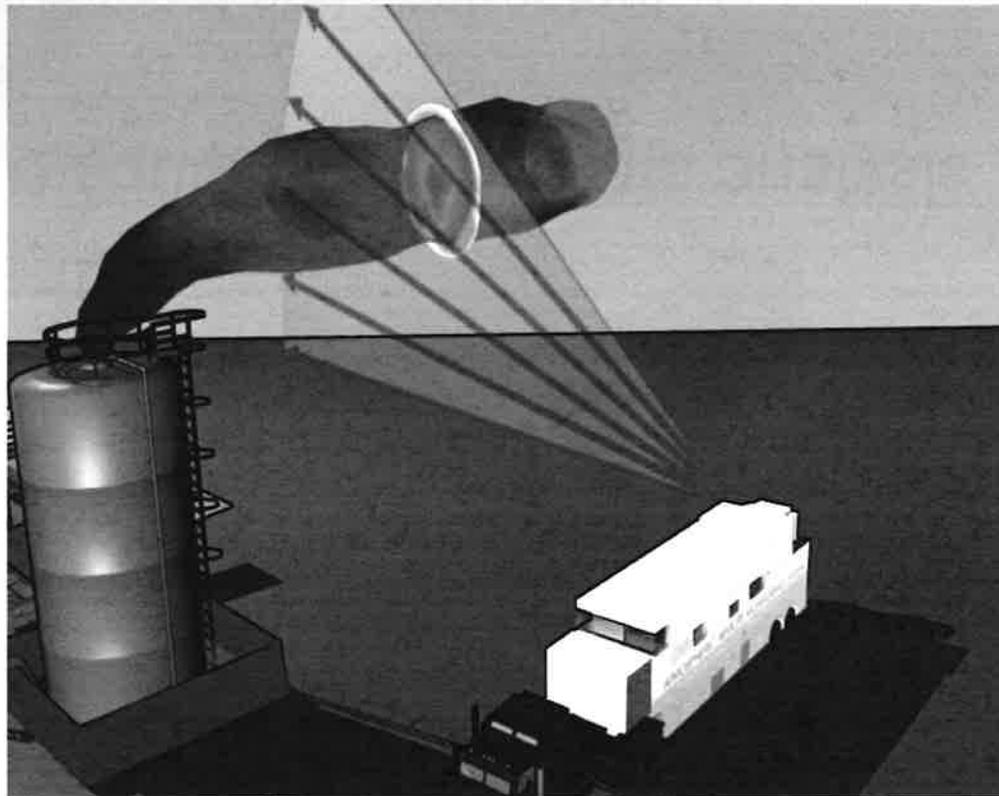
Site Cooperation

- 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

- 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

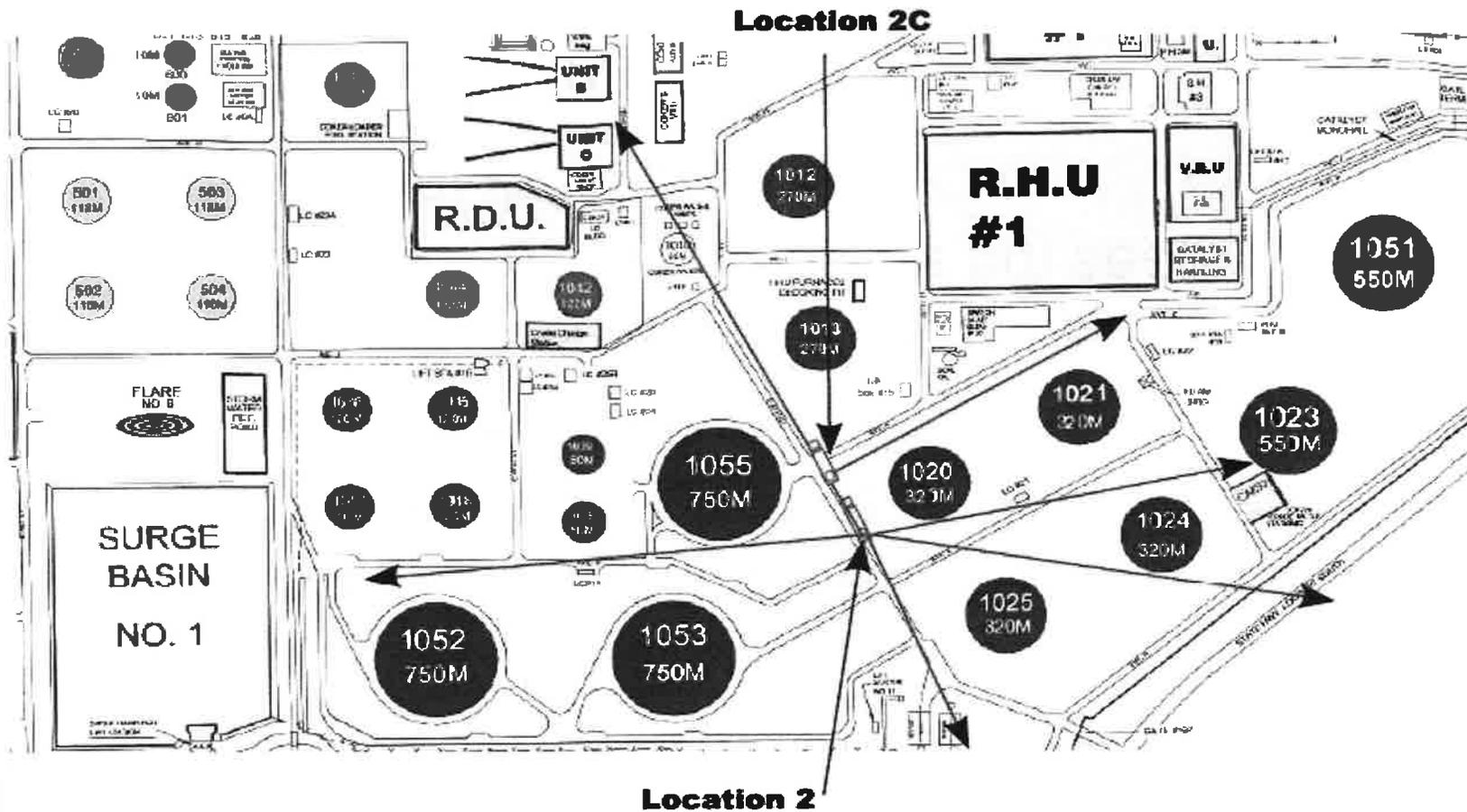


Crude Storage Tanks Observations

- 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

- 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

- 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

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

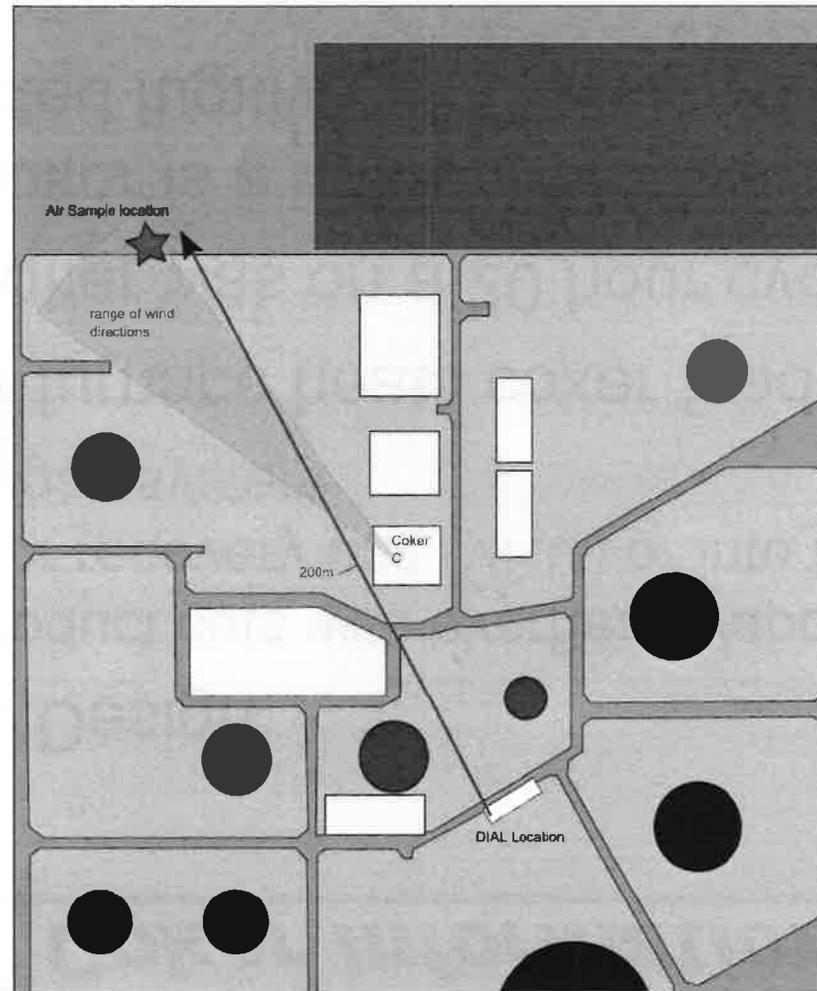


Coker Information

- 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

- 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.

- 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

- 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



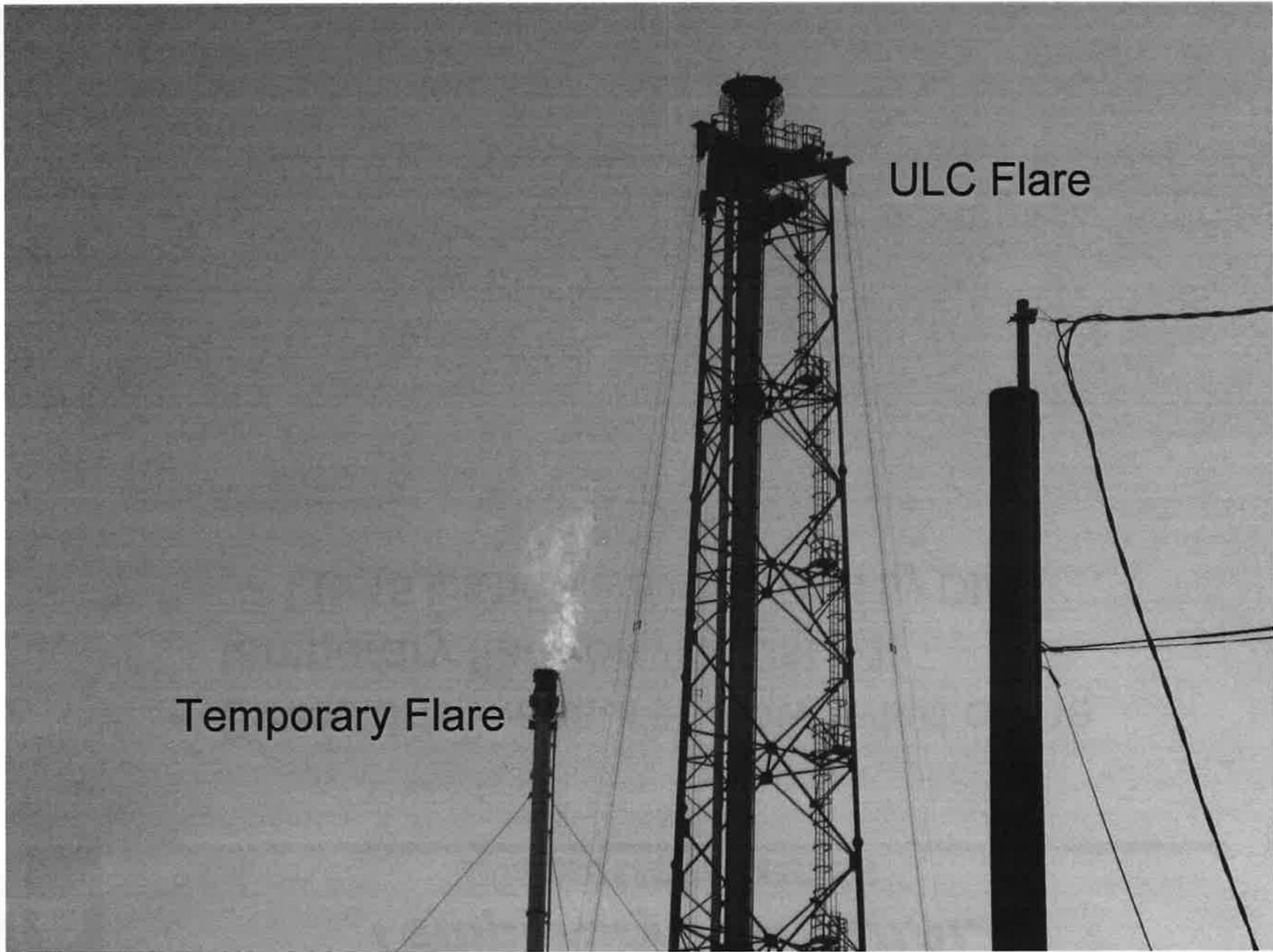
Temporary Flare Observations

- 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

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





ULC Flare Observations

- 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

- 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

- 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

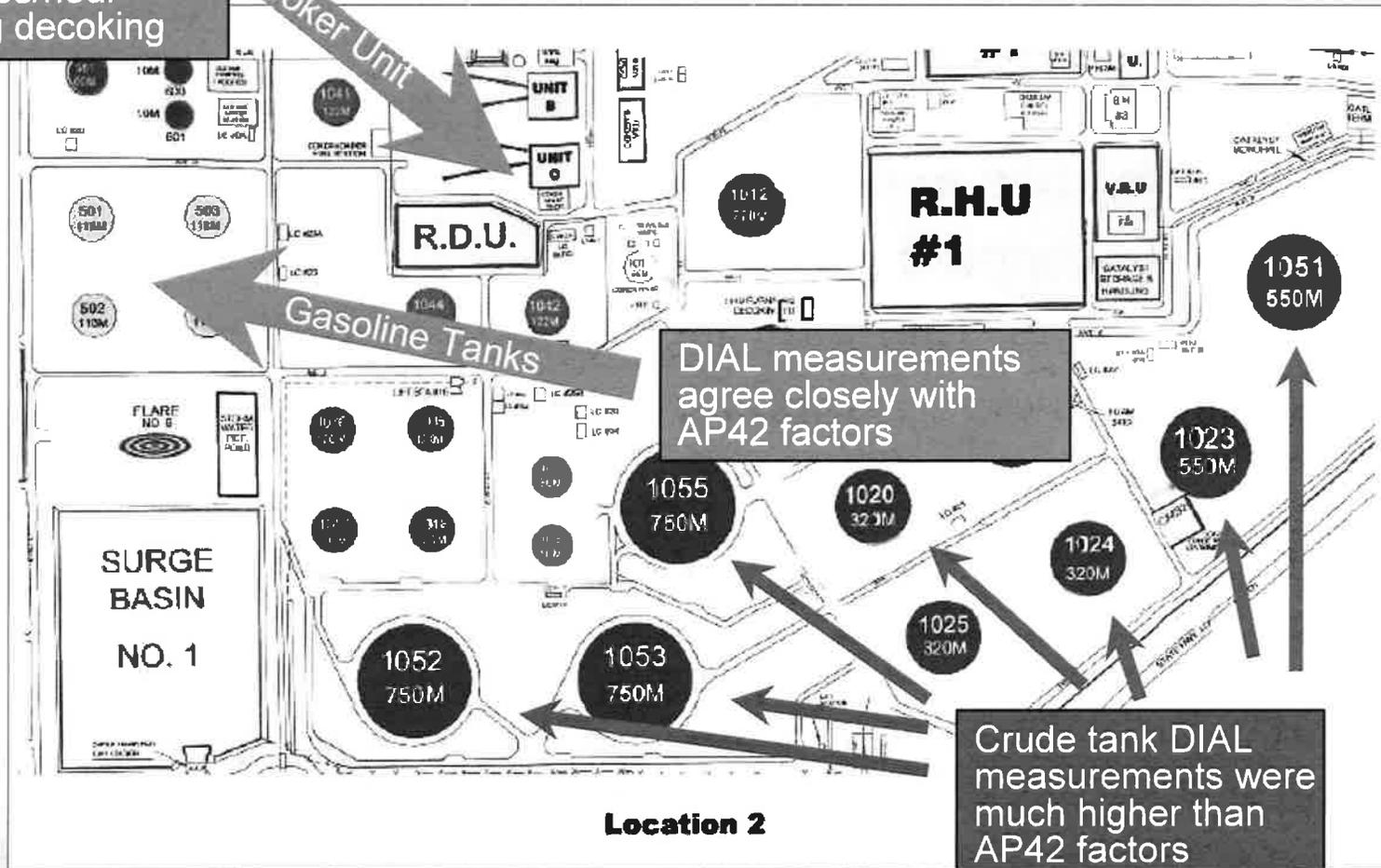
DIAL measurements closely agreed with:

- 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 ± 70 ppm



Project Conclusions

Coker benzene measurements <2.1 lbs/hour during decoking





Potential Storage Tank Emissions Determination Improvements

- 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

- 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

- 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

- 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

For a copy of the DIAL measurement report contact:

Russ Nettles, Air Quality Division, TCEQ,
(512) 239-1493 or e-mail

mettles@tceq.state.tx.us