

# Upstream Oil and Gas Emissions Inventory





# Outline

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- Emissions Inventory (EI) Overview
- Upstream Oil and Gas Sources
- Resources



# Types of EIs

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- Point sources
  - Developed from industry reported emissions
  - Industrial sources
  
- Area sources
  - TCEQ developed
  - Painting, gas stations, dry cleaners, etc.



## Types of EIs (cont.)

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- **Mobile sources**
  - TCEQ developed
  - On-road and non-road
  
- **Biogenic sources**
  - TCEQ developed
  - Based on estimates of vegetation type/quantity



# EI Reporting Requirements

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- Major source under §116.12 (New Source Review)
  - Rule defines potential to emit (PTE) thresholds
    - Applicability is based on attainment status of county
- PTE and actual emissions thresholds for regulated pollutants
- PTE and actual emissions thresholds for hazardous air pollutants (HAPs)



## EI Reporting Requirements (cont.) Statewide

- Regulated pollutants
  - PTE 100 tons per year (tpy) of any regulated pollutant
- HAPs:
  - PTE 10 tpy of any single HAP
  - PTE 25 tpy of all HAPs aggregated



## EI Reporting Requirements (cont.) Nonattainment Areas

- **Moderate** nonattainment counties under the eight-hour ozone standard: Dallas-Fort Worth (DFW) and Beaumont/Port Arthur (BPA)
- 10 tpy actual emissions or 100 tpy PTE volatile organic compounds (VOC)
- 25 tpy actual emissions or 100 tpy PTE nitrogen oxides (NO<sub>x</sub>)



## EI Reporting Requirements (cont.) Nonattainment Areas

- **Severe** nonattainment counties under the eight-hour ozone standard: Houston-Galveston-Brazoria (HGB)
- 10 tpy actual emissions or 25 tpy PTE VOC
- 25 tpy actual emissions or 25 tpy PTE NO<sub>x</sub>

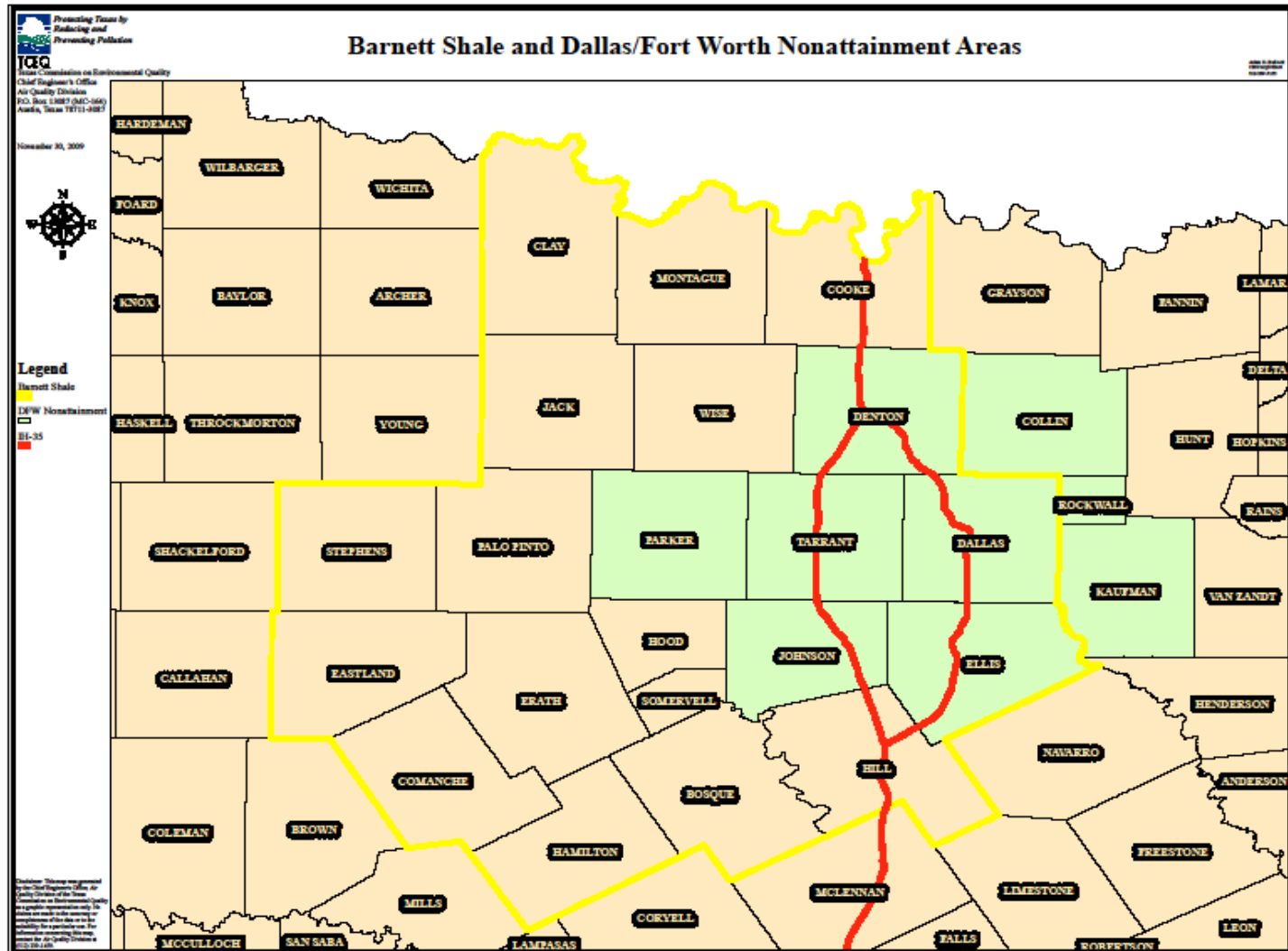


## EI Reporting Requirements (cont.) Special Inventory

- Regulated entities are only required to complete a special inventory if they receive a request from the TCEQ
- To address special data needs, such as:
  - 2007 DFW engine survey
  - Texas Air Quality Study II 2005-2006
    - Hourly inventory



# Barnett Shale and DFW Nonattainment Area





# Upstream Oil and Gas Sources

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- Typical emission sources for upstream oil and gas sites include:
  - Crude oil and condensate storage tanks
  - Combustion sources
  - Glycol dehydration operations
  - Fugitives
  - Other sources
    - Amine units
    - Blowdown vents
    - Loading operations



# Upstream Oil and Gas Tanks EI Improvement

- Houston Area Research Center (HARC) 51C Project
  - 33 storage tanks at wellhead and gathering site tank batteries were “stack” tested
  - Developed an emission factor that includes working, breathing, and flash losses
  - Condensate factor = 33 pounds of VOC per barrel condensate produced
  - Large number of well head storage tanks sites may exceed EI reporting thresholds

<http://files.harc.edu/Projects/AirQuality/Projects/H051C/H051CFinalReport.pdf>



## Upstream Oil and Gas Tanks HARC 51C Project (cont.)

- 2005 area source state-wide inventory was adjusted by approximately 700,000 tons per year
- Emissions determined using HARC 51C emissions factor and Railroad Commission production data



## Upstream Oil and Gas Tanks Flash Emissions Model Evaluation

- Study purpose: to evaluate methods and models for estimating VOC flashing emissions from upstream oil and gas storage tank batteries
- Study results were posted on Web for six weeks for informal comment
  - Comments received by deadline will be posted on same TCEQ website with final report
  - No formal TCEQ response will be published
  - However, technical comments will be addressed within the report itself
  - TCEQ report being finalized; will be published at:  
[http://www.tceq.state.tx.us/implementation/air/airmod/project/pj\\_report\\_ei.html](http://www.tceq.state.tx.us/implementation/air/airmod/project/pj_report_ei.html)



# Flash Emissions From Condensate Storage Tanks

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- “As a rough approximation, about half a mole of gas is vented from a condensate tank for each barrel of condensate collected. This gas evolution rate is based on a 65 pounds per square inch gauge (psig) low pressure separator pressure and an average vapor molecular weight approximating propane.”
  - Source: Oil and Gas Process Facility, <http://www.process-facility.com>
- 21 pounds (lbs) per barrel of condensate produced



# Flash Emissions From Condensate Storage Tanks (cont.)

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- Example using 21 lbs per barrel produced
  - 4 barrels per day x 21 lbs = 84 lbs per day
  - 84 lbs per day x 365 days per year / 2000 lbs per ton
  - 15 tons VOC emissions per year
- Meets EI reporting requirements



# Condensate Tank Vent Gas Composition

## Barnett Shale Oil & Gas Production Average Storage Tank Vent Gas Composition

Average  
speciation from  
20 condensate  
tank batteries

Data source:  
Upstream Oil  
and Gas Storage  
Tank Project  
(HARC) 51C and  
TCEQ Flash  
Emissions Model  
Evaluation  
Project

Chemical	Wt%
Nitrogen	2.48
Oxygen	0.88
Carbon Dioxide	1.44
Methane	10.72
Ethane	11.87
Propane	17.62
Isobutane	6.19
n-butane	13.33
2,2-Dimethylpropane	0.07
Isopentane	6.59
n-pentane	7.02
2,2-Dimethylbutane	0.17
Cyclopentane	0.20
2,3-Dimethylbutane	0.50
2-Methylpentane	2.56
3-Methylpentane	1.35
n-Hexane	3.35
Methylcyclopentane	0.84
Benzene	0.16
Cyclohexane	0.90
2-Methylhexane	0.91
3-Methylhexane	0.81
Dimethylcyclopentanes	0.24
2,2,4-Trimethylpentane	0.00
Other C7's	1.63
n-Heptane	1.48
Methylcyclohexane	1.06
Toluene	0.36
Other C8's	2.84
n-Octane	0.69
Ethylbenzene	0.03
m-Xylene	0.16
o-Xylene	0.03
Other C9's	0.95
n-Nonane	0.15
Other C10's	0.27
n-Decane	0.07
Undecanes Plus	0.08



# Combustion Sources

## Non-Flare Sources

- HAP/VOC speciation
  - Speciate VOC emissions to 90% for sources
    - $\geq 5$  tpy : east counties and El Paso County
    - $\geq 25$  tpy : west counties
  - Speciate all HAPs  $\geq 0.1$  tpy
  - If total VOC is  $\geq 2$  tpy (engines only)
    - Speciate formaldehyde

Note: For more information, see the 2008 EI Guidelines (Chapter 4- Determining and Reporting Emissions)



# Engine Example

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- Example calculating NO<sub>x</sub> emissions from a 200 horsepower (hp) 4-stroke rich-burn engines that ran 8,600 hours
  - 2 grams/hp-hour x 200 hp x 8,600 hours = 3,440,000 grams/per year
  - 3.78 tons of NO<sub>x</sub> emissions per year



# Glycol Stills

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- Determining annual VOC and HAP emissions:
  - Use site-specific data rather than defaults
  - Use extended gas analysis
    - Gas Processors' Association method 2286
- Preferred determination methodologies:
  - Use of extended gas analysis in conjunction with Gas Research Institute's GlyCalc program
  - Material balance equations in conjunction with rich-lean extended gas analyses



# Glycol Stills: Examples

- Simulation example
  - From API paper, “Aromatic Emissions from Glycol Dehydration Regenerators: Simulation and Correlation”
  - Mole percent benzene in feed = 0.007
  - Lean glycol recirculation rate, gallons/hour = 195
  - Contactor temperature, degrees Fahrenheit = 100
  - Contactor pressure, psig = 960
  - Gas inlet flow rate in million standard cubic feet/day = 30.2
  - 6.35 tons of benzene emissions per year
- Rich/lean analysis example
  - Glycol recirculation rate = 6 million gallons/year (690 gallons/hour)
  - Total VOC content glycol (rich-lean) = 400 milligrams/liter
  - 10 tons VOC emissions per year
  - Meets EI reporting requirements



# Fugitives

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- Do not apply Leak Detection and Repair (LDAR) reduction credits to average factors to determine emissions from monitored equipment leak fugitive sources
  - Most instrument-based LDAR program permit conditions will require screening value data
  - Data in correlation equations provides more accurate emissions determinations
- Only exception is for Audio/Video/Olfactory (AVO) reductions
  - Only LDAR program where the reduction credits are still allowed to be applied
- Non-monitored sites
  - Use average oil and gas production factors



# Resources

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- TCEQ Point Source Emissions Inventory
  - <http://www.tceq.state.tx.us/implementation/air/industei/psei/psei.html>
- Upstream Oil and Gas Storage Tank Project
  - <http://files.harc.edu/Projects/AirQuality/Projects/H051C/H051CFinalReport.pdf>
- EPA Clearinghouse for Inventories & Emissions Factors
  - <http://www.epa.gov/ttn/chief/efpac/index.html>
- Natural Gas STAR Program
  - <http://www.epa.gov/gasstar>



# Contact Information

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