

# Compressor stations & health risks: Moving New Jersey in the wrong direction

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Dorchester MA

Fore River Residents Against the Compressor Station  
Massachusetts Health Care Providers  
Against Fracked Gas

***For today:***

Basics of how a compressor station works

What pollution comes out of a compressor station?

What are the health risks?

# ***CS + Health: Strength of evidence***

Health effects associated with CS

>>>

Pollution known to be released by CS

- Studies on health effects of air pollution

>>>

Estimate effects from CS pollution

>>>

Suspected pollution, health issues not yet  
addressed



# New Jersey: “The Pipeline State”



Image courtesy New Jersey Conservation Foundation & Patty Cronheim



# ***Compressor stations***



# ***A Solar Taurus compressor engine***





# ***Typical compressor station equipment***

Compressor engine & turbine

Dehydrator, filter, separator

Condensate storage tank

Gas heater & cooler

Backup generator

Pipeyard

# ***How does a compressor station generate pollution?***

**Burn gas** in compressor

**Vent gas** (blowdown, shut down, emergency venting)

**Leak gas** under high pressure system

**Vent condensate** from tanks

**Noise**



***For today:***

Basics of how a compressor station works

What pollution comes out of a compressor station?

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# ***What comes out of compressor stations?***

## Definitely

Noise

Nitrogen oxides, particulate matter, carbon monoxide, volatile organic compounds, hazardous air pollutants (formaldehyde, benzene, etc)

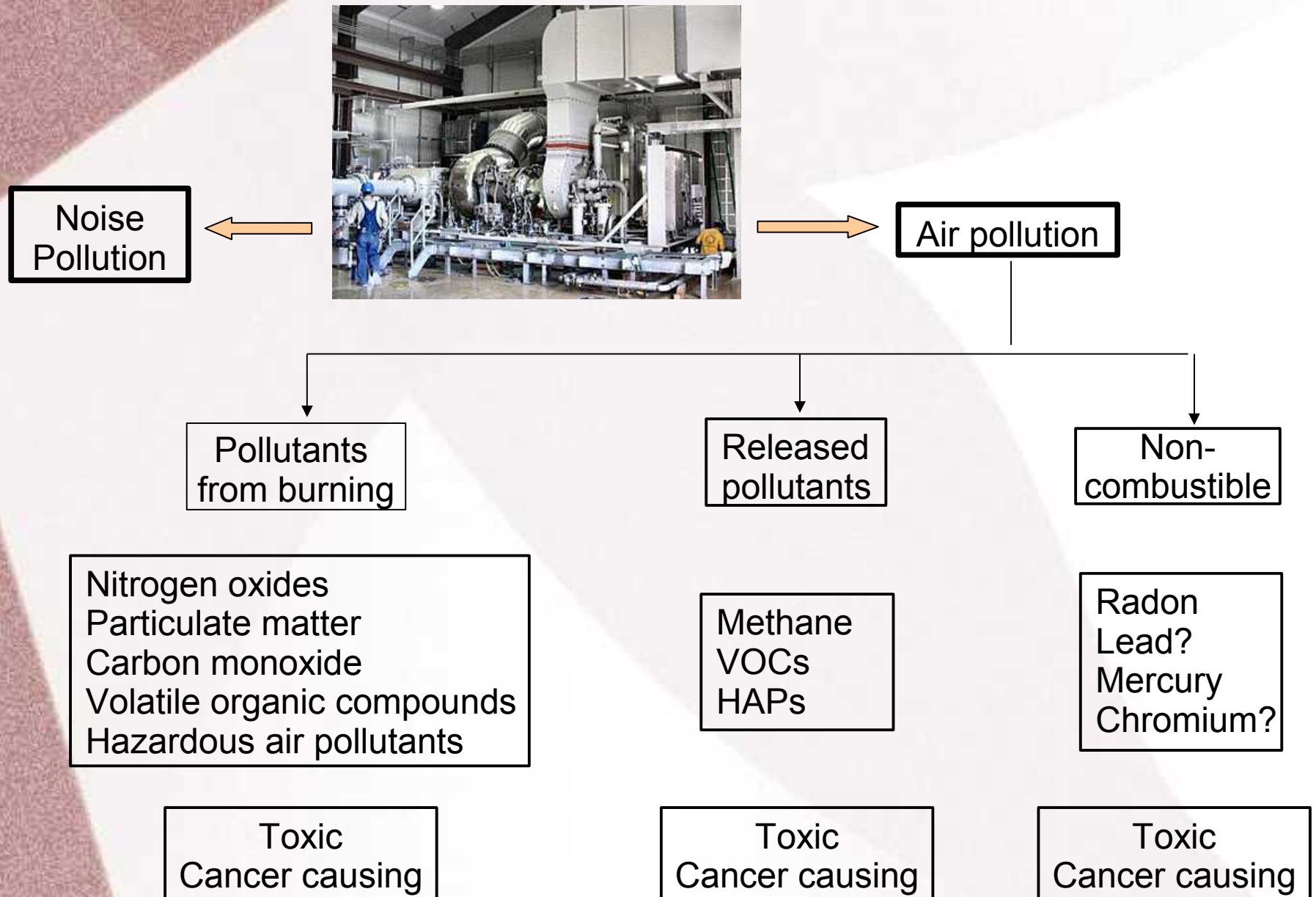
Radon

## Likely or possible

Mercury, (radioactive) lead, chromium

## Secondary formation

Ozone, particulate matter





# ***Compressor station noise: Neighbors' anecdotes***

It tends to vent at night

It rattled the dishes in the cupboards

It sounds like a jet engine

One event lasted several hours and  
sounded like a loud jet engine several  
miles away

# ***Compressor stations: Noise***

The noise and vibration emanating from the Burrillville [facility] is extremely disruptive to my husband and me and has negatively impacted our ability to sleep, enjoy our property and our health. My husband is a one-hundred percent disabled Vietnam Veteran and his health and survival relies on him getting good quality sleep, not to mention reduced stress levels. As a result of the continued noise and vibration his sleep pattern is negatively impacted and his stress level as a result has increased to a point where his cardiologist has told me not to have him get stressed over this situation. That is easier said than done when faced with the noise and vibration problem on a daily basis.

.....The current noise occurs on almost a daily basis and ranges from a constant drone similar to a diesel truck parked idling in my driveway to a loud – jet plane running. At times it sounds like a jet plane has taken off. When this occurs, the noise is extremely loud and lasts for several minutes. The noise cycles between the diesel truck idling to the jet plane taking off and can last for several hours.<sup>19</sup>



# Compressor noise + meditation center

The image is a screenshot of a Google Maps interface. On the left, there is a sidebar for the 'New Jersey Buddhist Vihara' listing, which includes a photo of a white Buddha statue, a 4.9-star rating with 12 reviews, and various action buttons like 'Directions', 'Save', 'Nearby', 'Send to your phone', and 'Share'. Below these are links to the address, website, phone number, and options to claim the business or suggest edits. On the right, the main map area shows an aerial view of the location in Princeton, NJ. A red pin marks the 'New Jersey Buddhist Vihara'. A white line is drawn on the map to measure a distance, with a pop-up box showing 'Total distance: 2,467.91 ft (752.22 m)'. Other labels on the map include 'Princeton Manor', 'Little Rocky Hill', and 'Franklin Turnpike'.

**New Jersey Buddhist Vihara**  
4.9 ★★★★★ · 12 reviews  
Buddhist Temple

Directions

SAVE NEARBY SEND TO YOUR PHONE SHARE

4299 NJ-27, Princeton, NJ 08540  
njbv.org  
(732) 821-9346  
Claim this business  
Suggest an edit  
Add a label

Measure distance  
Click on the map to add to your path  
Total distance: 2,467.91 ft (752.22 m)

Franklin Turnpike 518  
Princeton Manor  
New Jersey Buddhist Vihara  
LITTLE ROCKY HILL  
Brook Branch

Map

Imagery ©2017 Google, Map data ©2017 Google Terms Send feedback





# ***What are VOCs?***

Volatile: Airborne

Organic: Carbon based

Compounds: Molecules

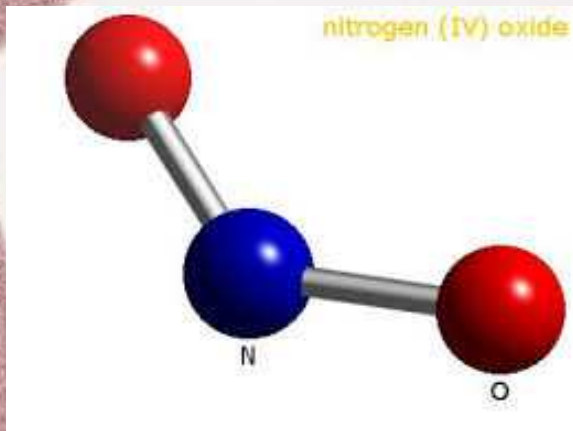
Examples:

Propane, butane, ethanol

**naphthalene\***, **benzene\***, **formaldehyde\***

*\* Also categorized as hazardous air pollutants*

# *Nitrogen dioxide*

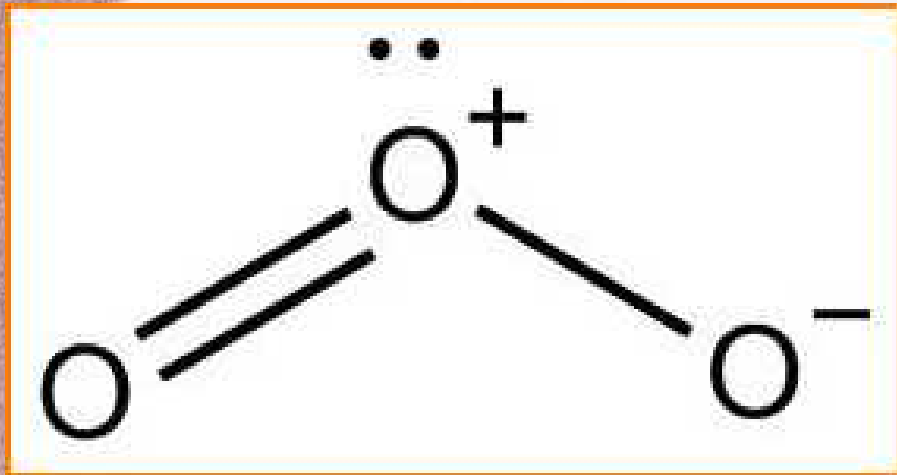


Toxic

$\text{NO}_2 + \text{VOC} = \text{Ozone, smog}$

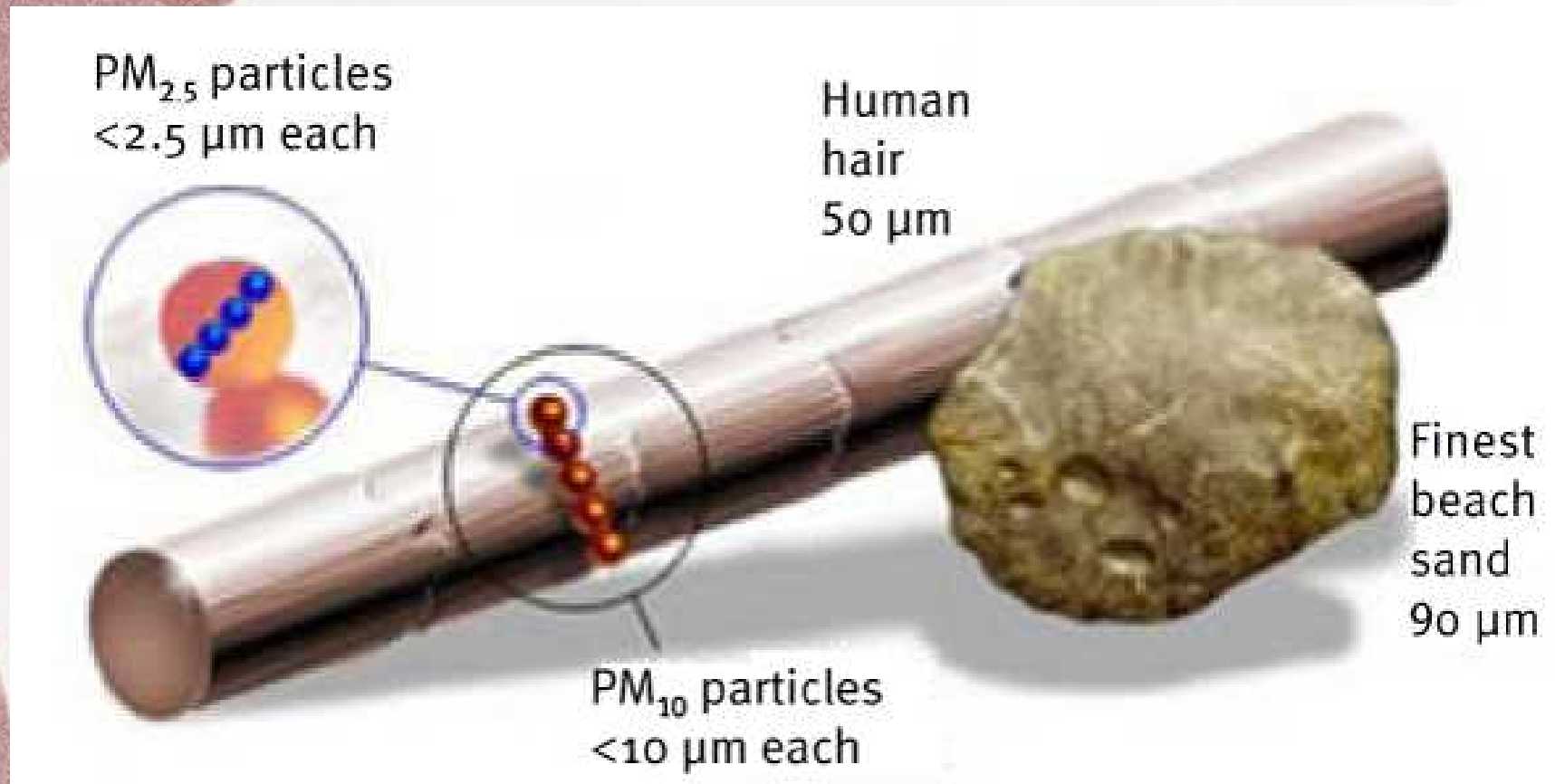


# Ozone



Ground level ozone  
“can damage lung tissue and plants”

# ***Particulate matter***



Organic compounds, metals  
Delivery system to the lungs  
Toxic

# ***CS 206 air pollution: Details in March?***

<b>Pollutant</b>	<b>Annual Compressor Station 206 Potential-to- Emit (tpy)</b>
CO	TBD
NO <sub>x</sub>	TBD
VOC	TBD
PM <sub>10</sub>	TBD
PM <sub>2.5</sub>	TBD
SO <sub>2</sub>	TBD
CO <sub>2</sub> e	TBD
<b>Total HAPs</b>	<b>TBD</b>

Transcontinental Gas Pipe Line Co. (Nov 2016). Northeast Supply Enhancement Project Draft Resource Report 9: Air Quality and Noise. Table 9.2-1, p 9-7.



# *The Mars 100 compressor: CS206 vs NED*

NESE

## New Compressor Station 206

- Construction of a new 32,000 horsepower (hp) compressor station and related ancillary equipment in Franklin Township, Somerset County, New Jersey, with two Solar Mars® 100 (or equivalent) natural gas-fired, turbine-driven compressors. The preferred location for Compressor Station 206 has not yet been selected.

NED

Station	Model	Rated Capacity <sup>1</sup>	ISO Rating <sup>2</sup>
Supply Path Head	Titan 130-20502S	19,443 hp	20,500 hp
	Mars 100-16000S	15,181 hp	16,000 hp
	Mars 100-16000S	15,181 hp	16,000 hp

32,000 hp (Mars 100 x2) = 61% of 52,500 hp

Tennessee Gas Pipeline Company (Nov 2015). Northeast Energy Direct Project. Resource Report 9, Table 9.1-16, p 9-30.

# ***Toxic air pollutants: Tons per year***

NED “Titan” +  
2 Mars engines:

Equipment	Tons per Year							
	NO <sub>x</sub>	CO	SO <sub>2</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	VOC <sup>2</sup>	GHG <sup>3</sup>	HAPs <sup>4</sup>
Total	66.60	86.17	25.02	11.96	11.96	22.42	215,460	4.20

Total x 61%  
(2 Mars engines):

40.6	52.6	15.3	7.30	7.30	13.7	131,430	2.6
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Tennessee Gas Pipeline Company (Nov 2015). Northeast Energy Direct Project. Resource Report 9, Table 9.1-17, p 9-32.



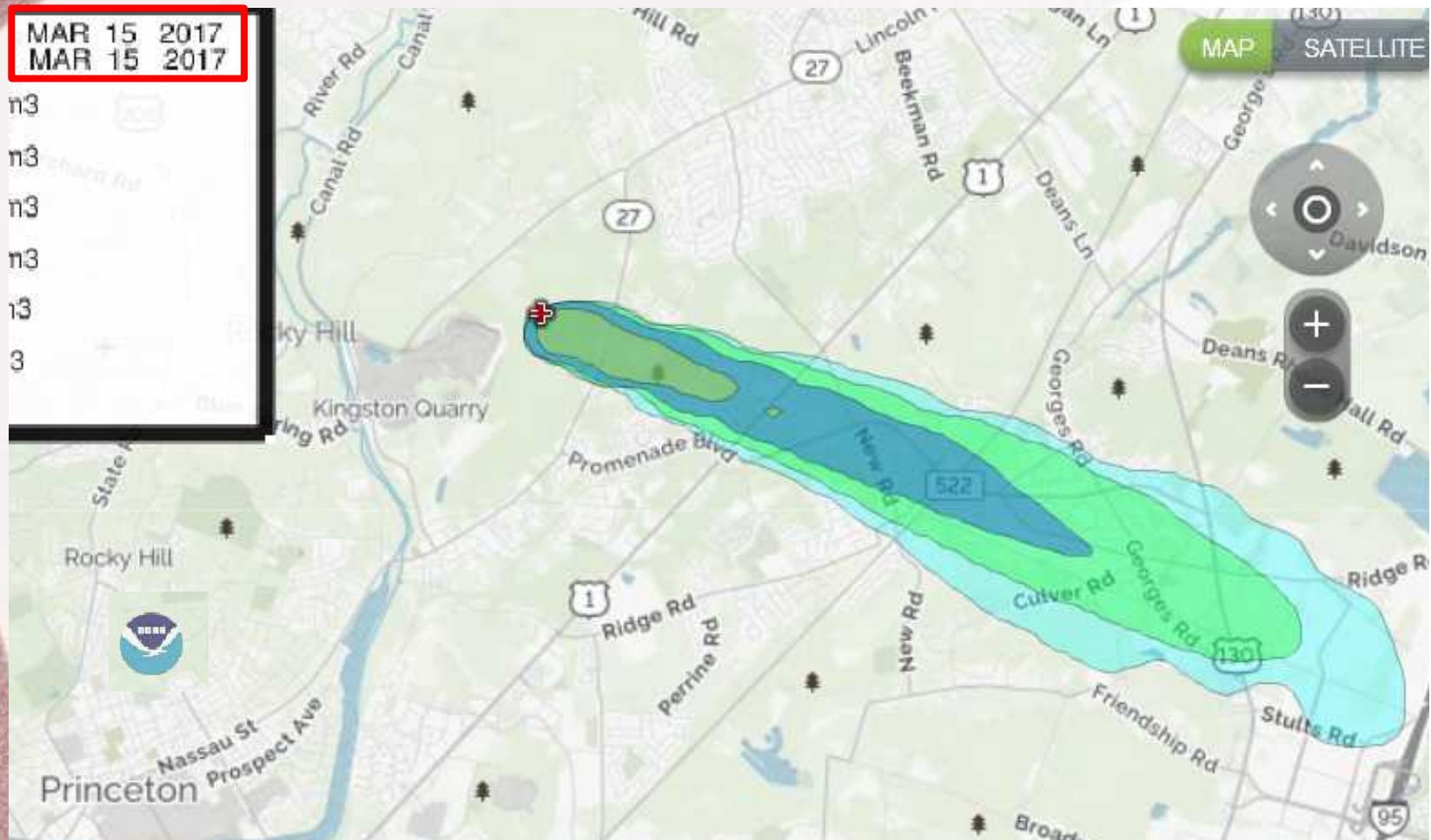
# ***Air pollution: Dispersion***





# *Where will the pollution go?*

## NOAA HYSPLIT Model



<https://ready.arl.noaa.gov/HYSPLIT.php>

# ***Where will the pollution go?***

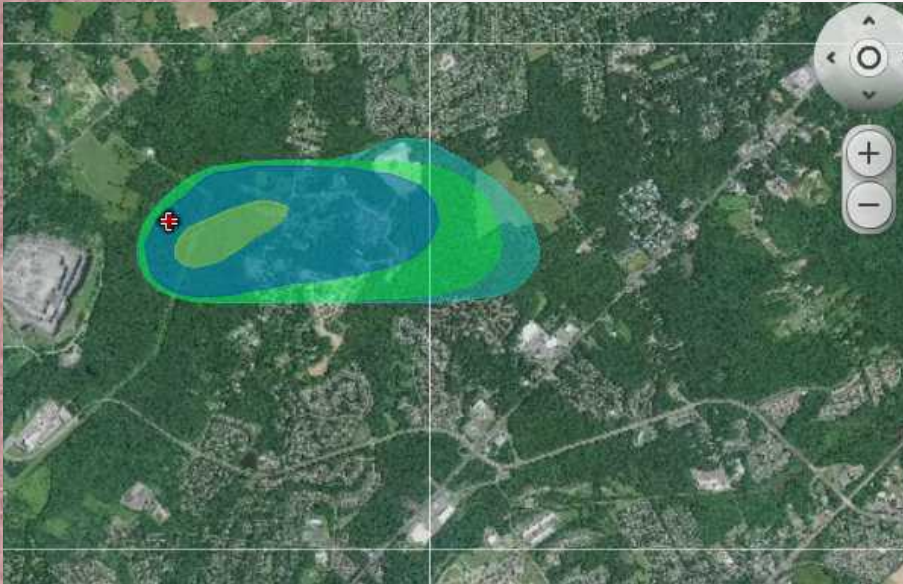


<https://ready.arl.noaa.gov/HYSPLIT.php>



# ***Where will the pollution go?***

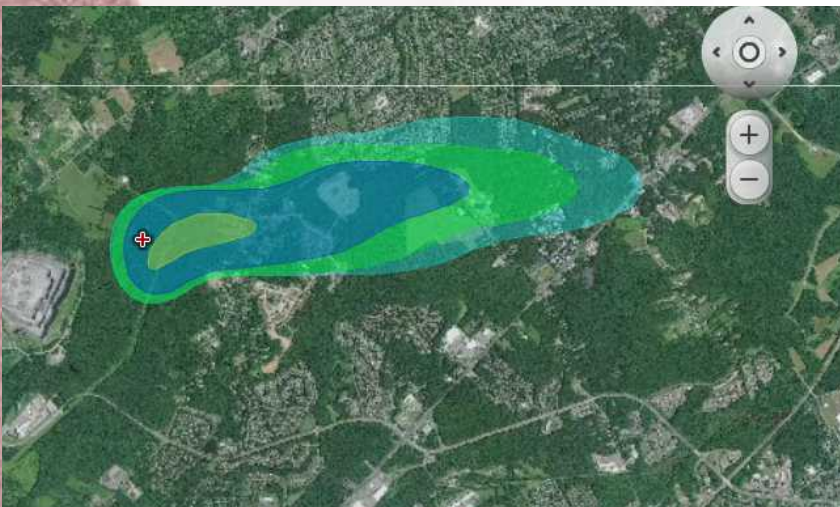
June 15 2016



Sept 15 2016



Dec 15 2016



Mar 15 2017





# ***EPA air quality standards: NAAQS***

**Table 9.2-7  
National Ambient Air Quality Standards**

Pollutant	Averaging Period	Primary Standard
CO	8-hour <sup>a</sup>	9 ppm (10,000 µg/m <sup>3</sup> )
	1-hour <sup>a</sup>	35 ppm (40,000 µg/m <sup>3</sup> )
Lead	Rolling 3-month <sup>b</sup>	0.15 µg/m <sup>3</sup>
NO <sub>2</sub>	Annual <sup>b</sup>	53 ppb (100 µg/m <sup>3</sup> )
	1-hour <sup>c</sup>	100 ppb (189 µg/m <sup>3</sup> )
Ozone	8-hour <sup>d</sup>	0.075 ppm
PM <sub>10</sub>	24-hour <sup>e</sup>	150 µg/m <sup>3</sup>
PM <sub>2.5</sub>	Annual <sup>f</sup>	12.0 µg/m <sup>3</sup>
	24-hour <sup>g</sup>	35 µg/m <sup>3</sup>
SO <sub>2</sub>	3-hour <sup>a</sup>	--
	1-hour <sup>h,i</sup>	75 ppb (195 µg/m <sup>3</sup> )

# Ambient air quality around CS206 site

Table 9.2-9  
Ambient Air Quality Data – Concentrations Representative of the Madison Loop, Compressor Station 206  
and Raritan Bay Loop

Pollutant	Averaging Period	Monitor Site	Monitor Value
CO	8-hour <sup>a</sup>	AQS 34-039-0004 Elizabeth NJ	1.8 ppm
	1-hour <sup>a</sup>		2.4 ppm
Lead	Rolling 3-month	AQS 42-101-0014 Philadelphia PA	0 µg/m <sup>3</sup>
NO <sub>2</sub>	Annual <sup>b</sup>	AQS 34-023-0011 East Brunswick NJ	10.25 ppb
	1-hour <sup>c</sup>		45 ppb
Ozone	8-hour <sup>d</sup>	AQS 34-023-0011 East Brunswick NJ	0.073 ppm
PM <sub>2.5</sub>	Annual <sup>e</sup>	AQS 34-023-0006 North Brunswick NJ	8.0 µg/m <sup>3</sup>
	24-hour <sup>c</sup>		19.7 µg/m <sup>3</sup>
PM <sub>10</sub>	24-hour <sup>a</sup>	AQS 42-101-0048 Philadelphia PA	64 µg/m <sup>3</sup>
SO <sub>2</sub>	3-hour <sup>a</sup>	AQS 34-039-0004 Elizabeth NJ	29 ppb
	1-hour <sup>f</sup>		14 ppb

45% of NAAQS  
97% of NAAQS  
67% of NAAQS

Transcontinental Gas Pipe Line Co. (Nov 2016). Northeast Supply Enhancement Project Draft Resource Report 9: Air Quality and Noise. P 9-20.

# ***Local impacts from a 52,500 hp station***

Pollutant	Averaging Period	SIL ( $\mu\text{g}/\text{m}^3$ )	Maximum Conc. for SIL Analysis <sup>1</sup> ( $\mu\text{g}/\text{m}^3$ )	Significant Impact Area (SIA) (km)
NO <sub>2</sub> <sup>3</sup>	1-hour	7.5	39.36	6.67
	Annual	1	1.18	0.13
CO	1-hour	2000	30.83	NA
	8-hour	500	21.28	NA
PM <sub>10</sub>	24-hour	5	3.14	NA
PM <sub>2.5</sub>	24-hour	1.2	3.03	0.20
	Annual	0.3	0.58	0.16
SO <sub>2</sub>	1-hour	7.8	20.63	1.89
	3-hour	25	13.69	NA

Tennessee Gas Pipeline Company (Nov 2015). Northeast Energy Direct Project. Resource Report 9, Table 9.1-18, p 9-34.

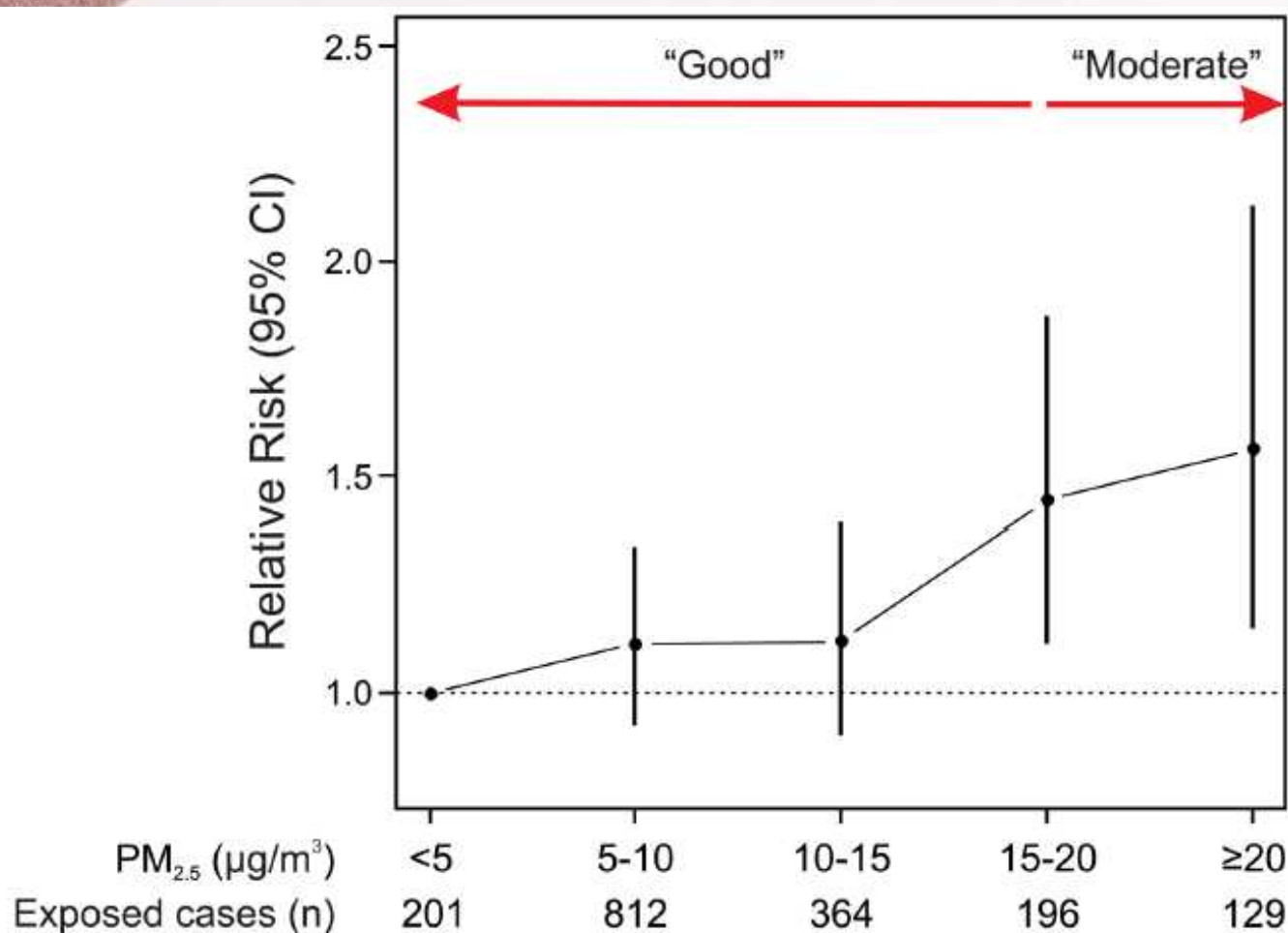


# ***NAAQS and 52,500 hp station: No problem?***

Pollutant	Averaging Period	Modeled Design Conc. for NAAQS <sup>2</sup> (µg/m <sup>3</sup> )	Ambient Background (µg/m <sup>3</sup> )	Total Impact (µg/m <sup>3</sup> )	NAAQS (µg/m <sup>3</sup> )
NO <sub>2</sub> <sup>3</sup>	1-hour	28.77	75.8	104.6	188
	Annual	1.18	20.0	21.2	100
CO	1-hour	30.32	2,061	2,091	40,000
	8-hour	20.63	1,603	1,623.6	10,000
PM <sub>10</sub>	24-hour	2.94	45.0	47.9	150
PM <sub>2.5</sub>	24-hour	2.59	22.3	24.9	35
	Annual	0.58	9.5	10.1	12
SO <sub>2</sub>	1-hour	17.19	21.0	38	196
	3-hour	12.45	21.0	33.4	1,300

Tennessee Gas Pipeline Company (Nov 2015). Northeast Energy Direct Project. Resource Report 9, Table 9.1-18, p 9-34.

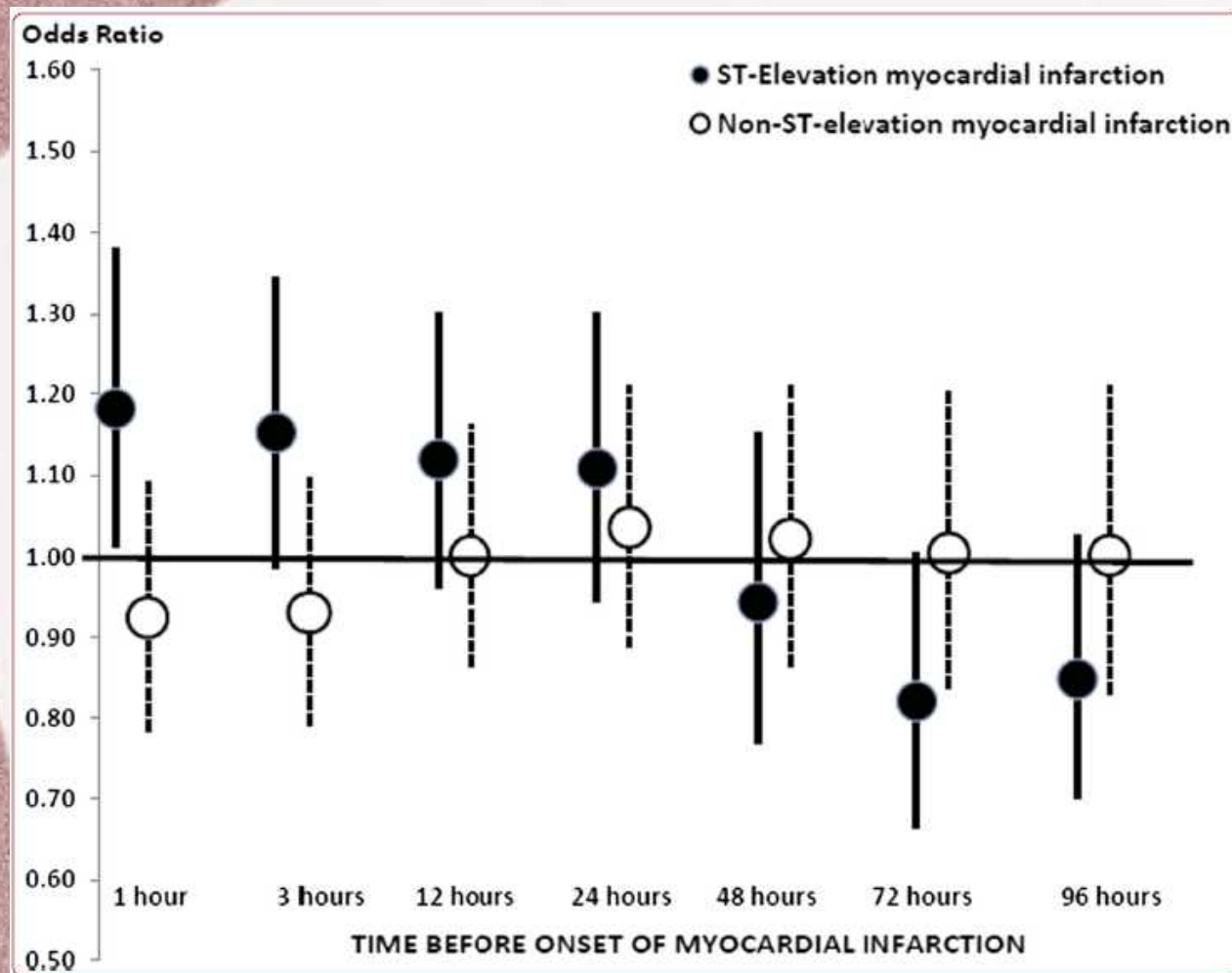
# ***PM<sub>2.5</sub> below NAAQS: More strokes***



**Figure 1.**

Odds ratio of ischemic stroke onset for categories of mean PM<sub>2.5</sub> levels in the 24 hrs preceding stroke onset.

# Shorter (1 hr) averages: More heart attacks



7.1  $\mu\text{g}/\text{m}^3$  PM<sub>2.5</sub> =  
18% increased risk of  
heart attack

Gardner, B et al (2014). *Particle and Fiber Toxicology*, 11:1.



***For today:***

Basics of how a compressor station works

What pollution comes out of a compressor station?

What are the health risks?

# ***Assessing health risks: Types of data***

Public health/epidemiology

<<Not available>>

Surveys

Symptoms

Pollution

Change in pollutant concentration

# ***Self-reported symptoms near compressor station***

Health surveys of 35 residents within ~1 mile  
of a new compressor station (Minisink NY;  
12,260 hp)

## Symptoms:

Respiratory & nosebleeds: 63%

Headaches: 34%

Rash: 29%

Southwest Pennsylvania Environmental Health Project (2015). Summary of Minisink monitoring results. <http://www.environmentalhealthproject.org/resources/presentations/>



# ***PM<sub>2.5</sub>, NO<sub>2</sub> & health outcomes: A partial (!) review***

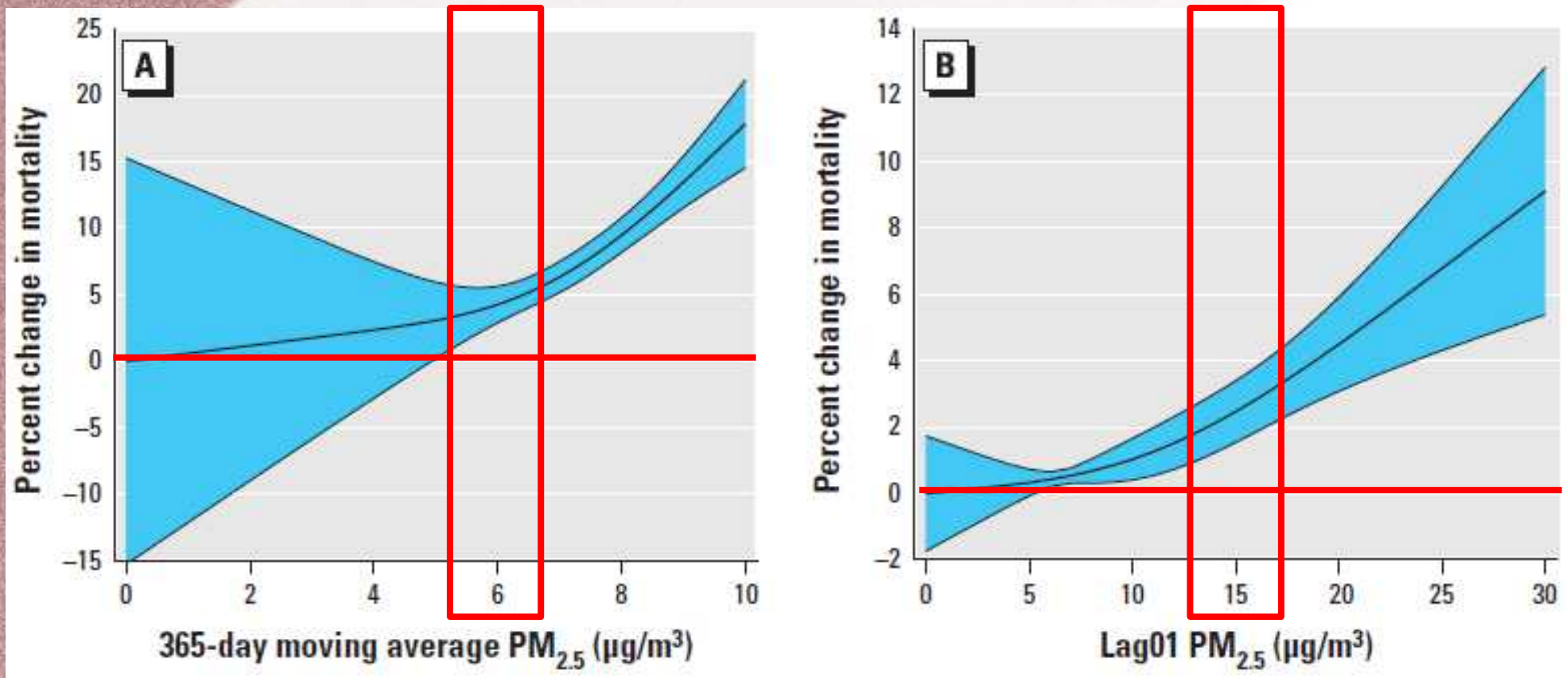
	Diagnosis	Clinic visit	Hospitalization	Death
Asthma	X	X	X	
Respiratory cancers		X	X	X
COPD		X	X	X
Autism (ASD)	X			
Alzheimers			X	
Parkinsons			X	
Heart attack			X	X
Diabetes		X	X	X
All non-accidental death				X

# ***What is a health outcome?***





# *Health is not part of the pipeline review process*



Shi, L et al (2016). *Environmental Health Perspectives*, 124(1): 46-52.



# ***Answers to health questions: Research, health assessments***



Resolution #17-002  
3/15/2017

**RESOLUTION REQUEST THE FEDERAL ENERGY REGULATORY COMMISSION TO CONDUCT A HEALTH IMPACT ASSESSMENT OF THE PROPOSED WILLIAMS TRANSCO COMPRESSOR AT TRAP ROCK QUARRY IN FRANKLIN TOWNSHIP**

**NOW, THEREFORE, BE IT RESOLVED** by the Board of Health of the Township of Franklin in the County of Somerset, State of New Jersey formally requests the Federal Energy Regulatory Commission to conduct a Health Impact Assessment of the proposed Williams Transco Compressor Station on the residents of the Township of Franklin.

# ***Hazardous air pollutants from burning gas***

	Maximum Annual
TOC (Total)	12.2278 tpy
Methane	9.5599 tpy
Ethane	0.3335 tpy
VOC (Total)	2.3344 tpy
VOC (non-HAP)	1.1924 tpy
HAP (Total)	1.1420 tpy
Acetaldehyde	4.45E-02 tpy
Acrolein	7.11E-03 tpy
Benzene	1.33E-02 tpy
Biphenyl	
Butadiene (1,3-)	4.78E-04 tpy
Carbon Tetrachloride	
Chlorobenzene	
Chloroform	
Dichloropropene (1,3-)	
Ethylbenzene	3.56E-02 tpy
Ethylene Dibromide	
Formaldehyde	7.89E-01 tpy
Hexane (n-)	
Methanol	
Methylene Chloride	
Methylnaphthalene (2-)	
Naphthalene	1.45E-03 tpy
PAH	2.45E-03 tpy
Phenol	
Propylene Oxide	3.22E-02 tpy
Styrene	
Tetrachloroethane (1,1,2,2-)	
Toluene	1.45E-01 tpy
Trichloroethane (1,1,2-)	
Trimethylpentane (2,2,4-)	
Vinyl Chloride	
Xylenes	7.11E-02 tpy

1578 lbs formaldehyde/year X

50% catalytic efficiency =

**789 lbs/year**

Spectra Energy Partners, Atlantic Bridge Project. Resource Report 9. Table B1Ai. (PDF pg 736).

***(Compressor station)  
formaldehyde:  
Toxic & Cancer causing***



Carcinogen: 0.08 mcg/m<sup>3</sup>

Toxicity: 10-49 mcg/m<sup>3</sup>

Toxicity symptoms:

Nasal & eye irritation; neurologic effects; Increased asthma, allergies, & eczema; decreased lung function

-US Agency for Toxic Substances and Disease Registry  
<http://www.atsdr.cdc.gov/>  
-EPA IRIS database



# ***Formaldehyde concentration near compressor stations***

State/ID	County	Nearest infrastructure	Chemical	Concentration ( $\mu\text{g}/\text{m}^3$ )
PA-4083-003	Susquehanna	420 m from compressor	Formaldehyde	83
PA-4083-004	Susquehanna	370 m from compressor	Formaldehyde	7.6
PA-4136	Washington	270 m from PIG launch <sup>a</sup>	Benzene	5.7
PA-4259-002	Susquehanna	790 m from compressor	Formaldehyde	61
PA-4259-003	Susquehanna	420 m from compressor	Formaldehyde	59
PA-4259-004	Susquehanna	230 m from compressor	Formaldehyde	32
PA-4259-005	Susquehanna	460 m from compressor	Formaldehyde	34

C = chronic; A = acute; I = intermediate.

<sup>a</sup>Launching station for pipeline cleaning or inspection tool.

PA-4259: 6200 hp Teel Compressor station

Macey et al. (2014) *Environmental Health*, v13, 82

***~790m radius from  
proposed site***

Measured Formaldehyde:

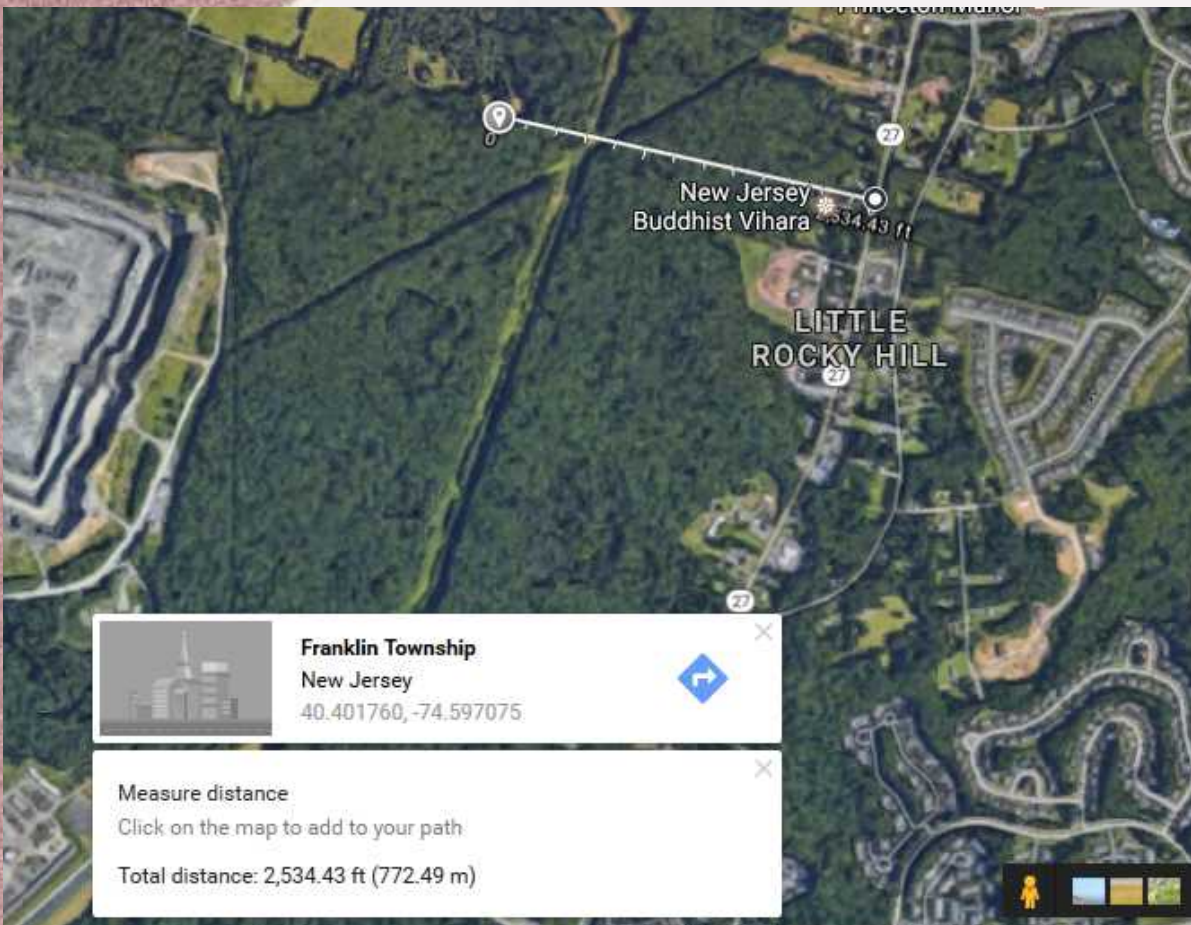
at 790m - 61 mcg/m<sup>3</sup>

Carcinogen: 0.08 mcg/m<sup>3</sup>

Toxicity: 10-49 mcg/m<sup>3</sup>

**762X Carcinogen threshold**

**1.25-6X Toxicity threshold**



# ***Answers to health questions: Research, health assessments***



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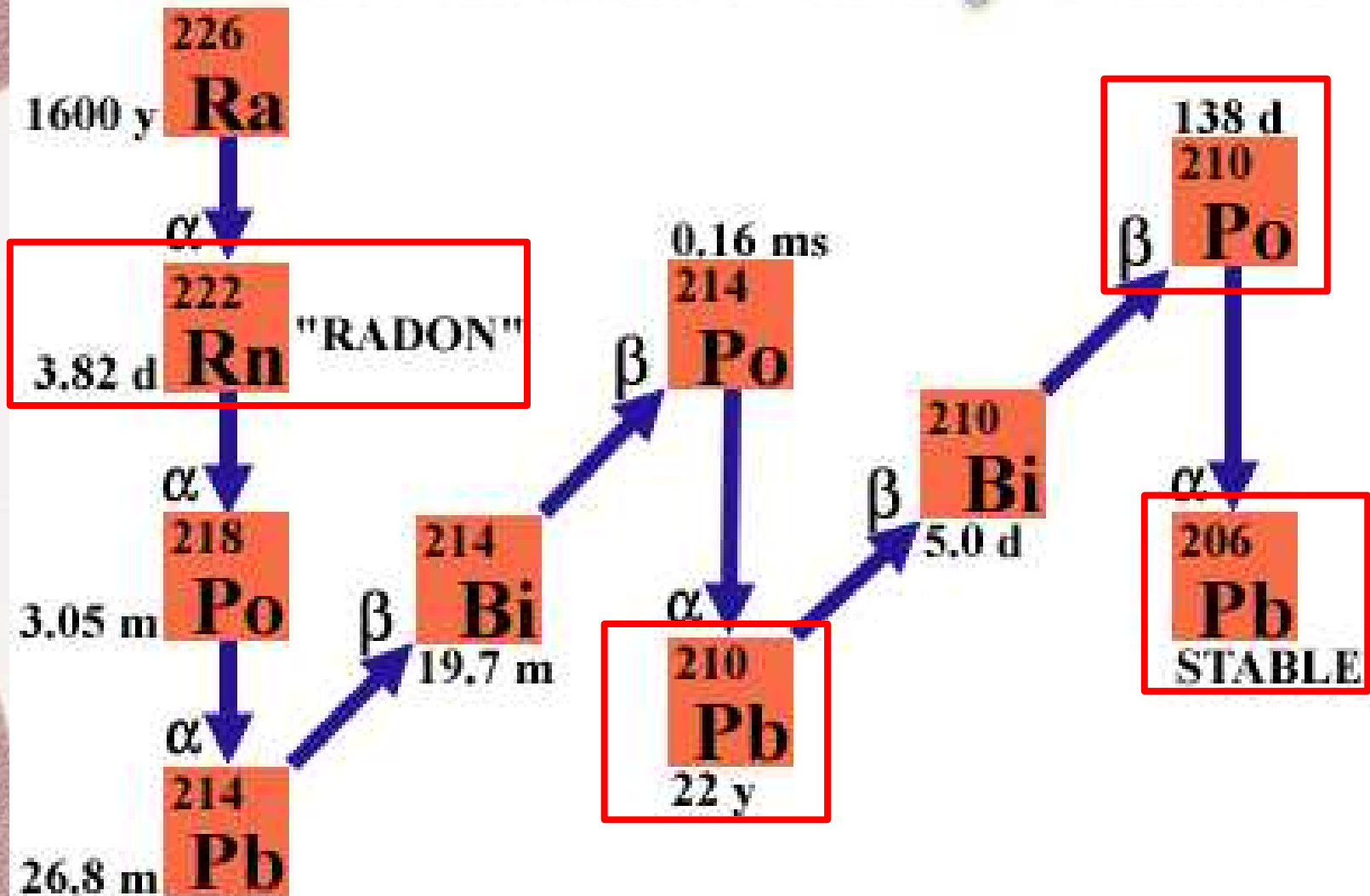


# ***Pennsylvania fracked gas: Radon***

Sample ID	<sup>222</sup> Rn Activity (pCi/L)	Reservoir Name and Age	Lithology	Approximate Reservoir Depth (ft)
A-1	35	Marcellus Shale, Middle Devonian	Black shale	8,000
A-2	40	Marcellus Shale, Middle Devonian	Black shale	8,000
A-2, duplicate	45	Marcellus Shale, Middle Devonian	Black shale	8,000
A-3	79	Marcellus Shale, Middle Devonian	Black shale	8,000
A-3, duplicate	79	Marcellus Shale, Middle Devonian	Black shale	8,000
A-4	76	Marcellus Shale, Middle Devonian	Black shale	8,000
A-5	1	Marcellus Shale, Middle Devonian	Black shale	8,000
A-6	3	Marcellus Shale, Middle Devonian	Black shale	8,000
B-1	38	Marcellus Shale, Middle Devonian	Black shale	8,000
B-2	1	Marcellus Shale, Middle Devonian	Black shale	8,000
B-3	4	Marcellus Shale, Middle Devonian	Black shale	8,000
C	30	Marcellus Shale, Middle Devonian	Black shale	8,000
D	65	Bradford and Elk Groups, Upper Devonian	Sandstone	4,000
E	46	Bradford and Elk Groups, Upper Devonian	Sandstone	4,000
F	42	Bradford and Elk Groups, Upper Devonian	Sandstone	4,000
G-1	21	Bradford and Elk Groups, Upper Devonian	Sandstone	4,000
G-2	7	Bradford and Elk Groups, Upper Devonian	Sandstone	4,000
H	37	Bradford and Elk Groups, Upper Devonian	Sandstone	4,000
I	50	Bradford and Elk Groups, Upper Devonian	Sandstone	4,000
J	32	Bradford and Elk Groups, Upper Devonian	Sandstone	4,000
K	49	Bradford and Elk Groups, Upper Devonian	Sandstone	6,000

Pennsylvania Department of Environmental Protection. Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) Study Report, Rev. 1. May 2016.

# Radium-226 Decay Chain



# ***Gas processing: Radioactive lead***

**Table 6-9. Compressor and Natural Gas Processing Plant Filter Media, Gamma Spectroscopy**

<b>Nuclide</b>	<b>Result</b>
Ac-228	0.141
Bi-212	0.287
Bi-214	0.564
K-40	1.30
Pb-210	3,580
Pb-212	0.066
Pb-214	0.629
Ra-226	0.585
Ra-228	0.141
Th-232	0.125
U-235	-0.105
U-238	-14.7



# Gas pipeline “liquids”: Metals and hazardous waste

## ALGONQUIN GAS TRANSMISSION, LLC -M&R 17 (2007)

Reporting Year: 2007

Facility #1 : ALGONQUIN GAS TRANSMISSION, LL

### Basic Facility Info ?

Handler ID	MAR000009993
Facility Name	ALGONQUIN GAS TRANSMISSION, LLC -M&R 17
Street Number	1183
Address Line 1	SHAWMUT
City	NEW BEDFORD
State	MA
Zip Code	02741
County	PLYMOUTH
113th Congressional District	MA09: Massachusetts 9
First NAICS Code	42471: Petroleum Bulk Stations and Terminals
Current Owner	ALGONQUIN GAS TRANSMISSION, LLC
Site Land Type	Private

### Generated Waste Basics ?

Page Number	1
Waste Description	WASTE PIPELINE LIQUIDS WITH GREATER THAN 50 PPMS PCBS
Form of Waste Category	Organic Liquids
Form of Waste (Regularized)	Other organic liquid (specify in comments) - Organic Liquids
Waste Source Category	Ongoing Production and Service Processes
Waste Source Type (Regularized)	Product and by-product processing - Production Processes
Tons Generated Current Year	1.874
Tons Managed	1.874
Federal Waste (Yes/No)	Yes
Tons Managed Onsite	0
Tons Managed Offsite	1.874
Include in National Report	Yes

### EPA Waste Codes for Generated Waste ?

EPA Waste Code
D001: Ignitable waste
D005: Barium
D007: Chromium
D008: Lead
D009: Mercury

(Facility #1 : ALGONQUIN GAS TRANSMISSION, LL, Generated LIQUIDS WITH GR, EPA waste code: all)

[http://www.rtknet.org/db/brs/brs.php?  
reptype=f&epa\\_id=MAR000009993&reporting\\_year=2007&database=brs&detail=3&datatype=T](http://www.rtknet.org/db/brs/brs.php?reptype=f&epa_id=MAR000009993&reporting_year=2007&database=brs&detail=3&datatype=T)

# ***Answers to health questions: Research, health assessments***



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# ***What about electric compressor stations?***

Air pollution is less

Air pollution is still produced

Assessment of electric compressor stations depends on scope of your vision



# ***An example electric compressor station***

Two electric compressors (15,000 & 8,000 hp)

Blowdown valves, filter/separator units, discharge cooler, backup generator, auxiliary piping systems, air compressor system, water heating system,

Compressor/valve building, control building, variable frequency drive building, building for gas coolers,

# ***An example electric compressor station***

Electric power substation and transformer

Pipeline condensate storage tank

Mainline valve with blowoff assembly

Bidirectional pigging traps

Stormwater retention pond, parking,  
outdoor storage

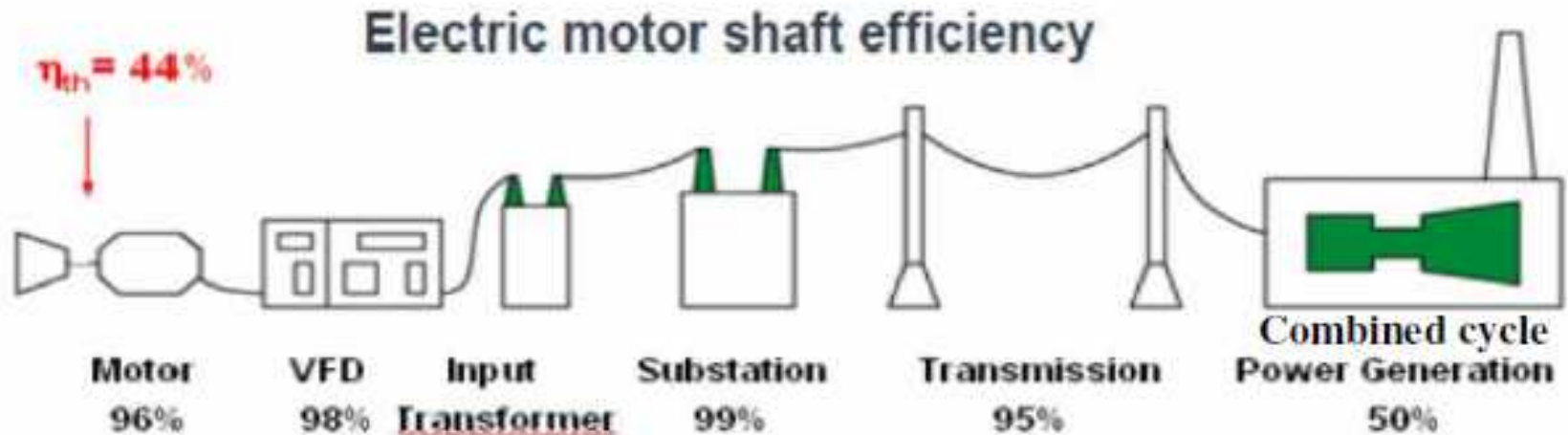
# ***Electric compressor station and substation***



Drivers for Gas Compression: A comparison between reciprocating engines, turbines, and electric motors. Wayne Longer, Caterpillar Global Petroleum.



# *One part of the big picture...*



True Carbon foot print ???

Drivers for Gas Compression: A comparison between reciprocating engines, turbines, and electric motors. Wayne Longer, Caterpillar Global Petroleum.

# ***Blowdowns: Proposed releases***

## Annual Emissions

450 actual cf/compressor blowdown

75 blowdowns/year

2 compressors

$67,500 \text{ acf/yr} = 450 \text{ acf/compressor blowdown} * 75 \text{ blowdowns/yr} * 2 \text{ compressors}$

$3,984,984 \text{ scf/yr} = 67500 \text{ acf/yr} * (964.7 \text{ psia} / 14.7 \text{ psia}) * (519.67^\circ\text{R} / 577.67^\circ\text{R})$

$86.955 \text{ ton/yr} = 3984984 \text{ scf/yr} * 0.0436 \text{ lb/scf} / 2000 \text{ lb/ton}$

$0.447 \text{ ton VOC/yr} = 86.955 \text{ ton/yr} * 0.5138 \text{ wt. \% VOC}$

$0.007 \text{ ton/yr HAPs/yr} = 86.955 \text{ ton/yr} * 0.0075 \text{ wt. \% HAPs}$

$0.069 \text{ ton CO}_2\text{/yr} = 86.955 \text{ ton/yr} * 0.0799 \text{ wt. \% CO}_2$

$81.869 \text{ ton CH}_4\text{/yr} = 86.955 \text{ ton/yr} * 94.1517 \text{ wt. \% CH}_4$

$2,046.80 \text{ ton CO}_2\text{e/yr} = 0.069 \text{ ton CO}_2\text{/yr} * (8186.926 \text{ ton CH}_4\text{/yr} * 25 \text{ CO}_2\text{e/CH}_4)$

$11.20 \text{ lb/yr n-Hexane} = 86.955 \text{ ton/yr} * 0 \text{ wt. \% n-Hexane}$

$1.23 \text{ lb/yr Benzene} = 86.955 \text{ ton/yr} * 0 \text{ wt. \% Benzene}$

$0.65 \text{ lb/yr Toluene} = 86.955 \text{ ton/yr} * 0 \text{ wt. \% Toluene}$

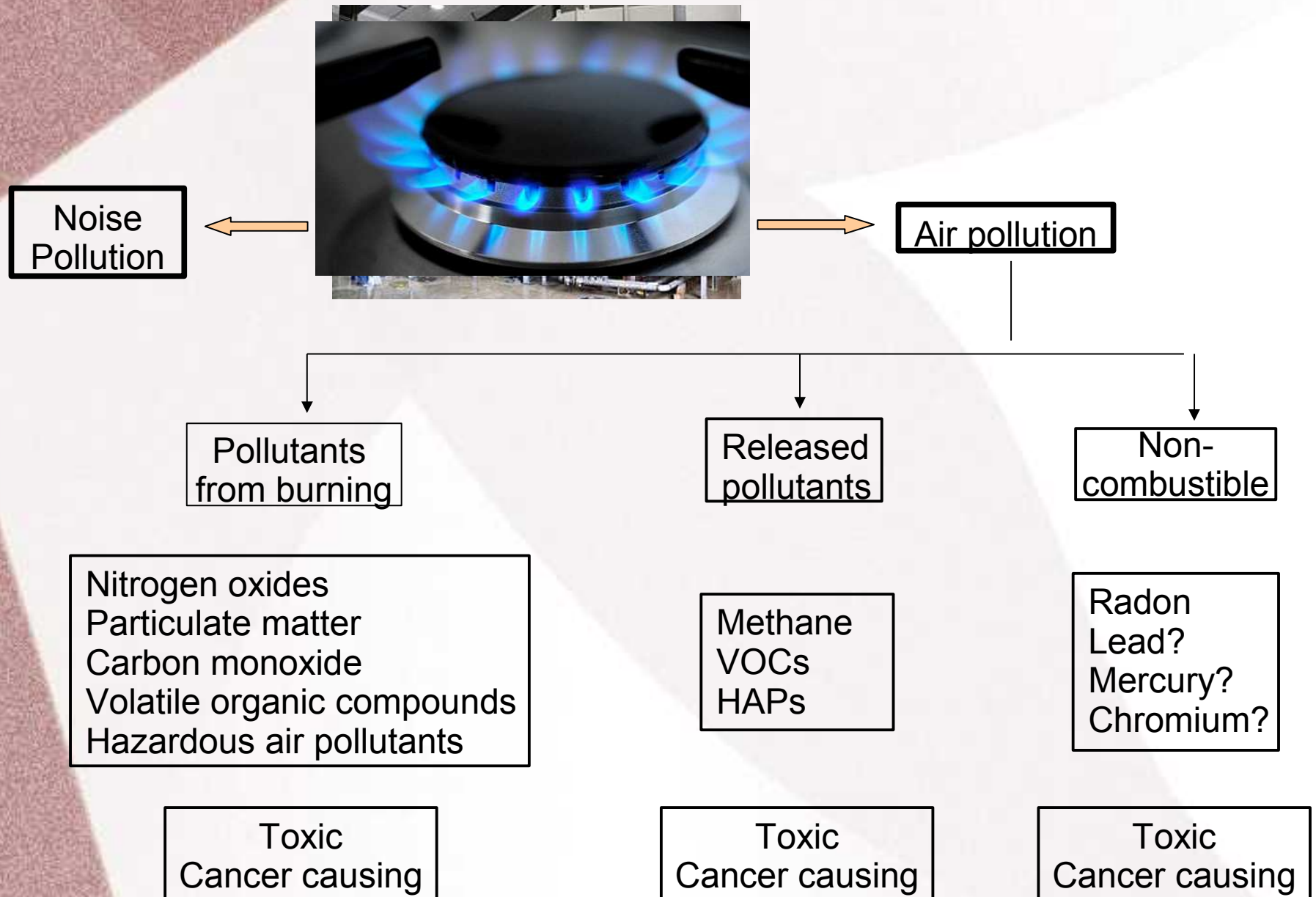
Tennessee Gas Pipeline Co. Nov 2015. Environmental Report, Northeast Energy Direct Project. Resource Report 9, Attachment 9b, emissions calculations, pg 6.

# Blowdowns: “Representative Gas”

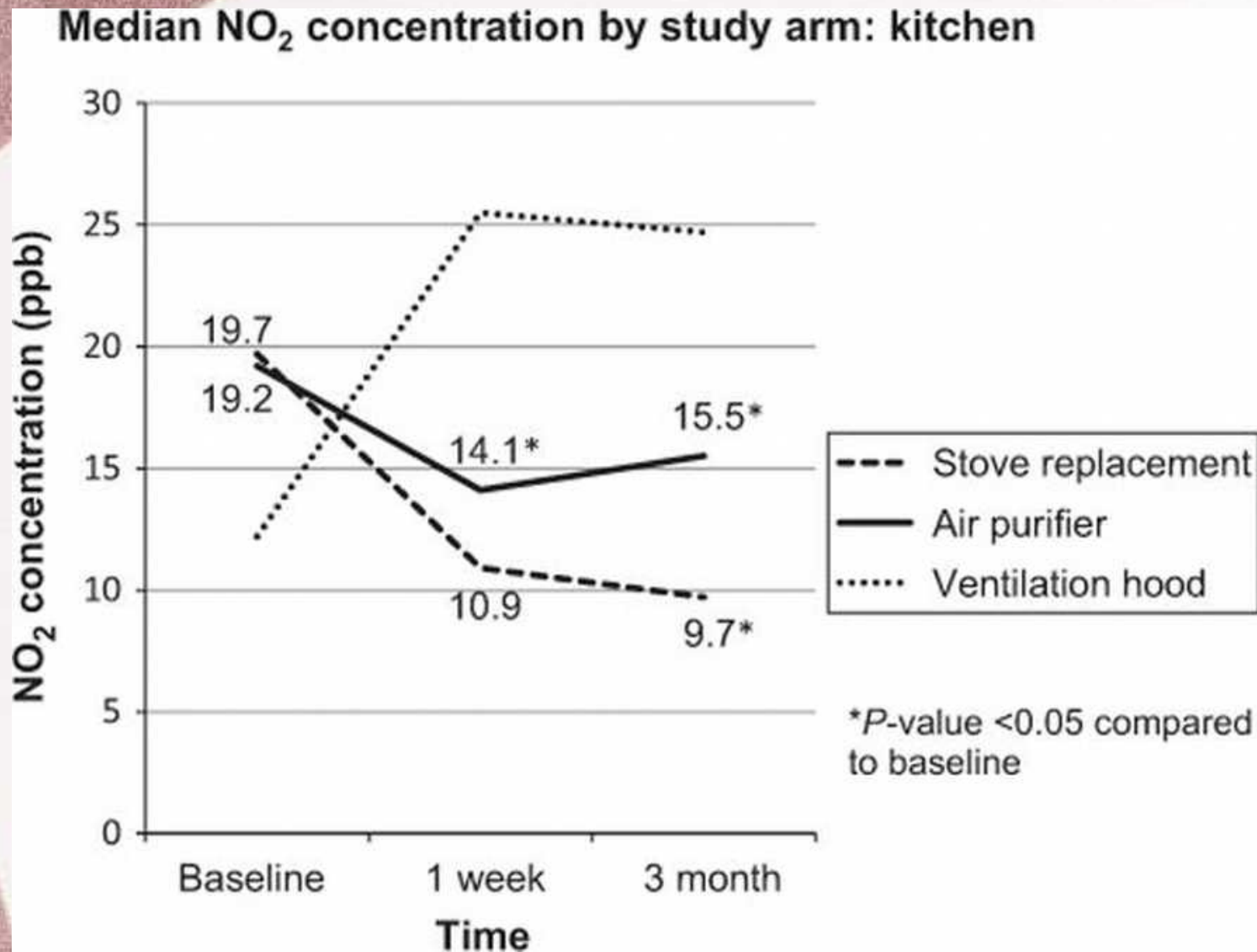
	Mol %	M.W.	lb/lb-mol NG	Mass %		Federal HAPs
Helium	0.02337%	4.0026	0.00094	0.0057%		
Hydrogen	0.01927%	2.0158	0.00039	0.0024%		
Nitrogen	0.41907%	28.0135	0.11740	0.7114%		
Methane	96.84615%	16.0428	15.53680	94.1517%		
CO2	0.02995%	44.0098	0.01318	0.0799%		
Ethane	2.48888%	30.0696	0.74840	4.5352%	non-VOC	
Propane	0.13313%	44.0965	0.05871	0.3558%	VOC	
I-Butane	0.01042%	58.1234	0.00605	0.0367%		
n-Butane	0.01643%	58.1234	0.00955	0.0579%		
I-Pentane	0.00463%	72.1503	0.00334	0.0203%		
n-Pentane	0.00327%	72.1503	0.00236	0.0143%	VOCs	
2,2-dimethylbutane	0.00045%	86.1754	0.00039	0.0023%		
2-methyl Pentane	0.00137%	86.1754	0.00118	0.0071%		
3-methyl Pentane	0.00060%	86.1754	0.00052	0.0031%		
n-Hexane	0.00123%	86.1754	0.00106	0.0064%	0.5138%	0.0064% HAP
MCY Pentane	0.00020%	84.1595	0.00017	0.0010%		
Benzene	0.00015%	78.1118	0.00012	0.0007%		0.0007% HAP
2-methyl hexane	0.00030%	100.2019	0.00030	0.0018%		
2,3-dimethyl pentane	0.00010%	100.2019	0.00010	0.0006%		
3-methyl hexane	0.00035%	100.2019	0.00035	0.0021%		
n-Heptane	0.00038%	100.2019	0.00038	0.0023%		
MCY C6/2,2 DM C6	0.00015%	98.1861	0.00015	0.0009%		
Toluene	0.00007%	92.1384	0.00006	0.0004%		0.0004% HAP
	100.000%		16.502	100.000%		0.0075% HAPs

Tennessee Gas Pipeline Co. Nov 2015. Environmental Report, Northeast Energy Direct Project. Resource Report 9, Attachment 9b, emissions calculations, pg 6.





# *Ditch the gas stove?*



Paulin, L. M. et al. "Home Interventions Are Effective at Decreasing Indoor Nitrogen Dioxide Concentrations." *Indoor air* 24.4 (2014): 416–424.

# ***Odds of pediatric asthma: lower if you ventilate your stove***

<b>Ventilation of gas stove</b>	<b>No. cases</b>	<b>OR (95% CI)</b>
No	269	1 Ref.
Yes	224	0.64 (0.43, 0.97)*

\*P-value <0.05.

Kile ML, et al. A cross-sectional study of the association between ventilation of gas stoves and chronic respiratory illness in U.S. children enrolled in NHANESIII. Environ Health. 2014 Sep 2;13:71



***For today:***

Basics of how a compressor station works

What pollution comes out of a compressor station?

What are the health risks?

# ***A few conclusions***

Presence of risk is clear

Degree of risk is unclear

Independent, comprehensive health impact assessment and more data are needed