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**ENGINEERING
EVALUATION / FACT SHEET**

BACKGROUND INFORMATION

Application No.: G70-A129
Plant ID No.: 085-00044
Applicant: Antero Resources Corp.
Facility Name: Zinn Wellpad
Location: Pennsboro, Ritchie County
SIC Code: 1311
NAICS Code: 211111
Application Type: Construction
Received Date: December 15, 2014
Engineer Assigned: Laura Jennings
Fee Amount: \$1,500
Date Received: December 19, 2014
Complete Date: January 15, 2015
Applicant Ad Date: December 17, 2015
Newspaper: *The Pennsboro News*
UTM's: Easting: 505.3265 km Northing: 4,352.317 km Zone: 17N
Lat/Long: Latitude: 39.320242 Longitude: -80.938208
Description: New construction of an oil and natural gas production facility.

DESCRIPTION OF PROCESS

A mixture of condensate and entrained gas from the wells enters the facility through a number of low pressure separators where the gas phase is separated from the liquid phase. Gas Processing Units (GPU) heaters (H001-H012) are used in conjunction with the separators to help separate the gas from the liquid phases. These heaters are fueled by a slip stream of the separated gas. The separated gas from the low pressure separators is sent to a compressor (ENG001). The compressed gas is then metered and sent to the sales gas pipeline. The separated condensate and water from the separators flow to their respective storage tanks (TANKCOND001 – 010 and TANKPW001-002).

The facility has ten (10) tanks (TANKCOND001-010) on site to store condensate and two (2) tanks (TANKPW001-002) to store produced water prior to removal from the site. Flashing, working, and breathing losses from the tanks are routed to the flare (FL001) to control the emissions. The flare that will be used to control emissions is designed to achieve a VOC destruction efficiency of 98%.

Condensate and produced water are transported off site on an as needed basis via tanker truck. Truck loading connections are in place to pump condensate (L001) and produced water (L002) from the storage tanks into tanker trucks. Emissions from the loading operations are vented to the atmosphere.

Emissions from the facility's emission sources were calculated using the extended analysis of the condensate and gas from Prunty No. 1H, one of the wells on the Lockhart Heirs well pad. These extended analyses are considered representative of the materials from the Strickling well pad, being in the same Marcellus rock formation. The representative condensate sample from Prunty #1H and the proposed wells to be drilled on the Zinn well pad are both considered wet gas areas within the Marcellus Formation. The Prunty #1H condensate sample was selected because the natural gas BTU value (1250) is expected to be similar in heating value to the proposed wells on the Zinn well pad.

There are 12 proposed natural gas wells to be located at this facility.

Emission Units Table:

Emission Unit ID	Emission point ID	Emission Unit Description	Year Installed / Modified	Design Capacity	Type and Date of Change	Control Device
H001 H002 H003 H004 H005 H006 H007 H008 H009 H010 H011 H012	EP-H001 EP-H002 EP-H003 EP-H004 EP-H005 EP-H006 EP-H007 EP-H008 EP-H009 EP-H010 EP-H011 EP-H012	Gas Processing Unit Heater(s)	New	1.5 MMBtu/hr (each)	New	N/A
TANKCOND001 TANKCOND002 TANKCOND003 TANKCOND004 TANKCOND005 TANKCOND006 TANKCOND007 TANKCOND008 TANKCOND009 TANKCOND010	FL001	Condensate Tank(s)	New	400 bbl (each)	New	FL001
TANKPW001 TANKPW002	FL001	Produced Water Tank(s)	New	400 bbl (each)	New	FL001
L001	EP-L001	Loading (Condensate)	New	7.36 MMgal/yr	New	N/A

L002	EP-L002	Loading (Produced Water)	New	88.30 MMgal/yr	New	N/A
FL001	FL001	Flare (Abutec-200)	New	138 scfm; 18.4MMBtu/hr	New	N/A
PCV	EP-PCV	Pneumatic Control Valves	New	6.6 scfd/PCV	New	N/A
ENG001	EP-ENG001	Compressor Engine (Kubota DG972-E2)	New	24 HP @ 3600 rpm	New	N/A

Control Device Table:

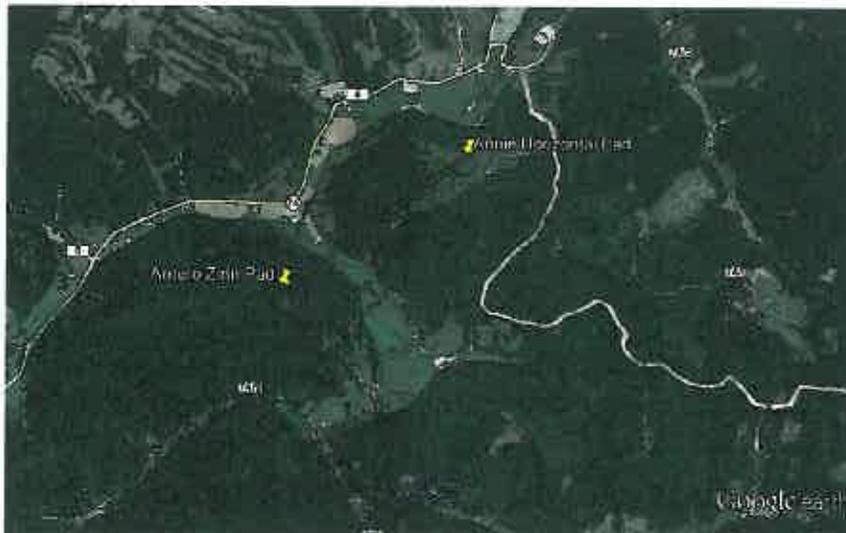
Emission Unit ID	Control Device ID	Control Device Description	Pollutant	Control Efficiency
FL001	FL001	Flare (Abutec-200)	VOCs	98%
			HAPs	98%

SITE INSPECTION

A site visit was conducted by James Robertson of DAQ's Compliance and Enforcement section on January 14, 2015. This site is located on top of a hill off Route 74. The pad itself has not been developed but he was able to drive to what he believed will be the eventual access road to the site. There was also a right of way with gas lines leading up to this point on the hill that is shown in the permit application to be the eventual location of the pad.

There are scattered houses along Route 74 but none located near the pad. Based on his site evaluation and Google Earth, it appears the closest occupied dwelling is over 1000 feet away at an elevation significantly lower than the eventual pad location. He did not see any business, public building, school, church, community, institutional building, or public park within 300 feet of the site. In the inspector's opinion, this site is suitable for a General Permit.

Directions to the facility are as follows: From the intersection of WV-74N/Mountain Dr. and Marsh Run, head north on WV-74N and go 3.5 miles to reach destination on the right.



SOURCE AGGREGATION

New source review for major source determinations includes consideration of the aggregation of related sources. A three-pronged test is used to evaluate whether sources should be aggregated. The three prongs are SIC code, contiguous and adjacent, and common control.

SIC Code: The Zinn well pad will operate under SIC code 1311 (Crude Petroleum and Natural Gas Extraction). There are other wells operated by Antero in West Virginia that share the same two-digit SIC code of 13, including the nearby Annie Horizontal Well Pad (085-00033 / R13-3187). Therefore, the facility shares the same SIC code.

Contiguous or Adjacent: The intent of this prong of the test is to assess whether or not other related operations meet the common sense notion of a single plant. While the terms “contiguous” and “adjacent” are not defined by the U.S. EPA, dictionary definition of “contiguous” means to be in actual contact and “adjacent” to be nearby and having a common endpoint or border. These definitions have been used to make these case-by-case determinations. The nearest well operated by Antero is the Annie well pad which is 0.85 miles northeast of the Zinn well pad location. The applicant states that the Annie Horizontal Well pad is not contiguous or adjacent to the Zinn well pad.

Common Control: Common control determinations can require review of contractual arrangements to ascertain the legal relationships between entities with ownership or management control of proposed facilities. The proposed Strickling well pad and the Alexander well pad will both be under Antero’s common control.

DAQ Conclusion: Based on this review, it is concluded that there are no existing well pads that meet all three aggregation criteria relative to this subject facility. While the Annie Horizontal well pad is operated by Antero under the same two-digit SIC code (13), the two facilities are not adjacent or contiguous. Therefore, the facilities should not be aggregated for the purposes of determining major source status for 45CSR14 or 45CSR30.

ESTIMATE OF EMISSIONS BY REVIEWING ENGINEER

This section includes a description of the emission calculation methodology used for each type of equipment. All emission calculations were reviewed and verified by the writer.

Gas Processing Unit Heaters

Emission factors used for the emission calculations of the eleven GPU Heaters (H001 – H012) are from AP-42, Section 1.4 for natural gas combustion. The rating of each GPU heater is 1.50 MMBtu/hr. The fuel heating value is 1,247 Btu/scf. Emissions from the GPU heaters are not controlled.

Storage Tanks

Vapor mass fractions, working, breathing, and flashing losses were calculated by the Promax modeling software program. Outputs from the modeling were provided in the application. The

flare (FL01) is used to control the emissions from the condensate storage tanks (TANKCOND001 – TANKCOND010) and the produced water tanks (TANKPW001 – TANKPW002). Condensate storage tank emissions are based on a total throughput of 480 barrels per day (7,358,400 gallons/year). Produced water storage tank emissions are based on a total throughput of 5,760 barrels per day (88,300,800 gallons/year). Emissions from the storage tanks are controlled by a flare (FL01) that has a destruction efficiency of 98% for VOCs and will be in operation 100% of the time that emissions are routed to it.

The controlled VOC emissions from each of the condensate tanks is 0.60 tpy and the controlled VOC emissions from each produced water tank is 0.23 tpy.

Flare (FL001)

Emission factors for the combustion from the flare are taken from AP-42, Section 1.4. Emissions from the flare include the combustion of the pilot flame fuel stream; the controlled emissions from the condensate storage tanks and the combustion emissions of that stream; and the controlled emissions from the produced water storage tanks and the combustion emissions of that stream. The flare has a destruction efficiency of 98%.

Flare (FL001) has a maximum design heat input of 18.4 MMBtu/hr and was designed per §60.18 according to the application. The pilot will have automatic re-ignition and a thermocouple will detect the presence of the pilot flame.

Truck loading (L001, L002)

The vapor mass fractions and molecular weight were provided in the output from the Promax simulation model. The RVP was taken from laboratory reports. The loading losses were calculated using the equation from AP-42, Chapter 5. The tank truck loading operation is not controlled and the emissions are vented to the atmosphere. The total condensate throughput used in the emission calculations is 7,358,400 gallons per year. The total produced water throughput used in the emission calculations is 88,300,800 gallons per year.

Engine

The Kubota DG972-E2 compressor engine (ENG001) is a RB4S engine type and has a power rating of 24 hp. The fuel throughput is 1.6907 MMft³/yr and the heat content of the fuel is 1219 Btu/scf. The NO_x emissions were calculated using the NOX standard provided on the EPA certificate of conformity for engine family DKBXS.9622HP. The CO emission factor was taken from the test data submitted for EPA certification for non-road small SI 2013 certification. AP-42, Section 3.2 provided the emission factors that were used to calculate the VOC, SO₂, PM₁₀, and formaldehyde emissions.

Greenhouse Gas Emissions

Global warming potentials are from the EPA site.

Emissions Summary Table:

Emission Point ID	Emission Unit ID	Control Device ID	Regulated Pollutant	Maximum Potential Uncontrolled Emissions		Maximum Potential Controlled Emissions	
				lb/hr	tpy	lb/hr	tpy
EP-H001 thru EP-H012	H001 thru H012	None	NO _x	1.44	6.32	1.44	6.32
			CO	1.21	5.31	1.21	5.31
			PM (Total)	0.11	0.48	0.11	0.48
			SO ₂	0.01	0.04	0.01	0.04
			VOC	0.08	0.35	0.08	0.35
			Total HAPs	0.03	0.12	0.03	0.12
			CO ₂ e	1742	7632	1742	7632
FL01	TANKCOND001 TANKCOND002 TANKCOND003 TANKCOND004 TANKCOND005 TANKCOND006 TANKCOND007 TANKCOND008 TANKCOND009 TANKCOND010 TANKPW001 TANKPW002	FL001	Total VOCs	309.12	1353.93	6.18	27.08
			Total HAPs	14.52	63.58	0.29	1.27
			Benzene	0.57	2.49	0.01	0.05
			Toluene	0.51	2.24	0.01	0.05
			Ethylbenzene	0.14	0.60	<0.01	0.01
			Xylenes	0.34	1.47	0.01	0.03
			Hexane	12.96	56.78	0.26	1.14
			NO _x	n/a	n/a	0.44	1.94
			CO	n/a	n/a	0.37	1.63
			PM	n/a	n/a	0.04	0.15
			PM _{2.5}	n/a	n/a	0.04	0.15
			CO ₂ e	1,460	6,395	1,507	6,599
			EP-L001, EP-L002	L001, L002	None	Total VOCs	9.53
Total HAPs	0.03	0.01				0.03	0.01
CO ₂ e	8.27	3.02				8.27	3.02
EP-ENG001	ENG001	None	CO	5.64	24.72	5.64	24.72
			NO _x	0.32	1.38	0.32	1.38
			SO ₂	<0.01	<0.01	<0.01	<0.01
			PM/ PM ₁₀ / PM _{2.5}	<0.01	0.01	<0.01	0.01
			Total VOCs	0.01	0.03	0.01	0.03
			Formaldehyde	0.01	0.02	0.01	0.02
			CO ₂ e	27.78	122	27.78	122

Fugitive Emissions

Fugitive emissions from leaks are based on an estimated component count of 600 valves in gas VOC service, 708 connectors in gas VOC service, 156 flanges in gas VOC service, and 624 valves in light liquid VOC service. Emission factors for oil and gas production facilities come from EPA's "Protocol for Equipment Lead Emission Estimates", November 1995, EPA 4531, R-95-017, Table 2-4.

Pneumatic control valves are part of the GPU heaters. These are intermittent low bleed valves and their emissions are assumed to be occurring throughout the year. The pneumatic control valve (PCV) bleed rate of 6.6 scf/day/PCV was obtained from the user manual for PCV and is based on 48 PCV.

Fugitive Emissions Table:

Source	Regulated Pollutants	Maximum Potential Uncontrolled Emissions		Maximum Potential Controlled Emissions	
		lb/hr	tpy	lb/hr	tpy
Equipment Components	VOCs	4.56	19.99	4.56	19.99
	n-Hexane	0.33	1.44	0.33	1.44
	Total HAPs	0.44	1.92	0.44	1.92
	CO ₂ e	96.87	424	96.87	424
Pneumatic Control Valves (PCV)	VOCs	0.14	0.60	0.14	0.60
	Total HAPs	0.02	0.07	0.02	0.07
	CO ₂ e	10.84	47.48	10.84	47.48

The total facility potential to emit (PTE) including fugitive emissions is provided in the table below:

Pollutant	Facility Wide PTE (tons/year)
Nitrogen Oxides	9.64
Carbon Monoxide	31.66
Volatile Organic Compounds	51.53
Particulate Matter 2.5	0.60
Particulate Matter	3.73
Sulfur Dioxide	0.04
n-Hexane	2.77
Total HAPs	3.42
Carbon Dioxide Equivalent	14,832

REGULATORY APPLICABILITY

Applicable state and federal regulations are included in the G70-A general permit. Only state and federal rules specifically relating to the applicability requirements of the G70-A general permit or relating to the section applicability of the G70-A registration are addressed in this section.

State Regulations

45CSR2 (To Prevent and Control Particulate Air Pollution From Combustion of Fuel in Indirect Heat Exchangers)

45CSR2 establishes emission limitations for smoke and particulate matter that are discharged from fuel burning units. The Gas Processing Unit Heaters (H001 – H012) are subject; however the units have a rating of 1.5 MMBtu/hr and therefore are not subject to the weight emission standard for particulate matter set forth in 45CSR2-4.1.

Antero Resources is subject to the opacity requirements set forth in 45CSR2, Section 3.1. Compliance will be demonstrated by demonstrating compliance with the G70-A, Section 7 requirements to which they applied.

45CSR6 (To Prevent and Control Air Pollution from the Combustion of Refuse)

45CSR6 prohibits open burning, establishes emission limitations for particulate matter, and establishes opacity requirements. Sources subject to 45CSR6 include completion combustion devices, enclosed combustion devices, and flares.

The flare (FL001) is subject to the particulate matter weight emission standard set forth in §45-6-4.1; the opacity requirements in §§45-6-4-3 and 4-4; the visible emission standard in §45-6-4.5; the odor standard in §45-6-4.6; and the testing standard in §§45-6-7.1 and 7.2.

Antero has applied for registration to Section 14 of the G70-A general permit That includes requirements for 45CSR6. The flare will be burning natural gas and the potential PM emissions will be 0.01 lb/hr demonstrating compliance. Additional compliance will be demonstrating by demonstrating compliance with the requirements of Section 14 of the G70-A general permit.

45CSR10 (To Prevent and Control Air Pollution from the Emission of Sulfur Oxides)

45CSR10 establishes emission limitations for SO₂ emissions which are discharged from stacks of fuel burning units. A “fuel burning unit” means and includes any furnace, boiler apparatus, device, mechanism, stack or structure used in the process of burning fuel or other combustible material for the primary purpose of producing heat or power by indirect heat transfer. Sources that meet the definition of “Fuel Burning Units” per 45CSR10-2.8 include gas producing units, in-line heaters, heater treaters, and glycol dehydration unit reboilers.

The Gas Processing Unit Heaters (H001 – H012) each have a rating of 1.5 MMBtu/hr and are therefore exempt because they are less than 10 MMBtu/hr.

45CSR13 (Permits for Construction, Modification, Relocation and Operation of Stationary Sources of Air Pollutants, Notification Requirements, Administrative Updates, Temporary Permits, General Permits, and Procedures for Evaluation)

Antero Resources submitted a complete G70-A registration application, published the required Class I legal advertisement, and paid the appropriate fees. The Class I legal advertisement ran in *The Pennsboro News*, on December 17, 2014.

Based on the information provided in the application along with the site inspection conducted by DAQ, the proposed facility will not be constructed within 300 feet of any occupied dwelling, business, public building, school, church, community, institutional building or public park. The application meets all other requirements for registration under a G70-A general permit, including not being subject to 45CSR30, 45CSR14, or 45CSR19.

The registrant meets the applicability requirements of the G70-A General Permit.

45CSR16 (Standards of Performance for New Stationary Sources Pursuant to 40 CFR Part 60)

Antero Resources is subject to 45CSR16 because they are subject NSPS, Subparts JJJJ and OOOO described in more detail in the federal regulations section.

45CSR22 (Air Quality Management Fee Program)

This facility has paid the applicable \$1,000 NSPS fee and is required to maintain a current Certificate to Operate.

45CSR34 (Emission Standards for Hazardous Air Pollutants)

Antero Resources is subject to 45CSR34 because they are subject to the area source requirements of 40 CFR 63, Subpart ZZZZ described in more detail in the Federal Regulations section.

Federal Regulations

40CFR60, Subpart JJJJ (Standards of Performance for Stationary Spark Ignition Internal Combustion Engines)

The Kubota DG792-E2 engine (ENG001) has a rating of 24 HP @ 3600 rpm and a manufacture date of 2013. The engine is subject to 40CFR60, Subpart JJJJ because it is a stationary spark ignition internal combustion engine less than or equal to 25 hp that was constructed after June 12, 2006 and manufactured on or after July 1, 2008.

Antero Resources has demonstrated compliance with the emission standards by purchasing a certified engine. The certificate number provided in the application is DKBXS.9622HP-002 and covers engine family DKBXS.9622HP. Antero Resources is required to operate and maintain the certified SI internal combustion engine according to the manufacturer's emission-related written instructions to operate in a certified manner and maintain records of conducted maintenance to demonstrate compliance. There are no performance testing requirements for certified engines being operated and maintained in a certified manner.

40CFR60 Subpart OOOO (Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution)

EPA published in the Federal Register new source performance standards (NSPS) and air toxics rules for the oil and gas sector on August 16, 2012. 40CFR60 Subpart OOOO establishes emission standards and compliance schedules for the control of volatile organic compounds (VOC) and sulfur dioxide (SO₂) emissions from affected facilities that commence construction, modification or reconstruction after August 23, 2011. The following affected sources which commence construction, modification or reconstruction after August 23, 2011 are subject to the applicable provisions of this subpart:

- a. *Each gas well affected facility, which is a single natural gas well.*

The gas wells at the Zinn wellpad will be drilled after August 23, 2011 and are therefore considered affected facilities under this Subpart. Compliance includes notification and recordkeeping and will be demonstrated with compliance to the requirements in Section 5 of the G70-A General Permit to which the registrant applied.

- b. *Pneumatic Controllers*

- *Each pneumatic controller affected facility, which is a single continuous bleed natural gas-driven pneumatic controller operating at a natural gas bleed rate greater than 6 scfh which commenced construction after August 23, 2011, and is located between the wellhead and the point of custody transfer to the natural gas transmission and storage segment and not located at a natural gas processing plant.*
- *Each pneumatic controller affected facility, which is a single continuous bleed natural gas-driven pneumatic controller which commenced construction after August 23, 2011, and is located at a natural gas processing plant.*

There are no continuous bleed gas-driven pneumatic controllers with bleed rates greater than 6 standard cubic feet per hour (scfh) at the Zinn well pad. The pneumatic control valves that are part of the GPU heaters are intermittent low bleed valves that have a bleed rate of 6.6 scf/day. Therefore, there are no applicable requirements regarding pneumatic controllers under 40 CFR 60 Subpart OOOO that would apply.

- c. *Each storage vessel affected facility, which is a single storage vessel, located in the oil and natural gas production segment, natural gas processing segment or natural gas transmission and storage segment.*

This rule requires that the registrant determine the VOC emission rate for each storage vessel affected facility utilizing a generally accepted model or calculation methodology within 30 days of startup, and minimize emissions to the extent practicable during the 30 day period using good engineering practices. For each storage vessel affected facility that emits more than 6 tpy of VOC, the permittee must reduce VOC emissions by 95% or greater within 60 days of startup. The compliance date for applicable storage vessels is October 15, 2013.

The storage vessels at the Zinn well pad facility are controlled by a flare that has 98% control. The controlled VOC PTE for each of the condensate vessels at this site is 0.60 tpy and the controlled PTE for each of the produced water tanks is 0.23 tpy based on the information provided in the application. Antero Resources is not subject to the requirements of Section 12 of the G70-A General Permit.

40CFR63, Subpart ZZZZ (National Emission Standards for Hazardous Air Pollutants for Source Categories from Stationary Reciprocating Internal Combustion Engines – Area Source)

Subpart ZZZZ establishes national emission limitations and operating limitations for HAPs emitted from stationary RICE located at major and area sources of HAP emissions. This subpart also establishes requirements to demonstrate initial and continuous compliance with the emission limitations and operating limitations.

A stationary RICE located at an area source of HAP emissions is new if you commenced construction of the stationary RICE on or after June 12, 2006.

The compressor engine (ENG001) at the Zinn well pad is considered a new engine located at an area source of HAP emissions and is therefore subject to this subpart. Compliance with Subpart ZZZZ is demonstrated with compliance to 40 CFR 60, Subpart JJJJ previously discussed. The registrant has applied to Section 15 of the G70-A General Permit.

Non-applicability determinations

40CFR63, Subpart HH (National Emission Standards for Hazardous Air Pollutants for Source Categories from Oil and Natural Gas Production Facilities)

Antero Resources does not have a TEG dehydration unit at the Strickling Well Pad facility; therefore, they are not subject to this Subpart.

TOXICITY OF NON-CRITERIA REGULATED POLLUTANTS

Small amounts of non-criteria regulated hazardous air pollutants such as benzene, toluene, Ethylbenzene, xylene, n-hexane and formaldehyde may be emitted when natural gas is combusted in reciprocating engines, combusted in the fuel burning units, or combusted in one of the combustion type air pollution control devices. The summary information for n-hexane is provided below.

n-Hexane:

n-Hexane is a solvent that has many uses in the chemical and food industries, either in pure form or as a component of commercial hexane. The latter is a mixture that contains approximately 52% n-hexane; the balance is made up of structural analogs and related chemicals such as methylpentane and methylcyclopentane. Highly purified n-hexane is used as a reagent for chemical or chromatographic separations. Other grades of n-hexane are used as solvents for extracting edible fats and oils in the food industry and as a cleaning agent in the textile, furniture, and printing manufacturing industries. Hexane is the solvent base for many commercial products, such as glues, cements, paint thinners, and degreasers. n-Hexane is a minor constituent of crude oil and natural gas and occurs in different petroleum distillates. No data are available regarding the potential toxicity of n-hexane in humans orally exposed to n-hexane. However, as might be expected for a chemical with such wide application, the potential exists for persons to be environmentally and/or occupationally exposed to n-hexane via other routes of exposure.

AIR QUALITY IMPACT ANALYSIS

Modeling was not required of this source due to the fact that the facility is not subject to 45CSR14 (Permits for Construction and Major Modification of Major Stationary Sources of Air Pollutants).

MONITORING OF OPERATIONS

Antero Resources is subject to the following monitoring requirements at the Zinn Well Pad facility:

- NSPS, Subpart OOOO notification, recordkeeping and reporting requirements of Section 5 for the natural gas well affected facilities.
- The condensate storage vessels are subject to the MRR requirements of Section 6 of the G70-A.
- The GPU heaters are subject to the MRR requirements of Section 7 of the G70-A.
- The compressor engine is subject to the MRR requirements of Section 10 of the G70-A, and the MRR requirements of NSPS, Subpart JJJJ in Section 13 of the G70-A.
- The flare is subject to the MRR requirements of Section 14 of the G70-A .
- Condensate tank truck loading is subject to the MRR requirements of Section 11 of the G70-A including recordkeeping of annual throughputs.

RECOMMENDATION TO DIRECTOR

It is recommended that General Permit Registration G70-A129 be granted to Antero Resources, Zinn Well Pad facility located in Pennsboro, Ritchie County. Based on the information provided in the application including all supplemental information received, the applicant should meet all applicable state and federal requirements.



Laura Jennings
NSR Permit Engineer



Date