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April 29, 2010
Project No. 83088

Colorado Department of Public Health and Environment
Air Pollution Control Division
4300 Cherry Creek Drive South, APCD-SS-B1
Denver, Colorado 80246-1530

Subject: Revised Reasonably Available Control Technology (RACT) Report
Piñon Ridge Mill, Montrose County, Colorado
Permit Numbers: 09MO0945 through 09MO0952

Dear Sir or Madam:

Energy Fuels Resources Corporation (Energy Fuels) is submitting additional information for the air permit application for authorization to construct and operate a uranium and vanadium mill (Piñon Ridge Mill). The Piñon Ridge Mill site is located approximately 12 miles west of Naturita, Colorado along Highway 90, in Paradox Valley, Montrose County, Colorado. The Property address is 16910 Highway 90, Bedrock, Colorado 81411.

This submittal includes a revision to the Reasonably Available Control Technology (RACT) report that was submitted on November 10, 2009. The revision addresses items that were identified for further clarification in a letter from CDPHE dated February 19, 2010. Additional information regarding the feasibility of specific control technologies has been added. Each identified VOC control technology has been thoroughly investigated to determine applicability and feasibility for VOC control of the raffinate stream.

The raffinate solution is typically sent to the evaporation ponds and tailings cells after the useful organic and aqueous solutions have been removed. This raffinate stream is a concentrated brine solution containing waste ore materials such as metals, salts, and radionuclides. The stream consists of approximately 10% dissolved solids concentrations (100,000 ppm) at a low pH of 4.4. Raffinate waste streams contain relatively small organic concentrations, on the order of 10 to 100 ppm organic (0.001% to 0.01%). Therefore, separation of the remaining organic liquid from the brine solution is not easily achieved.

Although the RACT report states that some of the VOCs become entrained in the tailings, no emission reduction is taken for this assumption. This statement was made to show that there is likely a physical phenomenon taking place in the process that

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would reduce the amount of VOC being emitted due to evaporation; however, because of lack of data, no emission credit has been taken.

We have identified several strategies that are feasible to reduce and minimize the amount of VOC emitted by the process, the evaporation ponds, and tailings cells. These include (1) the use of covered tanks in the solvent extraction (SX) process, (2) the addition of a raffinate buffer tank and crud centrifuge, and (3) high efficiency pressure leaf filters. Covered tanks have typically not been employed at uranium mills, however the EFR facility will use enclosed mixer settler tanks to minimize the amount of organic evaporation during the solvent extraction process. The facility will also employ a unique process to reduce the organic entering the evaporation ponds and tailings cells. A raffinate buffer tank will be used to contain SX solution during process upset conditions and a crud centrifuge will be used to separate the organic and aqueous streams. The buffer tank and centrifuge will also be routinely used approximately six times a year, to recondition the SX solution by removing suspended particles and separating entrained organic solution from the aqueous stream. This will extend the useful life of the organic collector and reduce the need for organic makeup solution. Finally, the facility proposes to use high efficiency pressure leaf filters for removal of suspended particles prior to both the vanadium and uranium circuits, as opposed to typical solids filters. Use of pressure leaf filters is expected to minimize contamination of the system with suspended solids that form an emulsification (commonly referred to as crud) between the aqueous and organic phases that leads to upset conditions in the organic extraction processes and loss of the organic solution to the barren raffinate stream.

By employing these RACT strategies, the facility estimates that the amount of kerosene entering the process will be reduced from 663 tons per year (tpy) to 198 tpy, a 70% reduction. Process emissions will be reduced by 75%, from 145 tpy to 36 tpy. Fugitive emissions will be reduced by 69%, from 518 tpy to 162 tpy.

Our assessment of the remaining VOC control technologies demonstrates that no additional control technologies are considered technologically feasible. Therefore, it is our determination that each of the VOC control technologies considered technologically feasible within this RACT report have been examined and will be implemented.

APENs and emission calculations for AIRS ID 011 and AIRS ID 013 will require revision due to updated VOC calculations based on this revision of the RACT report. However, the updated APENs will not be submitted until the revised RACT report and associated calculations are deemed complete by CDPHE.

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Kleinfelder and Energy Fuels request a meeting in approximately two weeks upon receipt of this letter to further discuss and finalize this RACT assessment. Please contact Kris Allen or Michele Steyskal of Kleinfelder at (719) 632-3593. We appreciate your review of this RACT report and look forward to hearing from you.

Sincerely,

Michele Steyskal

Michele Steyskal
Air Quality Professional

cc.: Mr. Frank Filas (Energy Fuels Resources)
Mr. Bob Monok (Energy Fuels Resources)

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REASONABLY AVAILABLE CONTROL TECHNOLOGY REPORT

Rev. 1 **Date: April 29, 2010**

PIÑON RIDGE MILL
Montrose County, Colorado

Submitted to:

Air Pollution Control Division
Colorado Department of Public Health and Environment

Prepared for:

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Project No. 83088
DCN: 83088.6.2-ALB09RP003

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REASONABLY AVAILABLE CONTROL TECHNOLOGY REPORT

REV. 1

PIÑON RIDGE MILL
Montrose County, Colorado

Submitted to:

Air Pollution Control Division
Colorado Department of Public Health and Environment

Prepared for: **Energy Fuels Resources Corporation**
Lakewood, CO

Prepared by: **Kleinfelder West, Inc.**
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Project No. 83088
DCN: 83088.6.2-ALB09RP003
Date: 11/10/09
Revised 04/29/2010

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1.0 INTRODUCTION

This report evaluates Reasonably Available Control Technology (RACT) for reducing volatile organic compound (VOC) emissions from the Energy Fuels Resources Corporation (EFR) proposed Piñon Ridge Mill Site (Mill Site) located in Montrose County, Colorado. This RACT assessment was prepared in support of air permitting efforts in accordance with the Colorado Revised Statutes Regulations 3 and 7, verbal guidance from the Colorado Department of Public Health and Environment (CDPHE) Air Pollution Control Division (APCD), and the United States Environmental Protection Agency (USEPA) Control Technology Guideline (CTG) Series, Control of Volatile Organic Compound Emissions from Industrial Wastewater ("CTC Guideline"). This CTC Guideline contains emission control techniques and EPA guidance for a RACT assessment for industrial wastewaters generated in six specific industries. There is not a RACT guidance document specific to the uranium or vanadium industry, so it is considered as a general RACT guidance document for this project.

1.1 Basis for RACT Analysis

Pursuant to the Colorado Code of Regulations (CCR) 5 CCR-1001-5 Air Quality Control Commission Regulations (AQCC) Regulation 3.C.2.a, the facility would have to apply RACT for those regulated criteria pollutants for an area that is classified as non-attainment, or in attainment with a maintenance program. However, the area of the proposed Mill Site is in attainment and is not under a maintenance program for any regulated criteria pollutants. Therefore RACT is not triggered for the regulated criteria pollutants per AQCC Regulation 3.C.2.a. These regulated pollutants include particulate matter (PM_{10}/$PM_{2.5}$), volatile organic compounds (VOC), nitrogen oxides (NOx), sulfur oxides (SOx), and carbon monoxide (CO).

Pursuant to 5 CCR-1001-9 AQCC Regulation 7.V.A, the facility may not dispose of a VOC by evaporation or spillage unless RACT is utilized. Per discussion with the APCD, this regulation is considered to be applicable because the process results in VOC-containing liquids to be discharged to the evaporation ponds and tailings cells where it can then evaporate. Therefore, a RACT analysis specific to VOC reductions is required. This report provides an analysis of the effectiveness of control strategies for reducing VOC emissions from the process, the tailing cells, and evaporation ponds.

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1.2 RACT Analysis Approach

RACT is considered to be the lowest emission limitation that a particular source is capable of meeting by the application of control technology that is reasonably available, considering technological and economic feasibility. Accordingly, this RACT analysis includes identifying reasonably available control technologies and evaluating the economic and technological feasibility of those options. Since CDPHE does not have a cost-effectiveness threshold, the one-time (unannualized) capital cost of equipment will be considered.

The analysis also evaluated changes to the operational practices, materials used, management practices, and other environmental factors/consequences. A summary of the best options considered reasonable were concluded as the appropriate level for RACT.

Two control strategies applied for the reduction of VOC emissions are defined in the CTC guideline. The first control strategy is waste minimization through process modifications, modification of operating practices, preventive maintenance, recycling, or segregation of waste streams. These types of strategies were investigated and are detailed in Section 2 of this RACT assessment.

The second control strategy identified in the CTC guideline is to reduce the VOC content of the wastewater through treatment before the stream contacts ambient air. A more complete strategy for reducing the VOC content of the wastewater includes: (1) suppression of emissions from solutions entering the evaporation ponds or tailings cells by enclosing the evaporation ponds or tailings cells, (2) treatment of the organic and aqueous solutions to remove VOCs, and (3) treatment of residuals (organic phases or sludges). Various VOC treatment, capture, and control technologies were investigated and are discussed in detail in Section 3 of this RACT assessment.

Appendix A contains emission reduction calculations for each of the control technologies considered to be both technologically and economically feasible. Appendix B contains cost data references for these control technologies, however it should be noted that specific vendors have not been selected at this time, so equipment considered to be equivalent or manufactured by other vendors may be used.

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2.0 PROCESS UPGRADES AND WASTE MINIMIZATION

EFR designed the Piñon Ridge Mill based on input from former mill operators and discussions with vendors regarding currently available technology. This resulted in the incorporation of many technological improvements in the Piñon Ridge Mill design compared to the existing and former uranium/vanadium mills in the United States, which were largely constructed between 1950 and 1980. These improvements were especially notable in reducing air emissions and chemical and radiological exposures of mill workers. However, in calculating chemical consumption rates and associated costs, EFR relied primarily on historical records from other mill facilities. This resulted in an estimated consumption rate of 663 tons of kerosene per year for a 1,000 ton per day (tpd) mill. A comparison of the current technology proposed at the Piñon Ridge Mill to the older technology used in similar mills indicates that the kerosene consumption for the Piñon Ridge Mill will be 198 tons or less per year.

EFR proposes to include a number of conservation strategies and processing upgrades within its solvent extraction (SX) circuits where kerosene along with smaller amounts of other organics are used to extract and concentrate uranium and vanadium in separate circuits. These strategies and upgrades include the utilization of covered processing tanks, containment and treatment of solutions with high levels of organic entrainment, and high efficiency particle removal filters. These conservative processing approaches will reduce the amount of organics that the facility will consume, thereby reducing the potential for the generation of VOCs. Although not intended as a control device, the mixing of the raffinate with the tailings solution is expected to result in the permanent entrainment of some organics within the tailings cells that might otherwise evaporate as VOCs. Since the amount of organic material entrained has not been quantified, no emission reduction credit will be taken.

2.1 Solvent Extraction Covered Tank Option

Solvents containing VOCs are used in the uranium and vanadium SX circuits. The extraction mixer settler tanks contain an organic solution that is used to selectively remove the uranium or vanadium from acid solutions and concentrate them. The organic solution consists of kerosene (carrier) plus amine (collector) and alcohol (phase control). Similarly, a caustic solution is used in the scrubber mixer settler tanks and stripper mixer settler tanks to strip the products from the organic carrier. The stripped organic solution is pumped back to the barren organic tank for reuse in the extraction

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circuit while the barren aqueous solution or raffinate is pumped to the tailings and evaporation ponds. The pregnant solution containing the uranium or vanadium is pumped to the precipitation and packaging plant.

Traditionally the solvent extraction process tanks were not covered and organic solutions were exposed to airflow, causing accelerated evaporation. EFR will utilize enclosed mixer settler tanks, which are designed as covered processing tanks. These state-of-the-art mixer settler tanks would reduce VOC emissions by over 90%. Although the covered tanks will reduce VOC emissions by 90%, the tanks are occasionally uncovered for maintenance or cleaning purposes and therefore, a more conservative covered tank parameter (75%) is applied for emission calculation purposes. Emission reduction calculations are shown in Appendix A.

The covers for the uranium mixer tanks will cost $96,525 and will reduce VOC emissions by 46.8 tpy. Covers for the vanadium mixer tanks will cost $154,028 and will reduce VOC emissions by 62.3 tpy. Associated vendor cost data is provided in Appendix B, although equivalent equipment from another vendor may be used. The decrease in VOC emissions with the covers is 109.1 tons per year. This results in a cost of $2,297 per ton of VOC reduced. This technology is both technologically feasible and economically feasible and should be considered RACT for this process.

2.2 Solvent Extraction Covered Tank With Water Locks

Water locks are a proprietary cover sealing system that would reduce VOC emissions by an additional 5% over mixer settler tanks with covers alone. This would result in a reduction of VOC emissions by approximately 7.3 tpy. Total costs for covered mixer settler tanks were estimated to be $4,641,300, while covered mixer settler tanks with water locks would be approximately 50% higher or $6,961,950. Additionally, water locks are considered proprietary technology, offered by a specific vendor, and delivery schedule was estimated to be 50% longer than the covered tank option. Since the cost for water locks is estimated to be $317,897 per ton of VOC reduced, water locks were not considered economically feasible.

2.3 Crud Centrifuge and Raffinate Buffer Tank

When the solvent extraction system is operating at steady state, the organic solution will effectively extract the metal ores from the aqueous solution. However, if the organic and aqueous solutions become emulsified as a result of high levels of suspended solids

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in the aqueous solution, then the two solutions can not separate efficiently and an emulsified layer forms between the upper organic phase and the lower aqueous phase. Historically, facilities would “dump” the emulsified solution or “crud” when this type of upset condition occurred. The dumped solution would be directed to evaporation ponds and the process tanks were then refilled with new organic makeup solution.

EFR added a crud centrifuge to its processing system to allow for treatment and recovery of the organic compounds from emulsified solutions. When emulsification occurs, the organic will be drained off the raffinate settler and then the emulsified material (a.k.a., crud) will be drained off and pumped to the crud centrifuge where the emulsification is separated into aqueous and organic phases (which are recycled in the processing system) and suspended solids (which are wasted to the tailings cell). EFR is proposing to use the high end centrifuge that allows for separation of systems consisting of a solid material and two immiscible liquids. Using the high end centrifuge will not only allow the solids to be cleaned from the solution, but it also will allow the organic to be recovered from the solids before the solids are wasted to the tailing cell. The proposed centrifuge system is a system that has been used for solvent extraction systems (such as copper mills) and allows for high recovery rates of the organic solution. As a comparison, a dual phase centrifuge would only allow the solids to be separated from the solution without any organic recovery from the solids.

The vanadium SX circuit is especially susceptible to a second type of organic loss when a portion of the organic solution becomes entrained in the aqueous solution. Organic entrainment can be identified by the presence of finely-sized bubbles in the aqueous solution coming from the raffinate settlers. To prevent excessive loss of the organic, EFR proposes to add a holding tank (raffinate buffer tank) to collect the solvent extraction waste solutions (i.e., raffinate) when these conditions occur. The contents of the raffinate buffer tank would be stored for a period of time, which would allow the two phases to separate with the organic floating to the top of the aqueous solution. The organic material would then be skimmed off and recycled. Emulsified material, if present, would be sent to the crud centrifuge for further separation. This would substantially reduce the potential amount of organic solution that would otherwise be sent to the evaporation ponds because when an upset condition occurs, typically the solution can not be used further until it is cleaned and separated.

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The tank would hold 103,000 gallons of raffinate, large enough to contain the combined flow (385 gpm) from the two vanadium raffinate settlers for four hours. The raffinate buffer tank, including a pump to redirect the raffinate, would cost approximately $423,400. The crud centrifuge will cost approximately $353,100. The use of a raffinate buffer tank would reduce emissions from the evaporation ponds and tailings cells by an estimated 139 tons for each major upset episode. Major upsets are not anticipated to occur more than once or twice per year, although smaller upset conditions may occur. The centrifuge system is oversized at 20 gpm and is designed to empty the contents of the raffinate buffer tank every four days. Emission reduction calculations are shown in Appendix A. Assuming two major upsets occur each year, this equates to a cost per ton for VOC reduction of $2,783 per ton of VOC. This is considered an economically feasible option.

Besides using the buffer tank for upset conditions, EFR proposes to use the tank for solvent extraction reconditioning purposes. Every other month, or six times a year, the solvent extraction solution will be cycled into the buffer tank. During routine maintenance, the SX process liquid would contain approximately 10% organic liquid. After settling in the buffer tank, approximately 75% of this organic liquid could be readily decanted from the top of the tank and added back into the organic makeup tank. The remaining 25% of the organic liquid would be entrained with the aqueous solution in a boundary layer. This liquid boundary layer would be sent to the centrifuge for further reconditioning, where the organic liquid would be separated from the aqueous solution and placed back into the organic makeup tank. By performing the maintenance mode organic reconditioning six times per year, it is anticipated that the amount of organic solution required by the process will be reduced by approximately 52 tons per year from original estimates, based on historical data on organic material use. Because the buffer tank and centrifuge system are already proposed to be in place for upset conditions, this maintenance process is considered both technologically and economically feasible. On a separate note, using the tank for maintenance would not prevent the tank being used if an upset condition would occur. The maintenance would be done in cycles rather than a full tank dump; thus, if an upset were to occur during maintenance, there would still be room in the tank for the upset solution.

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2.4 High Efficiency Pressure Leaf Filters

As described in Section 2.2, much of the organic solution loss at similar facilities was attributable to upset conditions in the solvent extraction process that would result in dumping the contents of mixer settlers into the evaporation ponds. Because this is affected by the amount of suspended solids in the pregnant solution which can mix with the kerosene and form an emulsification (crud), more efficient filtering has been evaluated.

EFR anticipates fewer problems with organic solution contamination because they will utilize pressure leaf filters, which are high efficiency particle removal filters located prior to both the vanadium and uranium circuits. In comparison, most uranium mill facilities use older technology sand filters. The pressure leaf filters are expected to alleviate many of the upset conditions in the organic extraction processes and will allow the organic solution to continue to be recycled as designed through the process. These filters are expected to reduce the amount of organic makeup solution that the facility would introduce to the system, thereby reducing the potential for organic losses.

Costs for the pressure leaf filters are estimated to be $1,685,300. In comparison, the lower technology sand filters would cost $351,600 for a difference in cost of $1,333,700. It is not yet known what the VOC emission reduction would be from the application of modern pressure leaf filters versus sand filters, as only a few of the older uranium mills used pressure leaf filters and, to the best of our knowledge, they have not been used in mills with vanadium circuits. However, the facility estimates that the pressure leaf filters would reduce the amount of new organic solution entering the process by at least 25 tpy and possibly much more, since higher quality filters would reduce suspended solids in solution thereby allowing the extraction to be less susceptible to emulsification upset issues. Since the reduction of organics is only assumed at this time, the economic feasibility was not assessed. Regardless of economic feasibility, the pressure leaf filter technology will be implemented.

2.5 Tailings Entrainment

In an effort to minimize water consumption at the Piñon Ridge Mill, EFR elected to utilize most (i.e., about 72%) of the vanadium raffinate stream to mix with the tailings pulp (i.e., solid waste from the leaching process) to allow it to be more easily pumped to the tailings cell. In the tailings cell, the solids settle out of solution and the clarified water

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is recovered and recycled back to the mill for use. Although some of the organics would volatize in the tailings cell, some would be expected to adsorb or absorb onto the tailings solids and some would remain entrained within the saturated portion of the deposited tailings. At this time, it would be difficult to estimate how much of the organic material would remain in the tailings, as raffinate was not used historically for this purpose on a routine basis at other uranium mills. Therefore, no emission reduction credit is proposed for organic entrainment.

The tailings cells are lined at their base and sides with multiple synthetic and geosynthetic liners. Once a tailings cell is filled, it is dewatered to the extent practicable and covered with a thick radon soil barrier and a vegetated evapotranspiration cover. Therefore, any residual organic material in the tailings would remain permanently encapsulated within the tailings repository.

2.6 Dissolved Air Floatation

As described in prior sections, avoiding upset conditions by filtering out the solids from the solution is an effective way of recycling the solvent extraction solution back into the system rather than wasting it to the evaporation ponds. Dissolved air flotation (DAF) systems separate out suspended solids from wastewater streams by dissolving air in the water such that the air forms bubbles causing the suspended matter to float to the surface. The surface is then skimmed to remove the solids. DAF systems may require pre-treatment such as flocculants, oil-water separators, or pH pre-treatment depending on the application. A constant wastewater flow and loading are also requirements of a DAF system so that it works effectively by delivering the correct air ratio to the system.

Using a DAF system on the solvent extraction train could be utilized to remove solids from the solution, thereby prolonging the usefulness of the organic solution. However, the DAF system would not remove organics from the solids as would the proposed centrifuge system. The solids would have to undergo additional treatment which further complicates the viability of the DAF system in addition to the cost effectiveness. Further, the DAF system may require flocculants to aid in the removal of solids, and possibly pH pre-treatment of the solution according to a manufacturer of this type of system (Dissolved Air Floatation Corporation). Thus, while a DAF system may reduce the loss of organics, it is not considered technologically feasible due to the difficulties to maintain operations with little fluctuation in wastewater flow and loading, the need for

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post treatment of the solids, affects of pH, need for potential introduction of flocculants and overall effectiveness compared to other options.

2.7 Review of Process Chemistry

Since the solvent extraction process requires specific chemical reactions and proven methods, a change in the organic solution to reduce VOC losses would not be a practical option. The organic makeup solution, composed mostly of kerosene, is relatively benign, since it does not contain hazardous air pollutants. Therefore a change in the process chemistry to reduce or remove the potential for VOC emissions is not achievable at this time and would not be considered technologically feasible.

2.8 Emission Reductions and Economic Feasibility

The facility estimates that annual kerosene usage would be reduced from 663 tons per year (tpy) to 198 tpy by incorporating feasible process upgrades and waste minimization practices discussed above. As shown in the emission calculations provided in Appendix A, the annual process VOC emissions are anticipated to be approximately 36 tpy. By mass balance approach, this would yield 162 tpy fugitive VOC emissions from the tailings cells and evaporation ponds versus 145 tpy VOC from the process and 518 tpy fugitive VOC emissions without incorporating these upgrades. The total cost for all of the upgrades considered technologically and economically feasible is $2,712,353.

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3.0 CONTROL TECHNOLOGY ASSESSMENT

In addition to process upgrades for waste minimization, an evaluation of process controls that could be used to remove the VOC from the raffinate (i.e., effluent solution) was conducted. This included review of the RACT/BACT/LAER Clearinghouse (RBLC) and CTC guidance for wastewater controls. This section describes the control technologies identified and their feasibility.

3.1 Review of RACT/BACT/LAER Clearinghouse

A review was conducted of the RBLC found on the USEPA technology transfer network (TTN) website (http://cfpub.epa.gov/RBLC/htm/bl02.cfm?lang=eg). The review was extensive using several search options. However, no similar uranium or vanadium processing facilities or process source types were found. Therefore, no feasible control options are considered to be recognized through the RBLC.

3.2 Review of Process Control Technologies

Several VOC treatment, capture, and control technologies were investigated and are discussed in these subsections. Existing RACT options for control of VOCs include carbon adsorbers, concentrators, condensers, flares, thermal and catalytic incinerators and scrubbers. However, these control technologies are typically used to control air streams and are technologically infeasible for direct add-on control of the process effluent without first removing the VOC out of solution into an air stream. The following wastewater control technologies can be used on fugitive wastewater sources.

3.2.1 Steam Stripping

As defined in the CTC Guideline, steam stripping is a proven technology that involves the fractional distillation of wastewater to remove organic compounds. The basic operating principle of steam stripping is the direct contact of the wastewater solution with steam. A feed tank, which is covered and typically vented to an onsite control device collects and conditions the wastewater fed to the steam stripper. Feed tanks are typically sized to provide a hydraulic retention time of 48-hours. After the wastewater is collected and conditioned, it is pumped through the feed/bottoms heat exchanger and into the top of the steam stripping column. Steam is sparged directly into the stripper at the bottom of the column and as the wastewater flows down the column, it contacts the steam countercurrently. Latent heat is transferred from the steam to the organic compounds in the wastewater, vaporizing them into the vapor stream. A condenser

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system is used to recover the organics and recovered VOCs can be pumped to storage and recycled back into the process. If the vapor stream is contaminated with undesired constituents, then the resulting vapor stream would need to be destroyed by combustion or another method.

Specific characteristics of the raffinate from uranium and vanadium processing would make steam stripping technologically infeasible. One disadvantage of steam stripping systems is that maintenance problems can occur if the chemistry of the system is complex and not considered and designed into the system correctly. Fouling and/or plugging of the system can occur as inorganics precipitate and/or physical parameters of the system change such as temperature or pH level. Suspended solids can also cause plugging of a steam stripping column. Typically, if inorganic materials are likely to precipitate out into the column, pretreatment of the influent stream would be required (Jaeger Products). Pretreatment for pH neutralization requires the addition of chemicals, such as sodium hydroxide or sulfuric acid, to either raise or lower the pH to a neutral level and could potentially cause unknown chemical reactions. Pretreatment for inorganic and solids removal could require flocculation and or clarification systems such as a DAF as discussed earlier.

The raffinate stream will have a pH of 4.4 and a dissolved solids concentration up to 100,000 ppm with a relatively low hydrocarbon concentration, on the order of 10 to 100 ppm. There will also be a substantial amount of suspended solids in solution because the pH increases from 3 to 4.4 standard units during the final step in the vanadium SX process. This results in dissolved metals and other constituents precipitating out and becoming suspended in the solution. So, the raffinate solution would be considered a concentrated brine solution with a low pH and high suspended solids, making pre-treatment necessary. Not only does the raffinate stream contain suspended solids, but it may also contain emulsified crud not suitable for use in a steam stripping column as the solids would most likely plug the column. Additionally, the raffinate would require pretreatment due to its low pH and presence of inorganic metals, which would accelerate corrosion. Thus, the pretreatment may require steps to neutralize the pH as well as removing solids and inorganics prior to steam stripping to separate the organics. Therefore, this control technology would not be considered technologically feasible as a stand alone system.

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3.2.2 Air Stripping

Air stripping is another control technology that may be applied to wastewater collection systems. The general principle of an air stripper is by forcing large volumes of air through the organic-laden wastewater, the air water interface is increased, resulting in the transfer rate of the organic compounds into the vapor phase. Organics in the vapor phase are treated with add-on control devices, such as a carbon adsorber or thermal combustion to trap or destroy the organics. Thus, the air stripper would need to be used in conjunction with another control device to ensure that the resulting vapor phase organics would not be released as emissions. The main types of air strippers are packed column and sieve tray.

This technology works most efficiently with highly volatile compounds. However, the main component of the organic solutions used in the process is kerosene. Kerosene has low volatility in comparison to the volatile compounds this technology effectively controls and would not rapidly enter into the vapor phase, causing this control technology to be highly inefficient.

Air stripper systems are also subject to fouling or the accumulation of solids in the system. As noted in Section 3.2.1 above, the raffinate stream contains up to 100,000 ppm of dissolved solids and a high suspended solids concentration creating a dirty brine solution. If an air stripper system becomes fouled, it must be maintained and cleaned properly to ensure proper efficiency. Fouling can be prevented by pretreatments to the influent solution. Metals such as calcium and iron and suspended solids are common causes of fouling. Because the raffinate solution would contain metals, as well as suspended solids, it would not be a good candidate for air stripping as fouling would most likely occur often. A third type of air stripper, the diffused aeration stripper, has greater ability to handle suspended solids and more resistance to fouling; however, this type of air stripper is not very efficient (USACE, 2001).

Because kerosene has low volatility and the raffinate solution contains metals and suspended solids, this control technology would not be considered technologically feasible.

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3.2.3 Biological Organic Compound Destruction

A third control technology is biological organic compound destruction technology. Biological waste treatment is normally accomplished through the use of aeration basins. Microorganisms require oxygen to carry out the biodegradation of VOC that results in energy and biomass production. This control technology is very sensitive to environmental factors since living organisms are used. Due to the fact that the raffinate has high metal concentrations and a low pH, this type of control would not be technologically feasible.

3.2.4 Chemical Oxidization

A fourth control technology is chemical oxidation, which involves a chemical reaction between the organic compounds and an oxidant, such as ozone, hydrogen peroxide, permanganate, etc. Chemical oxidation uses these oxidants to destroy pollution in soil and groundwater. Kerosene would not be highly reactive to an oxidation process and other constituents in the raffinate would likely react much faster, causing unknown reactions and emissions. Due to the possible production of unwanted by-products, this technology is not considered technologically feasible.

3.2.5 Adsorption

A fifth control technology is adsorption, which takes advantage of compound affinities for a solid sorbant medium. Activated carbon or polymeric resins are often used as a medium and the volatile compounds are adsorbed onto the solid sorbent medium as they are contacted by wastewater. Polymeric resins are typically used with polar compounds and kerosene is non polar. Non polar compounds, such as kerosene, can be adsorbed onto the surface of activated carbon. Activated carbon is used with non polar compounds however, the ability to desorb (remove) the organic compounds is difficult and the carbon could become easily contaminated by other compounds, suspended solids, and emulsified materials. Because the organic compound is difficult to remove from the activated carbon, the activated carbon is typically recycled through thermal reactivation off-site at the manufacturer; thus, the organic material is destroyed during this process and can not be reused.

In typical wastewater treatment applications, activated carbon is used as a tertiary treatment; thus, it is assumed most of the sludge and solids have been removed from the wastewater stream. One of the main disadvantages of activated carbon systems is

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that they require pretreated streams when solids are present. Further, pH and temperature of the wastewater stream can impact the adsorption of VOCs onto carbon, thus reducing the effectiveness of the system (USEPA 2000). Because the raffinate stream at the Piñon Ridge Mill would contain solids and have a low pH, the stream would require pretreatment in order to use activated carbon technology to effectively remove VOCs. Therefore, this technology would not be considered technologically feasible as a stand alone system.

3.2.6 Membrane Separation

A sixth control technology is membrane separation, such as ultrafiltration and reverse osmosis. These types of separation processes work well on either high molecular weight (> 2,000 g/mole) compounds or those without suspended particulates (USEPA, D-93-056). The pore sizes in ultrafiltration systems range from 0.1 to 0.001 microns (Applied Membranes), therefore, large particles such as those present in the EFR vanadium raffinate, would rapidly clog the membranes. Due to the low molecular weight of kerosene and presence of suspended particulates, this technology would not be considered technologically feasible.

3.2.7 Liquid-Liquid Extraction

A seventh control technology is liquid-liquid extraction. The basis of this process is similar to the solvent extraction process, where a compound may be removed from the solution by the addition of a solvent. Once the constituent of interest is extracted, the process is typically followed by steps to removed residual solvent from the raffinate and also separate solvent from the extract (ChemPro). Since the raffinate is already a mixture of aqueous acids, suspended solids, emulsified materials, and organics that are not easily separated, adding another solvent would likely not help in the goal to reduce overall organics from the system. Further, previous discussions on the complexity of the raffinate solution and organic control systems have shown that the additional steps of separating out the solvent would not be easily achieved. Since the goal is to reuse the kerosene to reduce new organic makeup solution entering the system, this process would not be considered technologically feasible.

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3.2.8 Gravity Separators

Gravity separators are used to separate out oils, solids, and water solutions by relying on the principle that the three materials will separate out due to the differences in specific gravity. Different types of gravity separators exist such as parallel plate separators and API separators. The different types of gravity separators serve the same purpose, but have varying degrees of efficiency. The basis for this technology is that organic materials with specific gravities less than water will float to the top of the aqueous phase.

The proposed design of the Piñon Ridge Mill currently contains raffinate settler tanks. These are non-agitated tanks at the end of the solvent extraction trains that act essentially as gravity separators. The raffinate settler tanks allow the organic phase materials to float to the top and are then removed from the aqueous phase. Material exiting the raffinate settler tanks go either back into the barren organic tank for reuse, or to the raffinate tank for wasting to the tailings collection box or evaporation ponds. The aqueous material exiting the raffinate settlers that goes to the raffinate tank will contain only a small amount of residual organic material. The proposed maintenance and reconditioning of the organic solution using the raffinate buffer tank and the crud centrifuge provides for additional physical and gravity separation of the organic on a routine basis. Additional gravity separation beyond the proposed six maintenance periods would become much less efficient as the residual organic in the vanadium raffinate would decrease incrementally. Given the small amount present, it would likely require the use of a secondary organic collection system so that the residual organic could be trapped or destroyed. Thus, this technology is not technically feasible as a stand alone system.

3.3 Economic Feasibility

Since no add-on control technologies were identified to be technologically feasible as stand alone systems or would be required to operate in a train that is further technologically challenging, no additional economic feasibility assessment is required.

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4.0 SUMMARY CONCLUSIONS

4.1 RACT Findings and Conclusions

Several processing upgrades and waste minimization techniques were identified for this RACT assessment. These include the following options that will be implemented:

- Covered uranium and vanadium SX tanks;
- A crud centrifuge and raffinate buffer tank;
- High efficiency pressure leaf filters;
- Tailings entrainment.

Covered uranium and vanadium SX tanks would reduce VOC emissions from the process by approximately 90% during normal operation and by approximately 75% overall considering the tanks may be occasionally opened. The reduction in VOC emissions with the covers is estimated to be 109 tons per year. This option is considered both technologically feasible and economically feasible.

The raffinate buffer tank and crud centrifuge would be used, respectively, to collect the solvent extraction solution during an upset condition and recover the organic solution from emulsified and entrained mixtures. This technique alone would reduce the amount of kerosene added to the system by approximately 279 tons per year, given two major upset conditions, and therefore by direct mass balance, would reduce the annual VOC emissions from the evaporation ponds by 279 tons per year. This technology would also be used in a maintenance mode to recondition the organic solution. Using this technology for solvent reconditioning, six times per year, would reduce the amount of kerosene added to the system by an additional 52 tons per year. This option, used in both upset condition mode and maintenance mode, is considered both technologically feasible and economically feasible.

Pressure leaf filters are high efficiency particle removal filters. These filters, used in place of typical sand filters, are designed to effectively remove suspended solids and contaminants from aqueous solutions to minimize the potential for emulsification during the SX process. Use of these filters is estimated to reduce the amount of kerosene added to the organic makeup solution by 25 tons or more per year. This option is considered both technologically feasible and economically feasible.

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Other options have been reviewed for this RACT assessment, but other options were considered to be technologically infeasible.

The process upgrades and waste minimization measures EFR proposes to take will significantly reduce the potential losses of organic compounds thus reducing the amount of organic solution going to the evaporation ponds. These measures are in accordance with the level of measures considered to meet RACT based on technological and economical feasibility. Therefore, the remaining organic solutions entering the evaporation ponds, and resulting evaporative emissions, should be considered a fugitive source of emissions.

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APPENDIX A
Emission Calculations for Reduction of VOC

ENERGY FUELS PIÑON RIDGE MILL ANNUAL KEROSENE USAGE REDUCTION

Original annual Kerosene estimate of 663 tons per year based on historical data from other mills

a. Historically mills did not have covered tanks - Find difference in covered tanks vs uncovered
b. Historically, mills would have upset conditions due to solids in the solution - thus raising the amount of kerosene needed from steady state
c. Historically, mills used sand filter systems rather than pressure filter systems

a. Reduction in Kerosene usage due to tanks being covered:

Uncovered:
Uranium SX VOC Emissions:

Source ID	Emission Source	Chemical Species (i)	Mol Wt. (Species i) (lb/lbmol)	Partial Pressure (psia)	Bath Surface Area (ft^2)	Temp. (^oR)	Gas Constant R (psia-ft^3/^oR-lbmol)	Air Speed Across Liq. Surface (mph)	Gas Phase Mass Transfer Coeff. (ft/s)	Covered Process Tank Parameter	Agitated Tank Factor	VOC Emissions (lb/yr)	VOC Emissions (ton/yr)
420-MSS-01	Uranium Mixer Settler Tank A1	Kerosene	170	0.019	210	529.67	10.73	1.7	0.003137	**0**	1.1	12986.93	6.49
420-MSS-02	Uranium Mixer Settler Tank A2	Kerosene	170	0.019	210	529.67	10.73	1.7	0.003137	**0**	1.1	12986.93	6.49
420-MSS-03	Uranium Mixer Settler Tank A3	Kerosene	170	0.019	210	529.67	10.73	1.7	0.003137	**0**	1.1	12986.93	6.49
420-MSS-04	Uranium Mixer Settler Tank A4	Kerosene	170	0.019	210	529.67	10.73	1.7	0.003137	**0**	1.1	12986.93	6.49
430-MSS-01	Uranium Mixer Settler Tank B1	Kerosene	170	0.019	210	529.67	10.73	1.7	0.003137	**0**	1.1	12986.93	6.49
430-MSS-02	Uranium Mixer Settler Tank B2	Kerosene	170	0.019	210	529.67	10.73	1.7	0.003137	**0**	1.1	12986.93	6.49
430-MSS-03	Uranium Mixer Settler Tank B3	Kerosene	170	0.019	210	529.67	10.73	1.7	0.003137	**0**	1.1	12986.93	6.49
430-MSS-04	Uranium Mixer Settler Tank B4	Kerosene	170	0.019	210	529.67	10.73	1.7	0.003137	**0**	1.1	12986.93	6.49
440-MSS-01	Uranium Scrubber Mixer Settler	Kerosene	170	0.019	112.5	529.67	10.73	1.7	0.003137	**0**	1.1	6957.28	3.48
440-MSS-02	Uranium Stripper Mixer Settler #1	Kerosene	170	0.019	112.5	529.67	10.73	1.7	0.003137	**0**	1.1	6957.28	3.48
440-MSS-03	Uranium Stripper Mixer Settler #2	Kerosene	170	0.019	112.5	529.67	10.73	1.7	0.003137	**0**	1.1	6957.28	3.48
												TOTAL:	**62.38**

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ENERGY FUELS PIÑON RIDGE MILL ANNUAL KEROSENE USAGE REDUCTION

Uncovered:
Vanadium SX VOC Emissions:

Source ID	Emission Source	Chemical Species (i)	Mol Wt. (Species i) (lb/lbmol)	Partial Pressure (psia)	Bath Surface Area (ft^2)	Temp. (^oR)	Gas Constant R (psia-$ft^3/^oR$-lbmol)	Air Speed Across Liq. Surface (mph)	Gas Phase Mass Transfer Coeff. (ft/s)	Covered Process Tank Parameter	Agitated Tank Factor	VOC Emissions (lb/yr)	VOC Emissions (ton/yr)
620-MSS-01	Vanadium Mixer Settler Tank A1	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.003137	**0**	1.1	13636.28	6.82
620-MSS-02	Vanadium Mixer Settler Tank A2	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.003137	**0**	1.1	13636.28	6.82
620-MSS-03	Vanadium Mixer Settler Tank A3	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.003137	**0**	1.1	13636.28	6.82
620-MSS-04	Vanadium Mixer Settler Tank A4	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.003137	**0**	1.1	13636.28	6.82
620-MSS-05	Vanadium Mixer Settler Tank A5	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.003137	**0**	1.1	13636.28	6.82
630-MSS-01	Vanadium Mixer Settler Tank B1	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.003137	**0**	1.1	13636.28	6.82
630-MSS-02	Vanadium Mixer Settler Tank B2	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.003137	**0**	1.1	13636.28	6.82
630-MSS-03	Vanadium Mixer Settler Tank B3	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.003137	**0**	1.1	13636.28	6.82
630-MSS-04	Vanadium Mixer Settler Tank B4	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.003137	**0**	1.1	13636.28	6.82
630-MSS-05	Vanadium Mixer Settler Tank B5	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.003137	**0**	1.1	13636.28	6.82
640-MSS-01	Vanadium Scrubber Mixer Settler	Kerosene	170	0.019	120	529.67	10.73	1.7	0.003137	**0**	1.1	7421.10	3.71
640-MSS-02	Vanadium Stripper Mixer Settler #1	Kerosene	170	0.019	120	529.67	10.73	1.7	0.003137	**0**	1.1	7421.10	3.71
640-MSS-03	Vanadium Stripper Mixer Settler #2	Kerosene	170	0.019	120	529.67	10.73	1.7	0.003137	**0**	1.1	7421.10	3.71
640-MSS-04	Vanadium Stripper Mixer Settler #3	Kerosene	170	0.019	120	529.67	10.73	1.7	0.003137	**0**	1.1	7421.10	3.71
												TOTAL:	**83.02**

Note: Emissions from covered tanks in original APEN submittal and on page 4 and 5 of this attachment

Uncovered - Covered	**109**	**tpy**	(145.41 - 36.35)tpy

So, from being uncovered, an additional 109 tons per year of kerosene would be needed.

Now, Annual Kerosene usage:	**554**	**tpy**	(663 - 109)tpy

ENERGY FUELS PIÑON RIDGE MILL ANNUAL KEROSENE USAGE REDUCTION

b. Kerosene usage reduction using the upset buffer tank (Two Major Upsets):

Assume two major upsets from steady state conditions would occur and those upsets would get sent to the evaporation ponds rather than cleaned and reused.

Energy Fuels Pinon Ridge Mill will contain an upset buffer tank of approximately 103,000 gallons. A major upset would be considered a total 'dump' of the SX solution, when contamination or extreme emulsion of the organic and aqueous layers occurs. A conservative estimate is that 40% organic is recovered from the SX solution using decanting and centrifuge extraction.

Upset tank size (gal)	% Organic Recovered from SX Solution	Density of Kerosene (lb/gal)	Reduction in Kerosene due to one upset (tpy)
103,000	40%	6.76	139

Reduction in Kerosene from two major upset conditions going to the buffer tank: 279 tpy

New Pinon Ridge Mill estimate for annual Kerosene usage:	**275**	**tpy**	(554 - 279)tpy

Note: Solution in the buffer tank from an upset condition would be cleaned by using the crud centrifuge system and recycled back into the process at a later time.

c. Kerosene usage reduction due to maintenance mode use of upset buffer tank and centrifuge (routinely used 6 times per year):

Assume the solvent extraction process liquids are routinely sent to the SX buffer tank, at least six times per year. This routine use will recondition the organic, thereby decreasing the amount of makeup solutior entering the system. It is estimated that during the reconditioning event in maintenance mode, approximately 75% of the organic would settle to the top of the aqueous phase and could be decanted and the remaining 25% of the organic would be within the organic/aqueous boundary layer. This boundary layer would be reconditioned by the centrifuge and sent back to the organic makeup tank, thereby reducing th annual amount of kerosene makeup by an additional 9 tons per year. Further, it is not practical to recondition more than 6 times per year, as the efficiency of the production process would become impacted.

Energy Fuels Pinon Ridge Mill will contain a buffer tank of approximately 103,000 gallons. A conservative estimate is that 10% of the tank volume would be organic liquid during routine maintenance.

SX Buffer tank size (gal)	% Organic in SX Solution (Routine)	Density of Kerosene (lb/gal)	Percentage of Organic Decanted	Percentage of Boundary Layer Recondition	Reduction in Kerosene due to Recondition (tpy)
103,000	10%	6.76	75%	25%	9

Reduction in Kerosene from reconditioning solvent at least 6 times per year: 52 tpy

New Pinon Ridge Mill estimate for annual Kerosene usage:	**223**	**tpy**	(275-52)tpy

Note: Solution in the buffer tank from a reconditioning event would be cleaned by using the crud centrifuge system and recycled back into the process.

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ENERGY FUELS PIÑON RIDGE MILL ANNUAL KEROSENE USAGE REDUCTION

d. Kerosene usage reduction due the use of pressure filters in the SX systems:

Pressure filters are used in both the Uranium and Vanadium SX circuits.
Historically, other mills utilized a different filtering system (sand filters) that is not as effective at removing particles.

An exact effectiveness of the pressure filters over the sand filters is not known. It was estimated that the pressure filters would decrease the annual Kerosene usage by a minimum of 25 tons per year.

New Pinon Ridge Mill estimate for annual Kerosene usage:	**198**	**tpy**	(223 - 25)tpy

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ENERGY FUELS PIÑON RIDGE MILL KEROSENE EMISSION CALCULATIONS

Annual Kerosene Use (tpy)	Non-Fugitive Kerosene Total (tpy)	Fugitive VOC Total to Tailings/Evap Ponds (tpy)
198	**36.39**	**161.61**

All Emissions are Uncontrolled.

Uranium SX VOC Emissions:

Source ID	Emission Source	Chemical Species (i)	Mol Wt. (Species i) (lb/lbmol)	Partial Pressure (psia)	Bath Surface Area (ft^2)	Temp. (^oR)	Gas Constant R (psia-ft^3/^oR-lbmol)	Air Speed Across Liq. Surface (mph)	Gas Phase Mass Transfer Coeff. (ft/s)	Covered Process Tank Parameter	Agitated Tank Factor	VOC Emissions (lb/yr)	VOC Emissions (ton/yr)
420-MSS-01	Uranium Mixer Settler Tank A1	Kerosene	170	0.019	210	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3246.7328	1.623
420-MSS-02	Uranium Mixer Settler Tank A2	Kerosene	170	0.019	210	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3246.7328	1.623
420-MSS-03	Uranium Mixer Settler Tank A3	Kerosene	170	0.019	210	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3246.7328	1.623
420-MSS-04	Uranium Mixer Settler Tank A4	Kerosene	170	0.019	210	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3246.7328	1.623
430-MSS-01	Uranium Mixer Settler Tank B1	Kerosene	170	0.019	210	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3246.7328	1.623
430-MSS-02	Uranium Mixer Settler Tank B2	Kerosene	170	0.019	210	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3246.7328	1.623
430-MSS-03	Uranium Mixer Settler Tank B3	Kerosene	170	0.019	210	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3246.7328	1.623
430-MSS-04	Uranium Mixer Settler Tank B4	Kerosene	170	0.019	210	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3246.7328	1.623
440-MSS-01	Uranium Scrubber Mixer Settler	Kerosene	170	0.019	112.5	529.67	10.73	1.7	0.0031368	**0.75**	1.1	1739.3211	0.870
440-MSS-02	Uranium Stripper Mixer Settler #1	Kerosene	170	0.019	112.5	529.67	10.73	1.7	0.0031368	**0.75**	1.1	1739.3211	0.870
440-MSS-03	Uranium Stripper Mixer Settler #2	Kerosene	170	0.019	112.5	529.67	10.73	1.7	0.0031368	**0.75**	1.1	1739.3211	0.870
												TOTAL:	**15.60**

Uranium SX Organic Process Tanks:

Source ID	Emission Source	Chemical Species[2]	Capacity (gal)	Length (ft.)	Dia (ft.)	Annual Throughput (gal.)[1]	VOC Emissions (ton/yr)
440-TKH-01	Uranium SX Loaded Organic Tank	Kerosene	64298	19	24	202222	0.00856
440-TKH-02	Uramium SX Barren Organic Tank	Kerosene	64298	19	24	202222	0.00856
						TOTAL:	**0.02**

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ENERGY FUELS PIÑON RIDGE MILL KEROSENE EMISSION CALCULATIONS

Vanadium SX VOC Emissions:

Source ID	Emission Source	Chemical Species (i)	Mol Wt. (Species i) (lb/lbmol)	Partial Pressure (psia)	Bath Surface Area (ft^2)	Temp. (^oR)	Gas Constant R (psia-$ft^3/^oR$-lbmol)	Air Speed Across Liq. Surface (mph)	Gas Phase Mass Transfer Coeff. (ft/s)	Covered Process Tank Parameter	Agitated Tank Factor	VOC Emissions (lb/yr)	VOC Emissions (ton/yr)
620-MSS-01	Vanadium Mixer Settler Tank A1	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3409.0694	1.705
620-MSS-02	Vanadium Mixer Settler Tank A2	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3409.0694	1.705
620-MSS-03	Vanadium Mixer Settler Tank A3	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3409.0694	1.705
620-MSS-04	Vanadium Mixer Settler Tank A4	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3409.0694	1.705
620-MSS-05	Vanadium Mixer Settler Tank A5	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3409.0694	1.705
630-MSS-01	Vanadium Mixer Settler Tank B1	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3409.0694	1.705
630-MSS-02	Vanadium Mixer Settler Tank B2	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3409.0694	1.705
630-MSS-03	Vanadium Mixer Settler Tank B3	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3409.0694	1.705
630-MSS-04	Vanadium Mixer Settler Tank B4	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3409.0694	1.705
630-MSS-05	Vanadium Mixer Settler Tank B5	Kerosene	170	0.019	220.5	529.67	10.73	1.7	0.0031368	**0.75**	1.1	3409.0694	1.705
640-MSS-01	Vanadium Scrubber Mixer Settler	Kerosene	170	0.019	120	529.67	10.73	1.7	0.0031368	**0.75**	1.1	1855.2759	0.928
640-MSS-02	Vanadium Stripper Mixer Settler #1	Kerosene	170	0.019	120	529.67	10.73	1.7	0.0031368	**0.75**	1.1	1855.2759	0.928
640-MSS-03	Vanadium Stripper Mixer Settler #2	Kerosene	170	0.019	120	529.67	10.73	1.7	0.0031368	**0.75**	1.1	1855.2759	0.928
640-MSS-04	Vanadium Stripper Mixer Settler #3	Kerosene	170	0.019	120	529.67	10.73	1.7	0.0031368	**0.75**	1.1	1855.2759	0.928
												TOTAL:	**20.76**

Vanadium SX Organic Process Tanks:

Source ID	Emission Source	Chemical Species[2]	Capacity (gal)	Length (ft.)	Dia (ft.)	Annual Throughput (gal.)[1]	VOC Emissions (ton/yr)
640-TKH-01	Vanadium SX Loaded Organic Tank	Kerosene	64298	19	24	202222	0.00856
640-TKH-02	Vanadium SX Barren Organic Tank	Kerosene	64298	19	24	202222	0.00856
						TOTAL:	**0.02**

Storage Tanks:

Source ID	Emission Source	Chemical Species[2]	Capacity (gal)	Length (ft.)	Dia (ft.)	Annual Throughput (gal.)[1]	VOC Emissions (ton/yr)	
860-TKH-01	Kerosene Tank	Kerosene	38071	20	18	202222	0.00597	*APEN exempt
860-TKH-02	Organic Make-Up Tank	Kerosene	5875	10	10	202222	0.002845	*APEN exempt

Notes:
1. Although annual throughput was revised to 74,000 gallons/year, the TANKS program was not used to recalculate emission values with the new throughput. The emission values with the higher throughput are more conservative and are only a small portion of the overall total; thus, the higher emission values were kept.
2. Since trimethylamine and isodecanol are not listed compounds in the TANKS 4.09d model, the contents of the organic make-up tank are assumed to be 100% kerosene.

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APPENDIX B

Vendor Information and Cost Estimates

Note: The information contained in this appendix was submitted with the original document on November 10, 2009. There have not been any revisions to the material that was contained in this appendix.