Appendix D – Mill Components
Energy Fuels Resources Corporation ("Energy Fuels") plans to construct and operate the Piñon Ridge Mill Facility (the "Project" or the "Facility") in Montrose County, Colorado in order to process ore and produce both uranium oxide ("$\text{U}_3\text{O}_8$") concentrate and vanadium oxide ("$\text{V}_2\text{O}_5$") concentrate. The proposed mill is expected to process ore mined from Energy Fuels mine operations, and ore purchased from nearby mines owned and operated by others. The projected milling rate is 1,000 tons per day ("tpd").

The proposed milling stages at the Facility include:

- Grinding;
- Pre-leaching and Thickening;
- Leaching;
- Separation and Purification;
- Uranium Recovery; and
- Vanadium Recovery.

Following is a description of each primary mill component. Refer to Figure 5, Mill Facility, in the main body of this application for the proposed layout of the mill facilities. Figure D-1, Process Flowsheet, illustrates the milling stages.

**Grinding**

Energy Fuels will feed run-of-mine ("uncrushed") ore to the mill from onsite stockpiles using a front-end loader and/or trucks. The ore will be dumped into a feed hopper and delivered by belt conveyor to a semi-autogenous grinding ("SAG") mill located in the main mill building (SAG Mill/Leach Tank Building). In the SAG mill, the ore is combined with water and tumbled with steel balls. The tumbling action causes the larger ore pieces and steel balls to grind the ore into fine powder, exposing the uranium and vanadium mineral surfaces from the host rock.

**Pre-leaching and Thickening**

The resulting slurry from the SAG mill, consisting of 0.03-inch sized particles and water, is distributed to one of two large, steel pulp storage tanks located outside in the area west of the SAG Mill/Leach Tank Building. The slurry is pumped from the storage tanks to two rubber-lined, steel pre-leach tanks where the pulp reacts with sulfuric acid reducing the pulp density to approximately 25 percent solids. The pulp then reports to a 60-foot diameter, rubber-lined, steel thickener tank. The overflow from the thickener is clarified, filtered and sent to a feed tank for use in the uranium recovery circuit. The partially dewatered underflow from the thickener is pumped to the leaching circuit.

**Leaching**

The leach circuit, located in the SAG Mill/Leach Tank Building, consists of eight rubber-lined steel tanks with agitators. The tanks are arranged in a cascading and staggered configuration so that individual tanks can be bypassed if necessary. In the leaching circuit, the pulp pumped from the pre-leach thickener tank is heated to 185 degrees Fahrenheit using steam and then leached with sulfuric acid to dissolve the uranium and vanadium minerals. Sodium chlorate is also added as an oxidant, as necessary.
Liquid/Solid Separation and Purification

The leached pulp is pumped to a series of 40-foot diameter counter current decantation ("CCD") thickeners, where liquids and solids are separated. The uranium- and vanadium-bearing (or pregnant) solution is separated from the remaining solids, called tailings, which consist of a variety of other minerals that were present in the ore. The pregnant solution is pumped to the uranium recovery feed tank and the tailings are pumped to the tailings cell.

Uranium Recovery

A solvent extraction ("SX") process will be used to concentrate and recover the uranium from the pregnant solution. In the SX process, the pregnant solution is filtered and the uranium separated and purified using a kerosene-based solvent. The result is a pure, but weak, uranium solution, which is washed with sulfuric acid and water to remove impurities. Following washing, the uranium is stripped from the solvent using a sodium carbonate solution. The uranium SX circuit is located in the Solvent Extraction Building.

Within the Drying/Packaging Building, the uranium is continuously precipitated from the stripping fluid by adding hydrogen peroxide to the solution, which precipitates a bright yellow powder referred to as yellowcake. The powder is then partially dewatered, washed, filtered and dried in a steam dryer. Finally, the dried yellowcake is packed, weighed, and sealed in 55-gallon, steel drums for shipment. Each packed drum will weigh approximately 900 pounds.

At an ore processing rate of 1,000 tpd, an average ore grade of 0.23 percent $\text{U}_3\text{O}_8$, and a 96 percent recovery rate, approximately 4,400 pounds of yellowcake (or five drums) would be produced per day. The drums of yellowcake would be shipped to a conversion plant where the uranium is converted to uranium hexafluoride, which can be enriched for use in nuclear power plants. Conversion plants currently in operation include the ConverDyn facility in Metropolis, Illinois, the Cameco facility in Port Hope, Ontario, and several more facilities in both France and Great Britain. Shipment to the North American facilities would be via trucks licensed to transport low-level radioactive material. Shipment overseas would likely require truck transport to a port in Texas followed by ship transport. Typically, a transport truck can carry 25 to 27 tons of cargo, or up to approximately 55 to 60 drums of yellowcake. Approximately 30 truckloads of yellowcake would be shipped from the Facility per year.

Vanadium Recovery

When uranium-vanadium ores are treated, the portion of the solution that remains after the uranium minerals have been recovered (i.e., the raffinate solution) is prepared for vanadium recovery by oxidizing the vanadium ion species in solution with the addition of sodium chlorate, and reducing the acid concentration slightly by the addition of ammonia. In a similar fashion to the uranium recovery process discussed above, the vanadium circuit uses an SX process to recover vanadium. The vanadium SX circuit is located in the Solvent Extraction Building.

Ultimately, within the Drying/Packaging Building, the vanadium is precipitated by adding ammonium sulfate to the stripping fluid. The precipitate is then dewatered, dried and removed of ammonium in a kiln. The $\text{V}_2\text{O}_5$ discharging from the kiln is melted in a furnace and solidified into a black-flake product, which is packed, weighed and sealed in 55-gallon, steel drums for shipment. Each packed drum will weigh approximately 570 pounds.
At an ore processing rate of 1,000 tpd, an average ore grade of 0.92 percent $V_2O_5$, and an 80 percent recovery rate, approximately 14,700 pounds of $V_2O_5$ (or 25 drums) would be produced per day. The drums of $V_2O_5$ would likely be shipped via truck to a plant that produces ferro-vanadium products. Two of the larger, such plants include the Stratcor plant in Hot Springs, Arkansas and the Bear Metallurgical plant in Butler, Pennsylvania. Approximately 100 truckloads of $V_2O_5$ (which is not radioactive) would be shipped from the Facility annually.