energy fuels nuclear, inc.

URANIUM PROCESSING

White Mesa Uranium Mill
Blanding, Utah

This is an explanation of Energy Fuels Nuclear's uranium processing facilities in San Juan County, near Blanding, Utah.

Energy Fuels Nuclear, Inc. was founded in August, 1976, by Robert W. Adams. First efforts were in the activation of old mines, exploration and development of new mines and the construction of Ore Buying Stations at Hanksville and Blanding, Utah. In June of 1979, construction was started on the White Mesa Uranium Mill and culminated with Mill startup in May, 1980.


WHITE MESA URANIUM MILL

The White Mesa Uranium Mill and Tailings Ponds were designed and built at a cost of approximately $40,000,000.00.

From the time environmental assessment work and licensing procedures were begun, the project took approximately 2-1/2 years to complete, with actual Mill construction requiring eleven months. The first low grade ore was fed to the Mill on May 6, 1980.

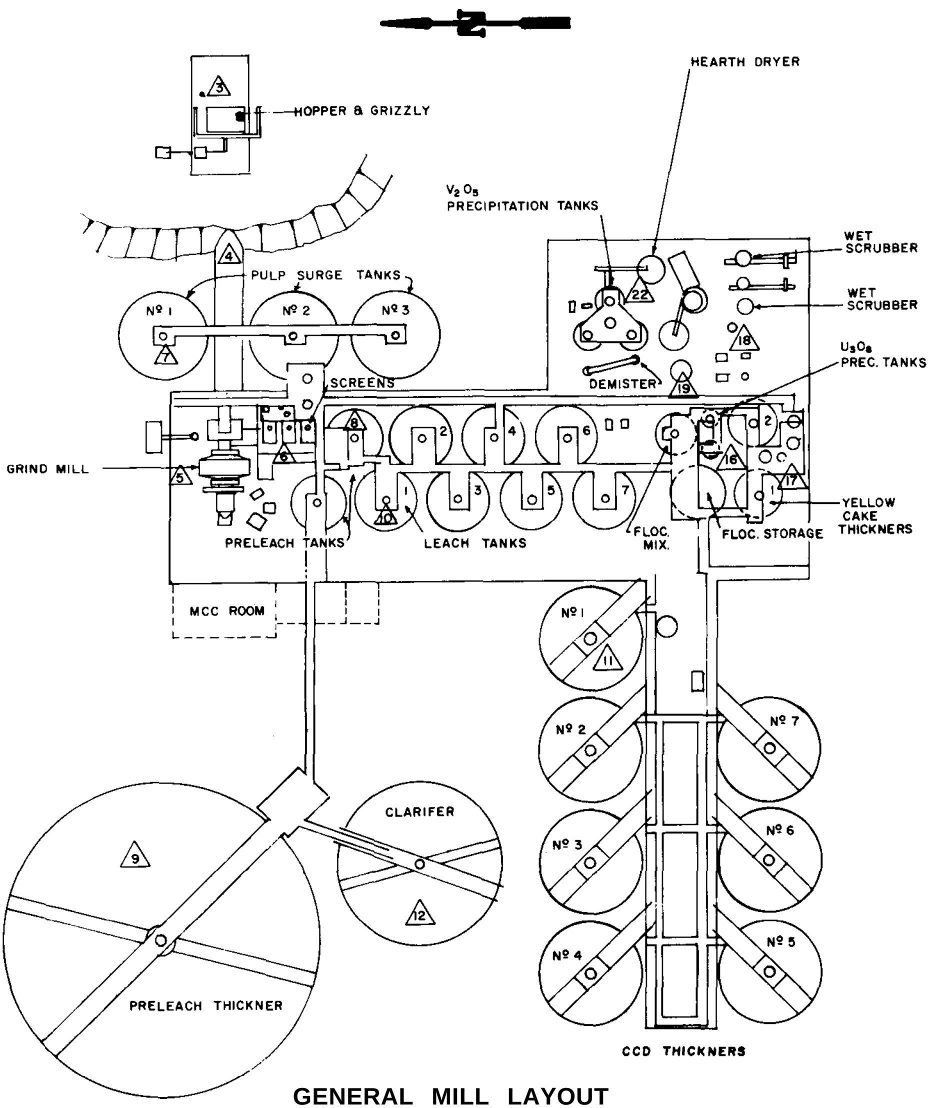
URANIUM PROCESSING

The function of the Energy Fuels Nuclear Uranium Mill is to extract uranium oxide (U_3O_8) concentrate, commonly called yellowcake, from uranium bearing ores found within the region.

Trucks haul the ore to the mill from Company owned and Vendor owned mines in the San Juan County area. Trucks arrive at the Blanding Ore Buying Station and drive up on large scales where the ore is weighed. From there the trucks move to the buying station yard and unload their ore in designated areas. From these small stockpiles of ore, samples are taken then dried and weighed to determine the moisture content. Accurate computation of the moisture content is highly important because the amount of ore fed to the mill is always figured in dry ton equivalents.

From the buying station yard, large front end loaders move the ore to the buying station where it is fed through a primary jaw crusher (1)* and reduced to approximately 1%" size. The ore is then run through a series of four stages of crushing and sampling (2) where the average 250 ton lot is reduced to approximately 75 pounds of sample at less than ¼" in maximum size. From there this sample is further mixed, dried and reduced down. Samples weighing less than 5 grams are sent to the metallurgical lab for assaying and a duplicate sample is also sent to the

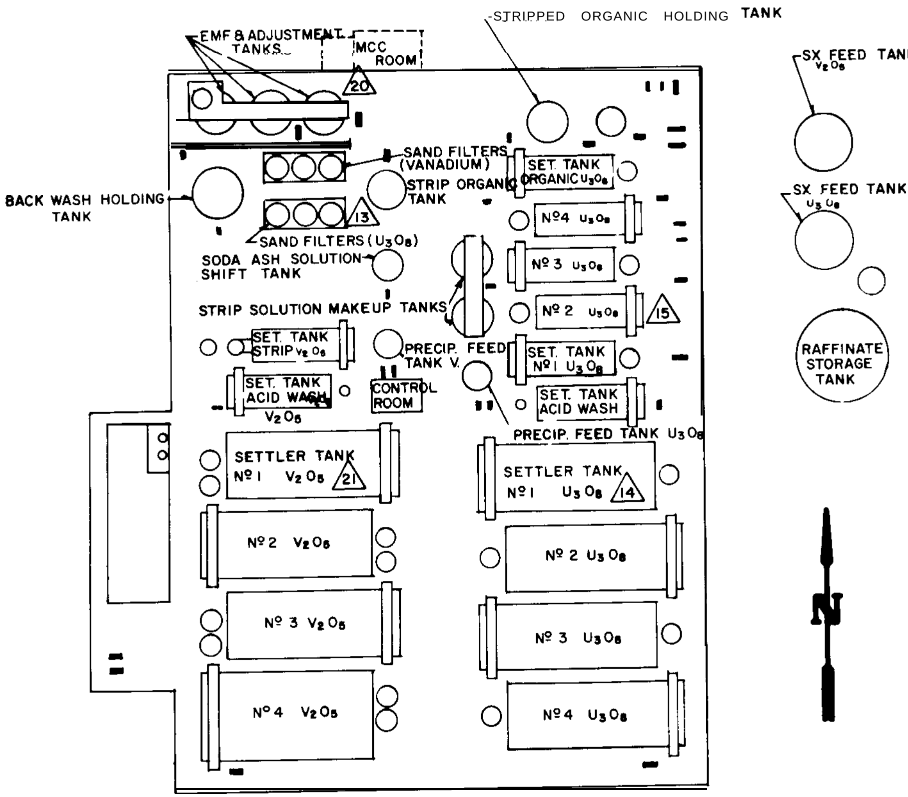
'See enclosed drawings for reference process point.



GENERAL MILL LAYOUT

rate. The slurried ore from the pulp storage tanks will usually be about 50% solids mixed with 50% water. This slurry will be mixed in the pre-leach tanks with a strong acid solution from the counter current decantation (CCD) circuit resulting in a density of about 22% solids. This step is employed to neutralize the excess acid from the second-stage leach with raw ore. By **doing** this, not only is the excess acid partially neutralized, but some leaching occurs in the preleach circuit and also less acid is needed in the second stage leach. The pre-leach ore flows by gravity to the pre-leach thickener (9). Here, flocculant is added and the solids are separated from the liquid. The under-flow solids are pumped into the second stage leach circuit (10) where acid, heat and an oxidant (sodium chlorate) are added. About 24 hours retention time is utilized in the seven second-stage leach tanks. The leach slurry is then pumped to the CCD circuit (11) for washing and solid-liquid separation. The liquid or solution from the pre-leach thickener overflow is pumped to the clarifier (12) and then to the filtration circuit in the SX building.

Seven thickeners are utilized in the CCD circuit to wash the acidic uranium bearing liquids from the leached solids. Water **or** barren solutions are added to the number 7 thickener and flow counter-current to the solids. As the solution advances toward the No. 1 thickener it carries the desolved uranium. Conversely the solids become washed of the uranium as they advance toward the last thickener. By the time the solids are washed through the seven stages of thickening they are 99% free of soluable uranium and may be pumped to the tailings pond. The clear overflow solution from No. 1 CCD thickener advances



SOLVENT EXTRACTION

through the pre-leach circuit and pre-leach thickener as previously explained and to the clarifier, which is an additional thickener giving one more step in order to settle any suspended solids prior to advancing the solution to the solvent extraction (SX) circuit.

The solvent extraction circuit is utilized to extract dissolved uranium from the clarified pregnant liquor. Beforeentering thesolvent extraction circuit the solution is filtered through charcoal (13) to assure that no minute solid particles of slime are entrained. The uranium solvent extraction, or liquid ion-exchange process, performs two basic functions. First, it selectively removes the uranium from the acid water solution leaving the unwanted metals in solution. Second, the uranium is concentrated by advancing organic (kerosene) through this circuit at 1/4 the rate of acid-water solution flow. This concentrates the uranium in the organic four-fold. The uranium-acid solution from the sand filters, or the aqueous feed, is pumped to the No. 1 mixer-settler (14) where it is mixed with the organic and dissolved uranium is transferred from the aqueous into the solvent organic phase. After mixing, the organic and aqueous are left to separate (kerosene floats to the top of water). The aqueous and organic solutions then flow continuously and countercurrently to each other through four stages of extraction. At this time the organic is "loaded" and the aqueous is barren of U_3O_8. The barren aqueous solution or "raffinate" now free of uranium leaves the last stage of the extraction circuit and is pumped to the vanadium solvent extraction circuit or into the CCD thickener circuit as a washing solution or is disposed of in the tailings pond. From the extraction circuit, the uranium, now concentrated in the organic solution, is pumped to the stripping circuit. Here the uranium is stripped from the organic in a six-stage mixer-stage mixer-settler circuit (15) and again concentrated. The latter is accomplished by advancing one part of stripping solution through 10 parts of organic solution. The strip solution, an acidified brine, leaves the circuit containing approximately 40 times the concentration of uranium as compared to the acid water solution or aqueous that was introduced into the solvent extraction circuit. The organic leaving the last stage of the strip circuit is free of uranium and ready for re-use in the extraction circuit. The organic might be referred to as a "selective carrier" of uranium. It picks up uranium in the solvent extraction phase and deposits uranium in the acid stripping solution. The loaded high-grade strip solution is then pumped to the precipitation circuit.

In the precipitation circuit (16) the uranium, which up to this point has been in solution, is caused to precipitate or actually "fall out" of the solution. The addition of ammonia, air, and heat to the precipitation circuit causes the uranium to become insoluble in the acid strip solution. During precipitation, the uranium solution is continuously agitated to keep the solid particles of uranium in suspension. Leaving the precipitation circuit, the uranium, now a solid particle in suspension, rather than in solution, is pumped to a two-stage thickener circuit (17) where the solid uranium particles are allowed to settle to the bottom of the tank. From the bottom of the thickener tank the precipitated uranium in the form of a slurry, about 50% solids, is pumped to a two-stage centrifuge circuit (18) where the solids are dewatered, then re-pulped, or mixed with wash water again, and de-watered again in the second centrifuge. From this centrifuge, the solid uranium product is pumped to the multiple hearth dryer (19). In the dryer, the product is dried at approximately 1200” F which dewaters the uranium oxide further and also burns off additional impurities. From the dryer, the uranium oxide concentrated to +95% is stored in a surge bin and packaged in 55 gallon drums. These drums are then labled and readied for shipment.

VANADIUM EXTRACTION

Along with the uranium operation, the White Mesa Mill also has the ability to extract vanadium from ores containing both these metals. The vanadium bearing ores are run concurrently with the uranium ores through the sampling, grinding, pre-leach and leaching, CCD and uranium solvent extraction circuit. As explained earlier, raffinates from the uranium solvent extraction circuit can be either run to the vanadium solvent extraction circuit or the CCD washing circuit or be pumped to tails for disposal. If vanadium bearing ores are being processed, the raffinates from the uranium solvent extraction will be retained and run through a solvent extraction circuit very similar to the uranium SX. The vanadium liquor, however, must be oxidized and pH (acid concentration) adjusted prior to solvent extraction. Raffinates from the uranium circuits that are to be treated for vanadium are pumped to the EMF (Electromotive Force) Adjustment Tanks (20) where the pH and EMF are adjusted by automatic additions of ammonia and sodium chlorate. The oxidized solution is pumped outside to the three aging or reaction tanks prior to filtration and solvent extraction (21). Following solvent extraction, the loaded vanadium strip solution is then batch precipitated (22), dewatered on a horizontal belt filter, and dried and packaged in much the same manner as the yellowcake.

TAILINGS DISPOSAL SYSTEM

Solid and liquid wastes, in the form of leached sands and barren solutions, from the White Mesa Mill, are disposed of in a 65 acre synthetic lined pond. Throughout the life of the Mill, the tailings system will be expanded to include three additional storage ponds with each pond able to hold 3 to 4 years' production of tailings. A fifth pond, to be used strictly for evaporation of water will be used throughout the operating life of the Mill.

As each pond, or cell, is filled with tailings, the water will be drawn off and pumped to the evaporation pond and the sands allowed to dry. As each cell reaches final capacity, reclamation will begin with placement of 13 feet of clay, rock and topsoil over the tailings. The area will be revegetated and eventually returned in appearance to the surrounding area.

Every effort has been made, from environmental monitoring, to synthetic lining of the ponds, to final cover and reclamation, in order to preserve and protect the environment and citizens of San Juan County, Utah.