DOCKET NO. 40-8027

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KERR-McGEE CORPORATION

KERR-McGEE BUILDING • OKLAHOMA CITY, OKLAHOMA 73102

May 10, 1972

Mr. L. M. Muntzing
Director of Regulation
United States Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muntzing:

RE: Application for Amendment to License No. SUB-1010, Docket No. 40-8027, to Permit Subsurface Storage of Certain Liquids at Kerr-McGee's Sequoyah Facility

Although Kerr-McGee's Sequoyah Facility has a licensed waste treatment and storage system in operation, we have continuously studied possible superior alternate systems since the decision to build this facility in Eastern Oklahoma. One system considered with the AEC and the State regulatory body over the period 1969 to date involves subsurface low level radioactive waste storage.

In May of 1970, after furnishing information requested by the AEC, we met with representatives of the AEC and USGS to discuss the feasibility of using a deep Arbuckle well for injection of the plant's entire liquid waste remaining after treatment into permeable members of the Arbuckle dolomite section. At that time, the pertinent government agencies had under consideration the development of an overall policy relating to deep well disposal, but AEC representatives advised that in their opinion this policy decision would not be resolved by the agencies involved for some time, perhaps 12 months or longer.

On October 15, 1970, we received a letter from the AEC stating that in its opinion the information submitted did not put it in a position to approve the deep well waste storage requested by Kerr-McGee, but that we could appeal the decision. In view of the overall situation we asked, and received AEC approval, to withdraw our application without prejudice to a future application, on the basis that we wanted to study the Arbuckle reservoir in greater detail as well as the plant's liquid waste streams.

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At about the time we withdrew our license application, we learned that the Federal government had published a policy statement on disposal or storage of wastes by subsurface injection in Federal Water Quality Administration Order COM 5040.10, which is apparently still the government's only published guideline. Therefore in hereby making this application for license amendment to permit subsurface storage of the below described plant liquid wastes, and in developing the waste handling program being submitted, we have been guided by the policies stated therein.

The FWQA policy states that the government is opposed to the disposal or storage of wastes by subsurface injection without strict controls and a clear demonstration that such wastes will not interfere with present or potential use of subsurface water supplies, contaminate interconnected surface waters, or otherwise damage the environment. In its second section it provides that all proposals for subsurface injection of wastes shall be critically evaluated to assure that certain criteria are met. These criteria and our compliance with each are summarized as follows:

(1) "Alternate measures have been explored and found less satisfactory in terms of environmental protection;"

As a result of our extensive exploration of possible alternate waste treatment and disposal methods, the plant's fluoride contaminated waste, the largest portion (90 gpm of a total of 120 gpm) of the waste stream originally proposed to be injected into the well, is now being successfully treated and the purified waste returned to the nearby Illinois River from which the Sequoyah Facility takes its water supply. Other means have been taken to reduce the quantity of waste being generated. For example, in one case the acidic condensate stream emanating from one of the processes has been rerouted for use in another process and the pure condensate previously being used there is now returned to the boiler feedwater system.

Due to these efforts, only the raffinate stream containing nitrates, radionuclides, and various other chemical contaminants from our solvent extraction uranium purification process, plus a few minor streams containing nitrates, are proposed to be injected into the well. The total raffinate and nitrate waste accumulation anticipated over the next five to 20 years is as follows:

After 5 years -	50 million gallons
After 10 years -	115 million gallons
After 20 years -	250 million gallons

For the first five years, this waste flow is expected to average only 19 gallons per minute, including injection of the accumulated raffinate now being stored at the Sequoyah Facility.

Process flow sheets have been studied of alternate methods of treating, recovering chemical values, concentrating dissolved materials into solids, breaking nitrates down into innocuous substances, etc. These are discussed in more detail in Exhibit E. However, none of these flow sheets are based on sufficiently developed technology that bench tests and pilot studies are not necessary prerequisites and it has been concluded that none could be available for practical use in less than some five years and possibly longer. Thus they do not present an immediate alternative to our current surface storage or proposed subsurface storage. However, for the longer term, we are evaluating the alternatives to determine which is the most promising and to determine exactly what bench tests need to be made.

Thus, while other alternatives have been and will continue to be explored and while some were satisfactory and are being used, there remains a significant waste stream for which storage appears the only immediate solution.

(2) "Appropriate preinjection tests have been made to allow prediction of the fate of wastes to be injected;"

It was in this area that the AEC questioned the appropriateness of our original application for underground storage and it is in this area we have concentrated our main efforts to strengthen the basis for this application. This work will be covered in detail later in this application.

(3) "There is adequate evidence to demonstrate that such injection will not interfere with present or potential use of water resources nor result in other environmental hazards;"

The work we have performed and the results presented herein clearly demonstrate that the subsurface wastes will be confined to the Arbuckle formation and that we have developed a monitoring system that will discern any subsurface conditions that could result in a potential loss of control of waste confinement before there could be any detrimental effect to water resources or the general environment. In addition, there are no significant fresh water aquifers in the area nor any significant mineral, natural gas or petroleum deposits to be endangered in any way by our proposed waste injection. See Exhibit F for detailed discussion in this area.

(4) "Best practical measures for pretreatment of wastes have been applied;"

The raffinate preinjection treatment program consists of removal of tributyl phosphate and hexane and monitoring and recycle if necessary to remove excess uranium. Stored raffinates to be mixed with fresh raffinate and injected will have undergone neutralization and settling of precipitated impurities. The preinjection treatment system is described more fully in Exhibit G.

(5) "The subsurface injection system has been designed and constructed using the best available techniques, equipment, and design criteria;"

The injection system both above ground and below ground was designed and constructed based on the best known design criteria, techniques, equipment and materials available. These are described fully in Exhibit H. Proposed additions to the system to improve monitoring capability are discussed under (6) below.

(6) "Provisions for adequate and continuous monitoring of the injection operation and resulting effects of the injection on the environment have been made;"

The original provisions for the routine monitoring of injection operations were described in detail under item (5) above and Exhibit H.

Since the original design criteria and design were developed, further study of good practice in deep well injection systems and the development of advanced monitoring techniques in our research program have indicated the need for additional well monitoring instruments to record injection flow (originally only indicated and totalized), to indicate and record well head injection pressure (originally injection pump pressure only was indicated and alarmed), to indicate and record well head injection temperature (not originally monitored), and to indicate and record tubing casing annulus pressure (originally only indicated).

A comprehensive program of testing the reactions of the well and reservoir to confirm continued safe and defined performance of the subsurface storage system is discussed later in this application. This program is the result of our work and is based on advanced, accepted and demonstrated engineering technology developed for and proved by the petroleum industry.

To provide additional assurance that no adverse effects on the surrounding surface and shallow subsurface environment are taking place, a program of surface and shallow subsurface monitoring is proposed and delineated in Exhibit I. In the extremely improbable event that some breach of waste confinement occurred and went undetected by the primary monitoring systems, this program would provide detection and enable quick and proper corrective action to be taken. As a result, any damage to the surrounding environment will either be avoided or minimized to the extent it will not be significant.

(7) "Appropriate provision will be made for plugging such wells at horizons below present or potential sources of water supply when their use for disposal is discontinued".

Adequate provisions are present to allow effective plugging of the well when use of the well is discontinued. The State of Oklahoma has specific procedures which must be followed when plugging wells as well as a system for inspection and record keeping.

The third section of the FWQA policy states that where subsurface injection of wastes is practiced, it will be recognized as a temporary means of ultimate disposal to be discontinued when alternatives enabling greater environmental protection become available. Our efforts to determine alternatives to injection and our currently licensed method were discussed in (1) above and in Exhibit E. Although no other alternatives are feasible at this time, our studies are continuing so that underground storage can be considered a temporary means to be discontinued when reasonably feasible alternatives are developed which provide greater environmental protection.

To provide complete answers to the points of concern raised in the AEC's letter to our Mr. Wuller of October 15, 1970, and to comply fully with the requirements of (2) and (3) above, we have engaged in a comprehensive and concerted research effort to develop by the most advanced and proved petroleum engineering and geological methods the data, information, and safeguards that would either satisfy the AEC and other regulatory bodies that we should proceed with subsurface storage or convince Kerr-McGee that subsurface low level radioactive waste storage was not a superior alternative for the Sequoyah Facility.

To this end, a research and field testing program was conducted based on advanced engineering reservoir technology. We believe that the research work performed, involving both actual well testing and development and utilization of a numerical reservoir model in a high speed computer for prediction of performance establishes such favorable subsurface reservoir conditions that utilization of the deep well promises superior waste handling for the Sequoyah Facility from a health, safety and environmental standpoint. This research has also assembled and demonstrated an additional method of monitoring the injection well which affords the control necessary to discern in a timely manner any unfavorable situation in the well bore and reservoirs and thereby to prevent the development of unsafe or unmanageable waste movement.

On a broader scale, we believe we have developed an approach for analyzing injection systems and reservoirs which, if allowed to be demonstrated, can show that this method is, from a health, safety, and environmental standpoint, a superior method of handling certain wastes under favorable conditions such as prevail at our Sequoyah Facility.

During the research program to better define the proposed storage reservoir, we made injectivity tests monitoring the flow into the various permeable zones, performed pressure fall off testing, and measured with in-hole flow monitoring devices the back-flow of some zones through the well bore into other zones after a period of water injection and gradual pressure increase. The injection profiling was conducted to determine the rates of water injection into each permeable zone of the total Arbuckle section at various times during the injection period. The pressure fall off testing was executed to reflect the transient pressure characteristics of the reservoir system. Exhibit A attached hereto gives an analysis of the results of the testing program; Exhibit B a detailed description and schedule of the testing program, as well as a tabulation of injection flow rates and surface pressures as measured and recorded by Kerr-McGee personnel; Exhibit C a report of the test results of the Well Analysis Company who made various in-hole measurements; and Exhibit D the test data on in-hole and surface pressures recorded via precision gauges furnished by the Sperry-Sun Well Surveying Company.

Pressure production tests, injection tests, and production or injection profiling are all utilized extensively in the petroleum industry and in the field of hydrology to obtain reservoir description. The test procedure analyzed in the attached report was designed to create a pressure distribution in the reservoir sufficient in magnitude to measure the pressure transients or pressure gradients propagated from the test well through the reservoir system as a function of time. Because a pressure transient moves through the reservoir as a function of reservoir rock and fluid properties, the recorded pressure behavior measured at the test well is directly related to these properties and to the geometry of the system. The physical laws of fluid flow and the mathematical relationships for calculating pressure behavior used in our consultant's study are those which have been accepted in the science of reservoir fluid mechanics.

Evaluations of the reservoir characteristics and predicted reservoir performance were accomplished with the aid of a three-dimensional numeric reservoir model used in a high-speed digital computer. A description of the model used and the means for calibration is included in the report in sections III B and III D.

In summary, our study reveals the reservoir to have five layers having a total volume of at least 860 million barrels (3.6×10^{10} gallons). These layers exhibit different permeabilities and no effective communication between the layers except in the well bore. The areal extent and dimensions for the various layers are presented in the report. The analyses show that the boundaries reflected by the pressure data are sealing and that other communicating faults or fracture zones do not exist within the areas analyzed in the calculations.

Temperature profiles and radioactive well bore fluid velocity surveys indicate that significant back-flow from Zone 5 occurred during the shut-in periods after each injection period. The specific nature of the observed back-flow and the favorable comparison of measured and calculated pressure fall off obtained with the model both substantiate that significant vertical communication does not exist between the layers in the reservoir outside of the well bore.

The model calculations incorporating the given injection rate schedule and individual layer permeability, porosity, thickness and dimensional data further indicate that after five years of injection, the injected fluid will disperse distances in the several layers ranging between 140 to 900 feet from the well bore. After five years the calculated well bore injection pressure is 1,420 pounds per square inch gauge at a depth of 2,650 feet (well below the lowest formation fracture pressure). The predicted modest pressure increase of 200 psi indicates that no significant danger exists in establishing pressure communication through the boundaries or between the respective layers for at least five and probably ten years or more.

The injection flow pressure and temperature at the well head can be continuously monitored so that any change in flow characteristics, such as would occur if a leak of any nature should develop, could be detected immediately. This continuous monitoring program combined with a periodic pressure fall off test program and analysis of the injection well would insure rapid detection of any broaching of the reservoir and would be superior in our opinion to a program using monitoring wells.

Because of the closed nature of permeable Lenses Nos. 1, 2 and 5, the relatively low permeability of the more extensive Layers 3 and 4, and the low magnitude of pressure increase calculated for many years, it is not reasonable to expect Arbuckle waters to be forced to the surface by the injection fluids. The extensive well monitoring program and environmental surface and shallow subsurface monitoring programs proposed would assure that timely and effective corrective action would be taken should a deviation from predicted performance develop.

We request a license amendment for injection into this existing storage well that would be revocable at any time that injection is determined to be harmful. We propose quarterly reports covering the performance of the well including any well test data taken during the period would be presented to the Commission who could then decide if any changes that have occurred are grounds for abandonment of the project.

A summary list of revision pages and the revised pages to be incorporated in the license pursuant to this application are attached to this letter.

Sincerely,

KERR-McGEE CORPORATION

George B. Parks
Executive Vice President

GBP:km

SUMMARY LIST OF REVISION PAGES

Revision 5/10/72

Reference: License SUB-1010, Docket 40-8027
Kerr-McGee Sequoyah Facility

Summary list of replacement pages, Revision 5/10/72

New Pages (5/10/72)	Revision Reason	Replaces Pages (2/3/70)
I-3	Added specific approval request to exceed 10CFR20 limits for well disposal.	I-3
Fig. III-2	Raffinate to well storage or surface pond.	Fig. III-2
III-3	Raffinate to well storage or surface pond.	III-3
IV-1 to IV-6.1 and Fig. IV-1 (7 pages)	Partial revision of Section IV - Waste Disposal to reflect waste well storage.	IV-1 to IV-6.1 (Figs. IV-1 and IV-2) (9 pages)
IV-7	Liquid waste releases.	IV-7
Total 11 new pages plus Appendix B		Total 13 pages to be removed.

a. Exemption is requested from the specific posting requirement of Section 20.203(e)(2) of 10CFR20 for areas and rooms within the plant. All entrances to the plant will be conspicuously posted in accordance with Section 20.203(e)(2) and with the words, "Any area or room within this plant may contain radioactive material".

b. Specific approval pursuant to 10CFR20.305 for incineration of contaminated combustible waste materials is requested. Incineration of radioactive contaminated waste will be conducted as described subsequently under the Waste Disposal section.

c. Specific approval pursuant to 10CFR20.302 is requested for underground storage of radioactivity in liquid waste in excess of the limits of Appendix B, Table II of 10CFR20. Liquid waste releases to the unrestricted area will be made by deep well injection as described subsequently in the Waste Disposal or Storage section.

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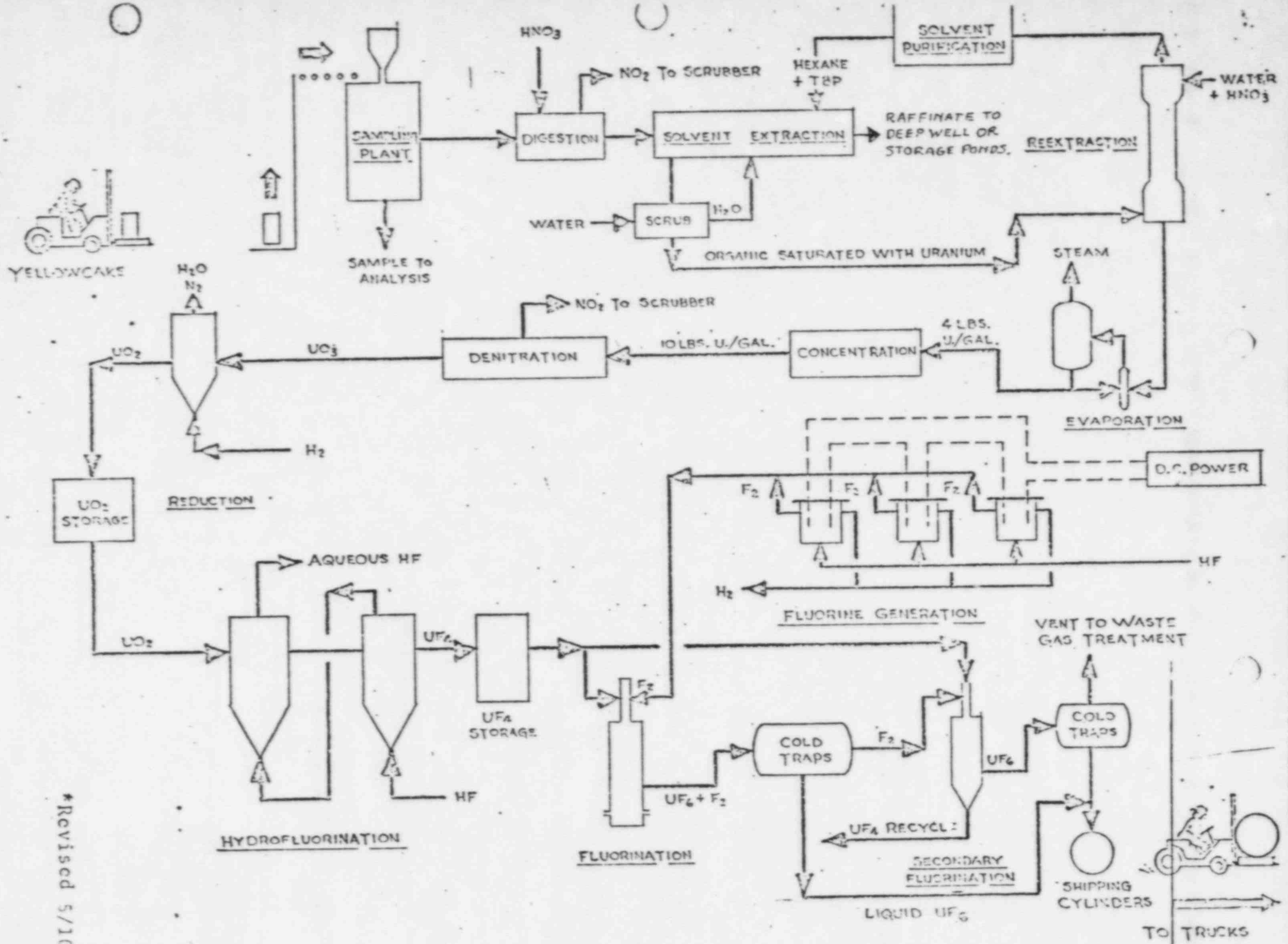

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After the uranium has been removed from the solvent, it is treated with ammonium sulfate-caustic to remove the residual uranium and TBP degradation products.

The raffinate from the extraction step (pumper-decanters) contains about 0.002 lb. U per gallon and the impurities associated with the yellowcake. *This waste is diluted with other waste liquids and pumped down a waste storage well or neutralized with ammonia and stored in a surface pond.*

Preparation of Uranium Trioxide

The aqueous uranyl nitrate prepared in the solvent extraction step is converted to dry uranium trioxide by a two-step procedure. The solution is first concentrated by evaporation to form uranyl nitrate hexahydrate (UNH) which is then heated to yield uranium trioxide. Continuous processes utilize stirred trough and/or fluid-bed denitrators.

Evaporation and Denitration

The purified uranyl nitrate is concentrated by evaporation in a single effect evaporator followed by batch boildown tanks and converted to UO_3 by heating in agitated trough denitrators.

The boildown tanks are heated by steam. The boiling temperature is controlled at levels ranging from 250 to 290°F. Solution freezing points range from 140 to 240°F., thus requiring heating on all transfer lines and storage tanks. In general, nitric acid is recovered from the denitrator off-gas and condensed streams containing uranium are recycled.

The concentrated uranyl nitrate hexahydrate (UNH) may be denitrated to UO_3 by a horizontal heated and agitated trough or in an externally heated fluidized bed reactor.

The process uses a heated trough, 26 inches in width, with a rounded bottom. The 12-foot long trough with a reaction length of about 6 feet is heated electrically and contains a horizontal agitator which rotates at 60 rpm. The agitator consists of an 8-inch diameter shaft with 12 arms each in the form of a T-bar. The clearance between the shaft and the arms is 1/8th inch. The agitator is driven by a 150 hp motor and generally draws about 90 hp.

Uranyl nitrate hexahydrate is introduced through four feed pipes extending vertically from the top of the trough to within about 3 inches of the bottom. The uranium trioxide product overflow through an adjustable weir into a collection bin below the reactor. The uranyl nitrate hexahydrate feed rate is regulated to control the bed temperature at a set value, usually about 570°F.

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*IV. WASTE DISPOSAL OR STORAGE

The various waste products which evolve from operation of the Sequoyah Facility are treated and disposed of or stored in a manner to avoid surface water or potable underground water pollution.

Liquid Waste Systems

The liquid waste handling scheme at the Sequoyah Facility is divided into four separate systems, namely:

1. Solvent extraction raffinate treatment facilities which prepare the raffinate for injection into a deep well storage system or for neutralization with ammonia and storage in waste ponds when the well is not available because of maintenance, testing, etc.

2. The waste well system includes a surge tank and associated liquid collection system, injection pumps, lines, automatic sampler, controls and instrumentation. The alternate storage systems consists of a neutralization mixing tank, ammonia addition system, lines, and surface storage ponds.

3. The fluoride waste stream system consists of a lime neutralization system, settling ponds, a clarification pond, and sulfuric acid addition system for aid in coagulation and neutralization of clarified effluent.

A simplified sketch of the liquid waste system is shown on Figure IV-1. The Oklahoma Water Resources Board has approved the overall waste treatment plan within their jurisdiction.

The quality of the various waste streams can be divided into two areas: 1) effluent to the disposal well, and 2) surface effluent.

The composition of the well effluent varies because it is made up of a mixture of several separate plant streams of widely varying compositions, many of which will flow only intermittently. The normal effluent to the disposal well is primarily inorganic nitrate solution containing about one molar free nitric acid, up to 0.5 lb/gal suspended solids, and traces of natural uranium, other metals, tributyl phosphate and hexane.

The only surface effluents which are released from the plant site are the sanitary lagoon effluent, cooling tower blowdown, boiler blowdown, once-through cooling water brine solution from the water treatment regeneration system and clarified water from the fluoride waste treatment system. All of these streams are diluted with excess raw water from Lake Tenkiller before entering the Illinois

SEQUOYAH FACILITY
WASTE SYSTEM-SIMPLIFIED FLOW SHEET

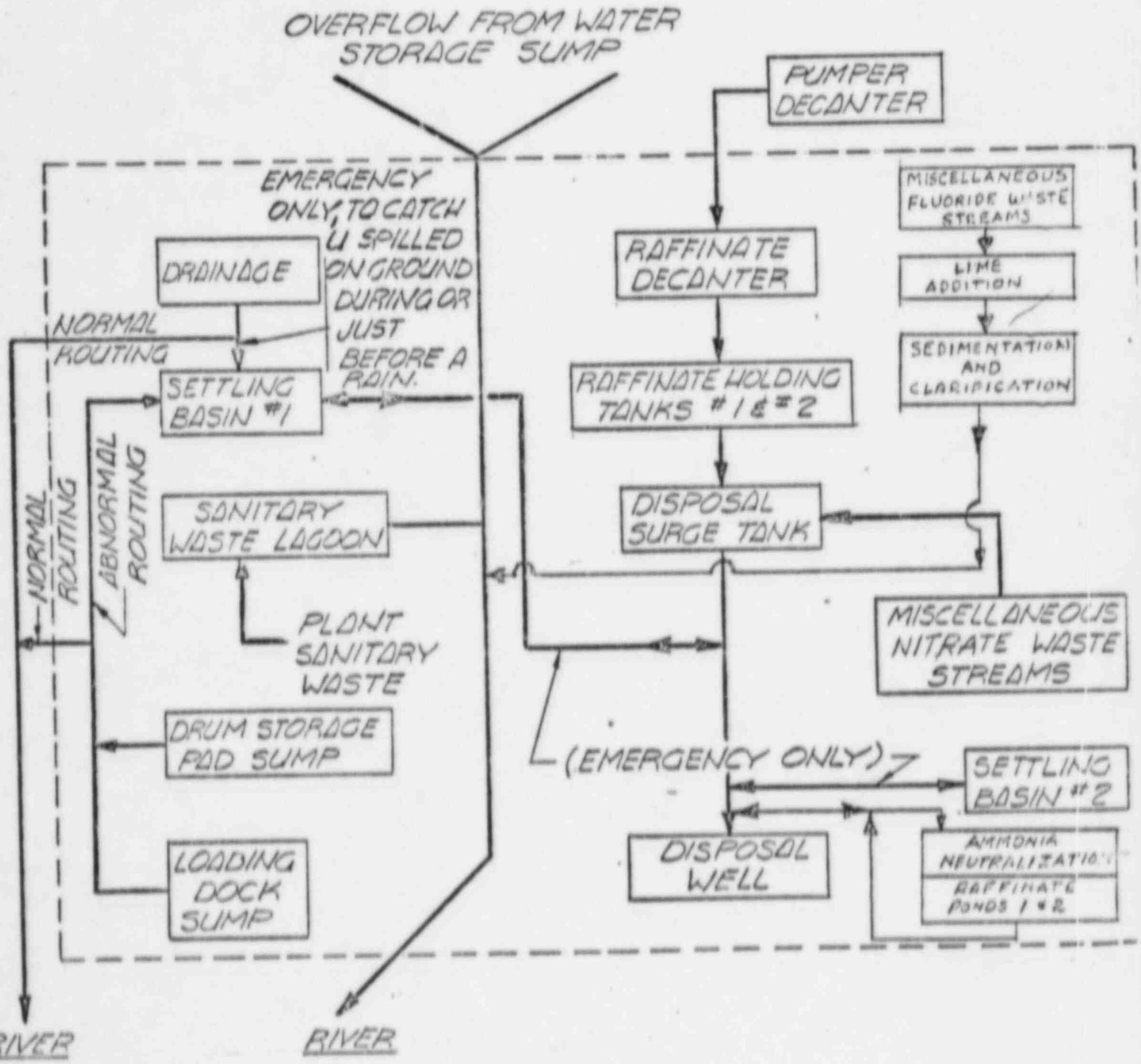

FIGURE IV-1
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River. The only release of radioactivity in this liquid effluent is from the laundry and ample dilution of the stream assures compliance with the regulatory limits. Continuous samples of the combined outfall to the river will be collected daily and analyzed radiometrically to demonstrate compliance to the release limits of 10CFR20. The surface effluent stream ultimately discharges to the Illinois River at 3,140 feet north and 3,700 feet west of southwest corner of Section 21,range 21E., and Township 12 N., Sequoyah County, Oklahoma.

Neutralization and impoundment provisions are available in case the storage well is not available. Included are provisions for a manual diversion and piping of the discharge stream from the well pumps through ammonia neutralization to one of two settling ponds or one of two raffinate storage ponds of 25 million gallon capacity. This separate impermeable surface storage is provided for temporary storage during periods that the well system may be inoperative and the construction of the ponds is in accordance with the AEC licensing guide for Embankment Retention Systems.

A flow indicator, totalizer and recorder measures the quantity and rate of liquid pumped either to the disposal well or the settling ponds.

All raffinate is thus impounded and there is no release to the river. Monitoring of ground waters in the area is periodically conducted to assure that ground seepage is not excessive.

The raffinates stored via deep well will pass into a confined reservoir of the Arbuckle limestone formation at a depth of approximately 1,600 to 3,100 feet. Nearby monitor wells, surface ponds, rivers and creeks are sampled and samples analyzed to assure that no contamination of upper potable aquifers occurs.

Raffinate Treatment

The primary purpose of the solvent extraction raffinate treatment system is to prepare the raffinate for injection into the storage well. The raw raffinate contains a considerable volume of the organic solvent tributyl phosphate (TBP) and may contain more than a desirable amount of uranium. The TBP is removed since it is detrimental to the lining material on the well tubing. The excess uranium is removed primarily for economic reasons and to control radioactive releases.

To remove the TBP, the raffinate is scrubbed with hexane in a decanter and the raffinate flows to one of two 5,000 gallon hold tanks until released to the well surge tank for disposal. If the uranium content is high, the raffinate is recycled to solvent extraction.

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The raffinate stream consists of the liquid volume from digestion, after solvent extraction, plus about 30% for scrub and other streams. It is about one molar in free nitric acid. The disposal system can handle a combined stream of fresh raffinate, stored raffinate and miscellaneous nitrate waste at up to 125 gpm.

Automatic samples are taken while filling a raffinate hold tank and analyzed prior to disposal. The hold tanks are used alternately but not at the same time. Provisions exist for recycling raffinate to a pumper decanter in case raffinate is high in uranium content. The raffinate hold tanks operate continuously on an alternating basis, one tank being filled in six to eight hours. One of the raffinate disposal pumps is operating continuously. Additional automatic sampling of the combined raffinate and chemical waste stream is done at the disposal pump and analyzed for final verification of the disposed contaminants.

Waste Well System

The waste well system includes the collection systems for all of the nitrate wastes that flow to the well, a surge tank, the well pumps, and the well itself. The surge tank insures holding capacity in case of high intermittent flows and maintains a positive suction head on the disposal pumps. One pump is in operation and one in standby. Each pump is rated for 125 gpm at 350-400 psig.

Raffinate acceptable for disposal is drained from the hold tanks to the 2,500 gallon surge tank. The hold tanks are controlled so that when draining they cannot be filled.

Liquid Effluent Handling and Storage

The liquid effluent handling and storage system processes all of the plant liquid wastes which do not normally go to the well. In addition, it provides emergency facilities for holding well wastes at times when the well is not operable.

The following specific facilities comprise this system:

Settling Basin No. 1 - Received drainage from loading dock sump and drum storage pad sump when radioactive contamination of this drainage is expected. Flow to well may be diverted to the basin when the well is not operating. Provision is made for pumping the chemical wastes back to the well system.

Settling Basin No. 2 - Flow to the well may be diverted to this basin when well is not operating and back to the well for disposal.

Sanitary Waste Lagoon - All plant sewage including laundry effluent flows to this oxidation type lagoon. The lagoon meets the design requirements of the Oklahoma State Health Department.

Excess Water Line - Lake Tenkiller water, which is surplus to the plant's requirement, is used to dilute the sanitary lagoon effluent and other streams before discharge to the Illinois River.

Loading Dock Sump and Drum Storage Pad Sump - These sumps may be drained to Settling Basin No. 1 in abnormal circumstances to limit the spread of any spilled uranium concentrate and/or chemicals.

Raffinate Storage Pond No. 1 - This earthen embankment pond with clay lining will hold about 8×10^6 gallons of neutralized raffinate.

Raffinate Storage Pond No. 2 - Similar to Pond No. 1 except 12×10^6 gallons capacity.

Neutralization Facility for adding lime to fluoride wastes and ammonia to nitrate wastes.

Fluoride settling ponds and clarifier pond with sulfuric acid neutralization system for fluoride wastes.

*Waste Disposal Well

(See Exhibits A through I - License Amendment Application Dated 5/10/72.)

Radiological Aspects of Well Disposal

The radioactivity in the liquid wastes is due to that of the natural uranium lost in the solvent extraction step plus that of the decay products of natural uranium which are purposely extracted; namely, thorium-234, thorium-230 and radium-226.

For the initial plant capacity, the release of natural uranium is expected to be slightly above the limits of 10CFR20 for release to the unrestricted area. The natural uranium in the effluent to the well is expected to average about 25 pounds per operating day (about 1.2 curie per year assuming 85% on-stream factor), for initial plant capacity of 5,000 tons annually, of which about 50% is soluble and 50% insoluble. This uranium is diluted with an average of about 20 gallons per minute of liquids before it is injected into the well. The resulting activity from the natural uranium is thus about 3.5×10^{-5} μCi/ml as compared to the allowable release concentration of 10CFR20 of 2×10^{-5} μCi/ml.

Because of its short half-life, the Th-234 reaches its equilibrium concentration in the feed material. The recovery of Th-234 in the solvent extraction process and subsequent disposal to the well results in the release of essentially the equilibrium quantity of Th-234 associated with the total uranium processed. This release will normally be about 0.075 μCi/ml for initial plant capacity which is about 3750 times MPC for the allowable release limit of 2×10^{-5} μCi/ml. This release does not constitute a health hazard in the disposal scheme and furthermore,

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1. After 235 days in the ground, the Th-234 decays to the allowable radioactivity limit due to its relatively short half-life.

2. The maximum radius of water travel after a five-year period is estimated to be only 900 feet from the well bore. Therefore, the radioactive waste is under land on which Kerr-McGee controls underground development until past the time when the Th-234 had decayed to acceptable unrestricted area release limits.

3. Experimental data from a similar well indicates that about 99% of the thorium will precipitate at the interface between the waste water and the disposal formation because of neutralization of the acid waste water. This also decreases the likelihood that radioactive thorium will migrate very far from the well bore. (Reference: Lynn, R. D., Arlin, Z. E., "Anaconda Successfully Disposes of Uranium Mill Waste Water by Deep Well Injection". Mining Engineering, July 1962, Page 49).

At an initial processing rate of 5,000 tons per year, the liquid waste could exceed MPC for soluble material by a factor of 500 MPC for Th-230 and by a factor of 1165 for Ra-226. The primary assumptions are:

1. The yellowcake as produced at the mill will contain 1% of the thorium 230 and 0.035% of the radium 226 originally present in the uranium ore (at radioactive equilibrium). These are average figures contained in the literature for acid leach type mills. Information sources are:

   a. "Waste Guide for Uranium Milling Industry," U. S. Department of Health, Education and Welfare, Public Health Service. Technical Report W62-12.

   b. "The Control of Radium and Thorium in the Uranium Milling Industry," Report WIN-112.

   Data related to acid leach type mills was assumed to be typical for the Sequoyah operation because (1) it is expected that in the long run, at least 50% of the yellowcake processed will come from Kerr-McGee's acid circuit mills and (2) about 80% of the remaining uranium milling capacity in this country is based on an acid circuit. Present sales indicate that more than 50% of the business involves Kerr-McGee yellowcake and that the balance of the yellowcake is (to the extent known) from acid circuit mills.

2. Yellowcake is likely to be stored for 18 months prior to processing to UF_6. Actually, the buildup of thorium 230 and radium 226 in this period is negligible relative to the amount of these materials left in the yellowcake at the mill. The following table relates to the nuclide buildup.

THORIUM AND RADIUM
PRESENT AFTER 18 MONTHS STORAGE

	μ Curies Per Milliter		
	AEC Limit	Sequoyah Well[1-2]	Times MPC[1-2]
Thorium 230	2×10^{-6}	1.7×10^{-6}	0.85
Radium 226	3×10^{-8}	1.8×10^{-8}	0.60

[1] Excludes original thorium and radium remaining in the yellowcake after milling.

[2] Based on 15,000 TPY uranium throughput. For the initial design throughput of 5,000 TPY uranium, one-third of this figure would apply.

Disposal Well Radioactivity Releases

Considering the anticipated expansion of the plant capacity, the possibility of increased losses in waste streams over that expected, and a dilution variance, it is requested that specific approval be granted to release radioactivity via the deep well up to the following average concentrations:

Isotope	Average Conc. (μCi/ml)
U-natural	15×10^{-5}
Th-234	4.5×10^{-3}
Th-230	3.0×10^{-5}
Ra-226	2.1×10^{-5}

Because of limited mobility and confinement within the storage reservoir, the radioactivity of the liquid injected into the well will not constitute a health hazard.

Incineration of Contaminated Waste

The incinerator is used to burn all waste materials and trash of a combustible nature only. All materials to be incinerated that may be contaminated with uranium are collected in a designated area

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and burned at specified times. The incinerator has a capacity of 50 lb/hr and is installed in a suitable location and vented to the plant stack. The ash is removed before and after incineration of potentially contaminated materials and is monitored and/or analyzed for uranium content prior to disposal by authorized methods.

Anti-Pollution Criteria

A study was undertaken to enumerate the type and quantity of chemicals and by-product constituents which would represent a potential pollution problem in operation of the Sequoyah Facility if adequate anti-pollution steps were not taken. The plant design includes measures by which the quantities and types of constituents released to the environment are held to a reasonable minimum consistent with the beneficial uses of the air and water in the Sequoyah site area.

Summary of Potential Radioactive Pollutants

UF_6 Gas - Traces of toxic UF_6 are relased to the atmosphere. Significant releases will not be allowed to persist for any consequential duration. The normal amount of UF_6 to escape from the secondary cold trap is only 0.00074 lb-mol/hour. It is released along with 3.3 lb-mol/hour of inert gases, giving a UF_6 concentration of .004 mg/m^3. Further, this quantity of UF_6 is immediately converted to UO_2F_2 upon contact with water and collected in the scrubber used to remove the HF in the effluent. The UO_2F_2 formed would be carried by the scrubber water to the waste disposal well.

Particulate Matter - All gas-solid reaction involves substantial dust evolution. However, these are contained by the use of micron metallic filters which are periodically automatically back flushed in order to assure their proper performance. Most of the effluent gases before release also go to an absorption tower or through scrubbers, which are excellent particulate traps.

Liquids - The nitrate waste is a combined stream containing SX raffinates, and low concentration nitric acids. These are all forced pumped into a deep well for storage. The waste stream will contain numerous metallic nitrates, possibly ammonium nitrate, from 0.5 to 1.0 molar free nitric acid, and numerous other lesser impurities depending upon the composition of the ore concentrate feed being processed.

The only release of radioactivity in liquid effluent is from the laundry and fenced fluoride wastes for which the plant cooling water will supply ample dilution to comply with regulatory limits.

Laundry services for the decontamination of employees' work clothes will result in a process stream averaging less than 1.0 gpm. The waste stream may contain chemical impurities and shall have a radioactivity concentration less than the allowable limits of 10CFR20.303. Laundry effluent

*Revised 5/10/72

Analytical Data on Raffinate Applications/1974 to Show Analytical Precision of Ra-Analyses

7/9/75

H. V. [illegible]

Date Generated	Sample Code	Date Submitted	Date Reported	Soluble ^{226}Ra min. pCi/L.	Soluble ^{226}Ra avg. pCi/L.	Soluble ^{226}Ra max. pCi/L.	Insoluble ^{226}Ra min. pCi/L.	Insoluble ^{226}Ra avg. pCi/L.	Insoluble ^{226}Ra max. pCi/L.
3/22/74	33T-B-HT	3/25/74	4/30/74	6.69	8.40	10.11	2.33	3.50	4.67
4/30/74	34T-C-ST	5/1/74	5/15/74	0.92	1.31	1.71	0.35	0.64	0.92
5/7/74	35T-C-ST	5/8/74	5/29/74	3.50	4.43	5.35	4.39	5.38	5.88
5/1/74	34T-C-HT	5/1/74	5/15/74	1.62	2.10	2.57	0.60	0.93	1.25
5/28/74	HT#2 Comp.	5/28/74	6/5/74	7.69	9.15	10.62	2.34	3.23	4.13
6/7/74	Resample HT#2 Comp.	6/7/74	6/14/74	36.04	39.57	43.12	1.63	2.81	4.00
([illegible] decomposed counting equip.)									
6/14/74	Resample HT#2 Comp.	6/14/74	7/17/74	—	0.52±0.5	—	—	0.91±0.5	—
6/14/74	ET-74-1A	6/18/74	7/17/74	—	0.78±0.5	—	—	1.45±0.5	—
6/17/74	ET-74-3A	6/18/74	7/17/74	—	1.8±0.5	—	—	2.5±0.5	—
6/28/74	ET-74-1B	7/10/74	7/24/74	7.14	8.39	9.63	2.30	3.14	3.97
7/16/74	ET-74-1C	7/17/74	10/2/74	0.63	1.11	1.58	0.00	<0.13	0.25
7/30/74	ET-74-1D	8/27/74	9/19/74	0.46	0.88	1.30	0.00	<0.13	0.34
8/13/74	ET-74-1E	8/27/74	9/19/74	0.36	0.75	1.14	0.00	<0.13	0.33
8/23/74	ET-74-1F	8/27/74	9/19/74	4.24	5.15	6.07	0.00	<0.13	0.25
9/6/74	ET-74-1G	9/25/74	10/31/74	4.56	5.72	6.88	0.15	0.62	1.09
9/24/74	ET-74-1H	9/25/74	10/31/74	1.03	1.70	2.37	0.00	0.19	0.36
10/11/74	ET-74-1I	10/15/74	11/8/74	—	2.82±0.8	—	—	<0.10±0.3	—
* 10/30/74	ET-74-1J	11/1/74	12/12/74	108.37	112.25	116.14	1.49	2.09	2.69
11/15/74	ET-74-1K	11/18/74	1/22/75	1.42	1.79	2.16	1.60	2.04	2.48

*Note: Counter in preliminary stages of total failure. Later samples run on different counter (scintillation, not proportional flow)

APPENDIX A

PERTINENT PARAMETERS CONTROLLING THE PROGRAM TO TEST THE EFFECTS ON THE ENVIRONMENT USING RAFFINATE FOR GRASSLAND FERTILIZER

AREAS AND SCHEDULED TREATMENTS OF GRASSLAND TEST PLOTS:

	Plot #1	Plot #2	Plot #3	Plot #4
Size	0.78 acres	0.74 acres	0.74 acres	0.64 acres (to be increased to ca. 0.75 acres in 1975 test program)
Treatment	1200 lbs. N/acre	400 lbs. N/acre	400 lbs. N/acre	None
Application Interval	Bi-Weekly	Monthly	Monthly	----
Source of Nitrogen	Raffinate	Raffinate	Commercial Fertilizer Ammonium Nitrate	----
Classification	Saturation Dosage	Normal Dosage	Normal Dosage (Commercial Material)	Control

SOURCE OF RAFFINATE SOLUTION FOR FERTILIZER:

Process Ident.	Date	Code	Soluble Ra	Insol. Ra	Total Ra	Volume
Run #33	3/22/74	33T-B-HT	8.40 pCi/L.	3.50 pCi/L.	11.90 pCi/L.	4,600 gallons
Run #34	4/30/74	34T-C-ST	1.31	0.64	1.95	3,000 gallons
Run #35	5/7/74	35T-C-ST	4.43	5.35	9.78	4,400 gallons
Heel/1973	4/30/74*	34T-C-HT	2.10	0.93	3.03	600 gallons
Composite (HT#1)	Calculated Values		5.28	3.51	8.79	12,000 gallons

*Note: Until we found Run #33 and the 1973 "heel" in this tank we thought the sample pulled was 34T-C-HT.

GENERAL ANALYSES OF THE RAFFINATE SOLUTION FOR FERTILIZER:

U-Conc.	Th-Conc.	Ra-Conc.	N-Conc.	Ca-Conc.	SO_4-Conc.	Na-Conc.	pH
0.17 mgs./L.	39 pCi/L.	See App. B	14.0 gms/L. (NH_4) 14.8 gms/L. (NO_3) 28.8 gms/L.	4.23 gms/L.	2.0 gms/L.	2.72 gms/L.	8.8

1975 Grassland Applications

7/9/1975 [signature]

Date of Application	Code	Date Submitted	Date Reported	Soluble ^{226}Ra min.	avg. pCi/L.	max. pCi/L.	Insoluble ^{226}Ra min. pCi/L.	avg. pCi/L.	max. pCi/L.
Smpl. Drawn 3/10/75	HT#1	3/13/75	6/18/75	0.02	0.09	0.16	0.00	0.01	0.04
Smpl. Drawn 3/10/75	HT#2	3/13/75	6/18/75	0.11	0.19	0.27	0.11	0.19	0.26
Smpl. Drawn 3/27/75	HT#1	5/2/75							
Smpl. Drawn 3/27/75	HT#2	5/2/75							
Smpl. Drawn 4/1/75	HT#1	5/2/75	6/18/75	0.06	0.12	0.18	0.01	0.05	0.09
Smpl. Drawn 4/1/75	HT#2	5/2/75							
5/1/75	ET-75-1A (from HT#2)	5/7/75	6/18/75	0.06	0.14	0.23	0.00	0.14	0.23
5/15/75	ET-75-1B (from HT#2)	5/16/75	6/18/75	0.02	0.09	0.15	0.06	0.14	0.21
5/15/75	ET-75-2A (from #2)	5/16/75							
5/15/75	ET-75-3A (Comm. Fert.)	5/16/75							
6/3/75	ET-75-1C (from #2)	6/4/75							
6/13/75	ET-75-1D (from HT#1)	6/19/75							
6/13/75	ET-75-2B (from #1)	6/19/75							
6/16/75	ET-75-3B (Comm. Fert.)	6/19/75							
6/30/75	ET-75-1E (from #1)	7/11/75							
7/10/75	ET-75-1F (from #1)	7/11/75							
7/10/75	ET-75-2C (from #1)	7/11/75							
7/11/75	ET-75-3C (Comm. Fert.)	7/11/75							