KERR-McGEE CORPORATION
KERR-McGEE BUILDING • OKLAHOMA CITY, OKLAHOMA 73102

May 27, 1970

Mr. Donald A. Nussbaumer
Fuel Fabrication and Transportation Branch
Division of Materials Licensing
United States Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Nussbaumer:

In response to your request made at the meeting in Bethesda yesterday, I am pleased to forward for your use the enclosed five 8 x 1 colored, aerial photographs of the Kerr-McGee Sequoyah Facility. We shall keep you informed on the status of our liquid waste handling at the Sequoyah Facility.

Sincerely,

G. E. Wuller

G. E. Wuller
Nuclear Division-Staff Engineer
Licensing and Regulation

GEW:sl

Enclosures

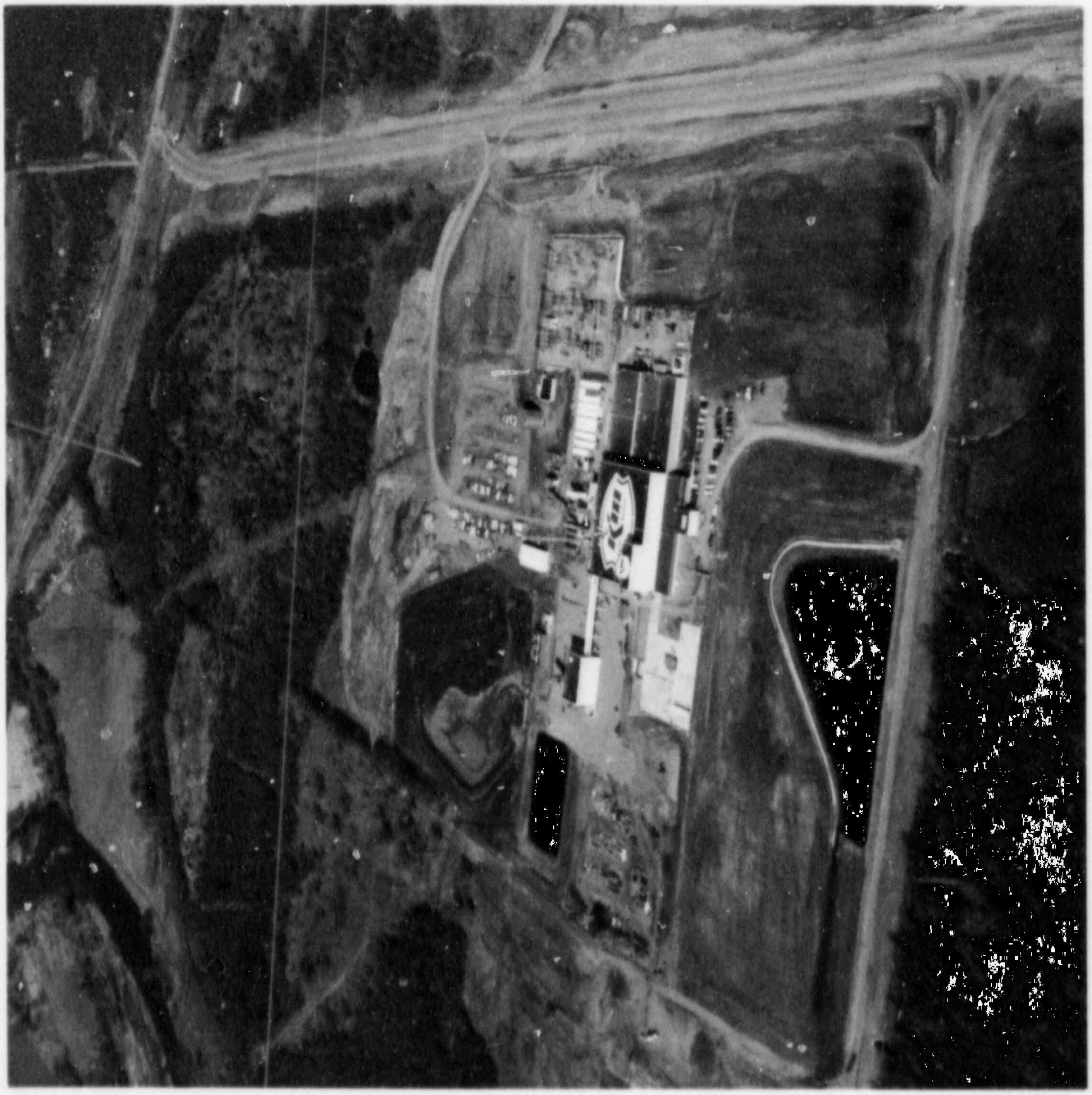
11/3/72

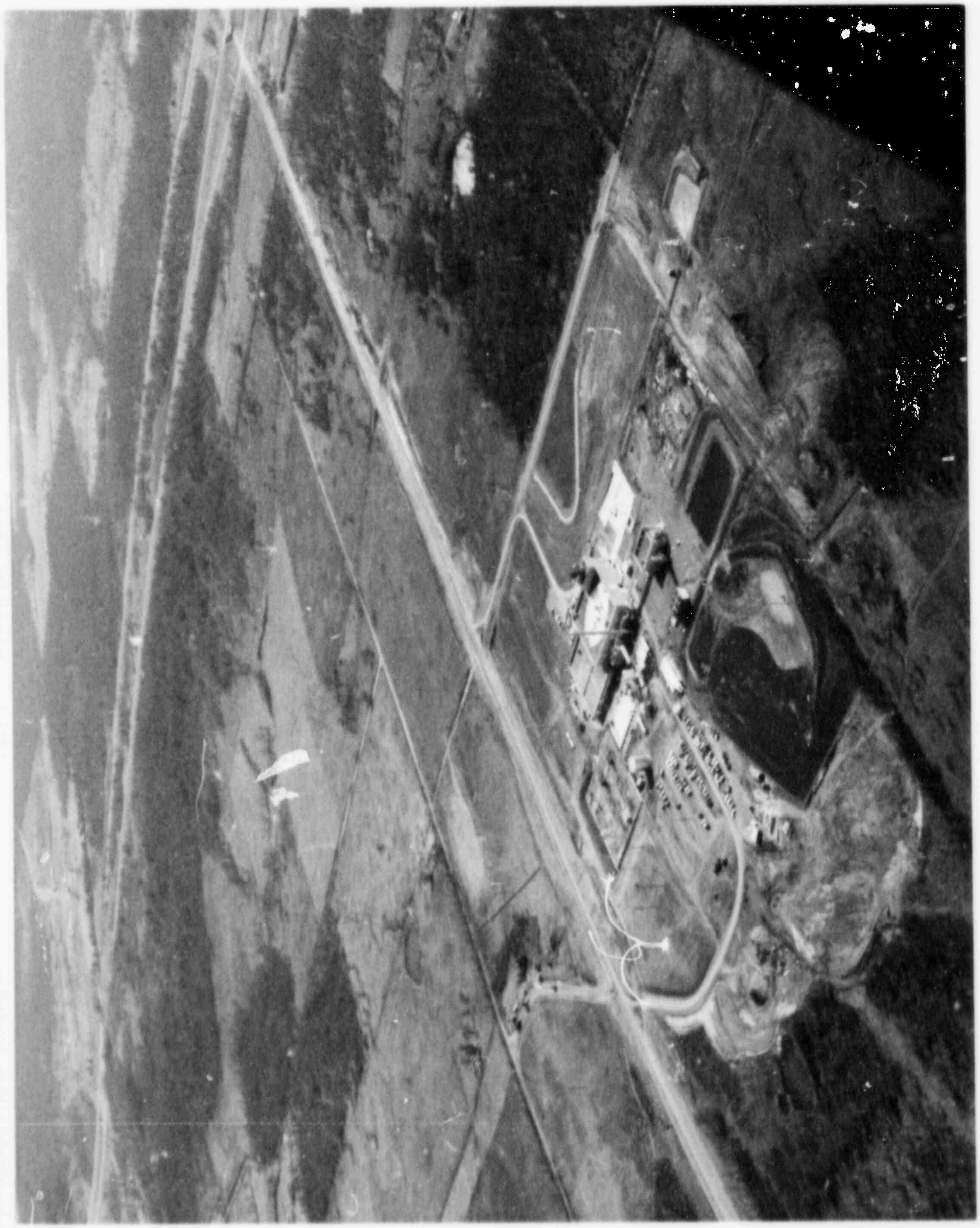
John Anderson, Div. of International Security Affairs, AEC, Germantown (phone 3357 mail station C-111)

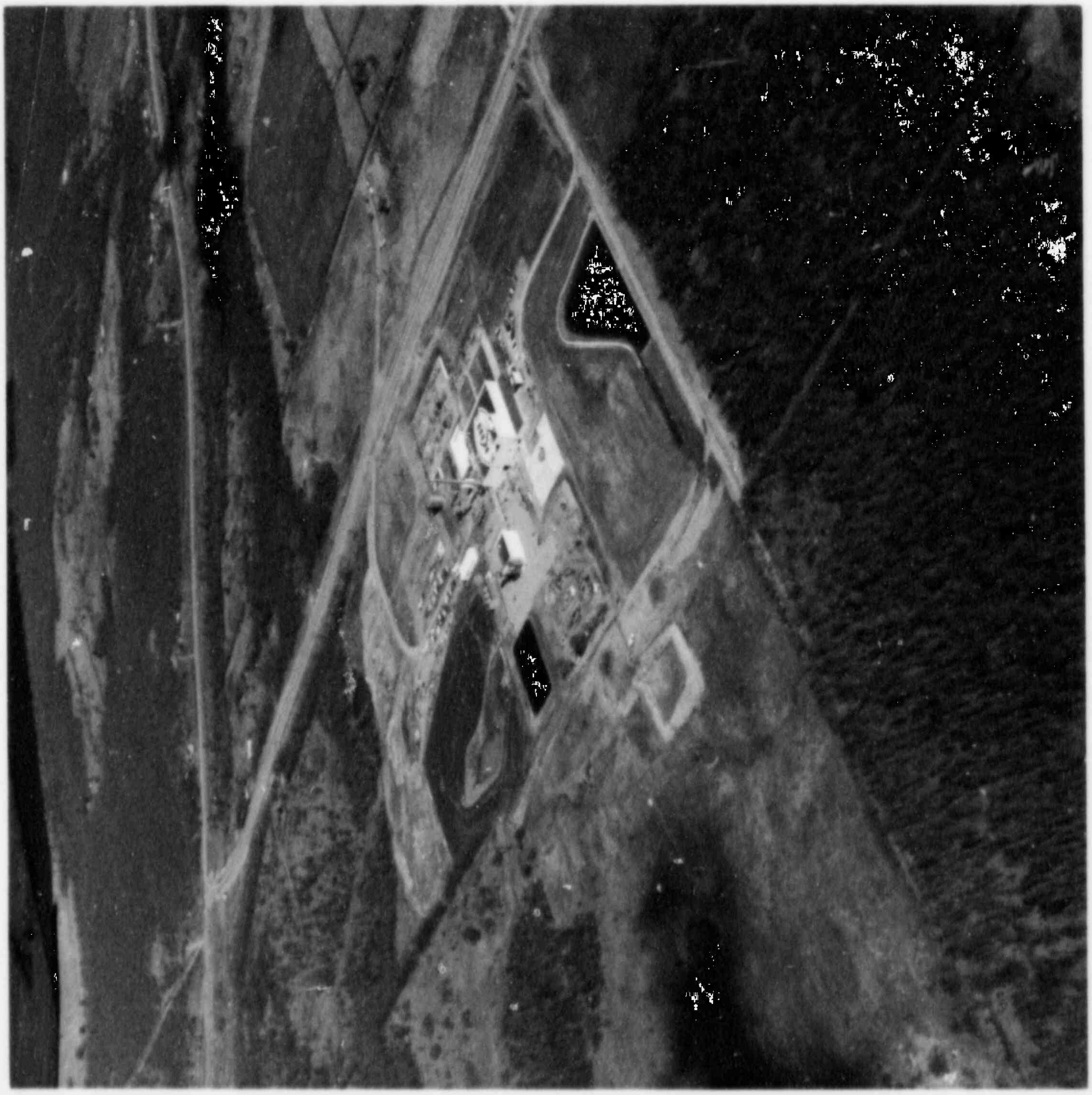
called and requested aerial photos of the Kerr-McGee Sequoyah UF_6 Plant along with a description of the process and buildings. Told him the best we could do would be what they have submitted in their environmental report and license applications.

I sent him copies of 2 colored photos of an aerial view of the plant taken around the time the plant was opened for operation. He is to return the photos in a week. I also sent him a copy of the K-G environmental report on the plant.

Cecil R. Buchanan







HQ-17
(11-65)

U. S. ATOMIC ENERGY COMMISSION

ROUTING SLIP

Organization

TO	NAME, TITLE, UNIT OR MAIL STATION
	Jim Malaro
	Cecil Buchanan
	These should be added to our Kerr McGee file. They should be packages so as to prevent mutilation.
	Jon

- ☐ As Requested
- ☐ Correction
- ☐ Filing
- ☐ Full Report
- ☐ Information
- ☐ See Me
- ☐ Answer or Acknowledge Before ______
- ☐ Prepare Reply for the Signature of ______
- ☐ Allotment Symbol
- ☐ Approval/Signature
- ☐ Comment/Concurrence
- ☐ Necessary Action
- ☐ Note and Return
- ☐ Per Conversation
- ☐ Read & Destroy
- ☐ Recommendation
- ☐ Handle Directly
- ☐ Immediate Action
- ☐
- ☐

REMARKS:

Jon.

You might be interested in having these. I had given them to Cy for the Commission Briefing (which never came off)

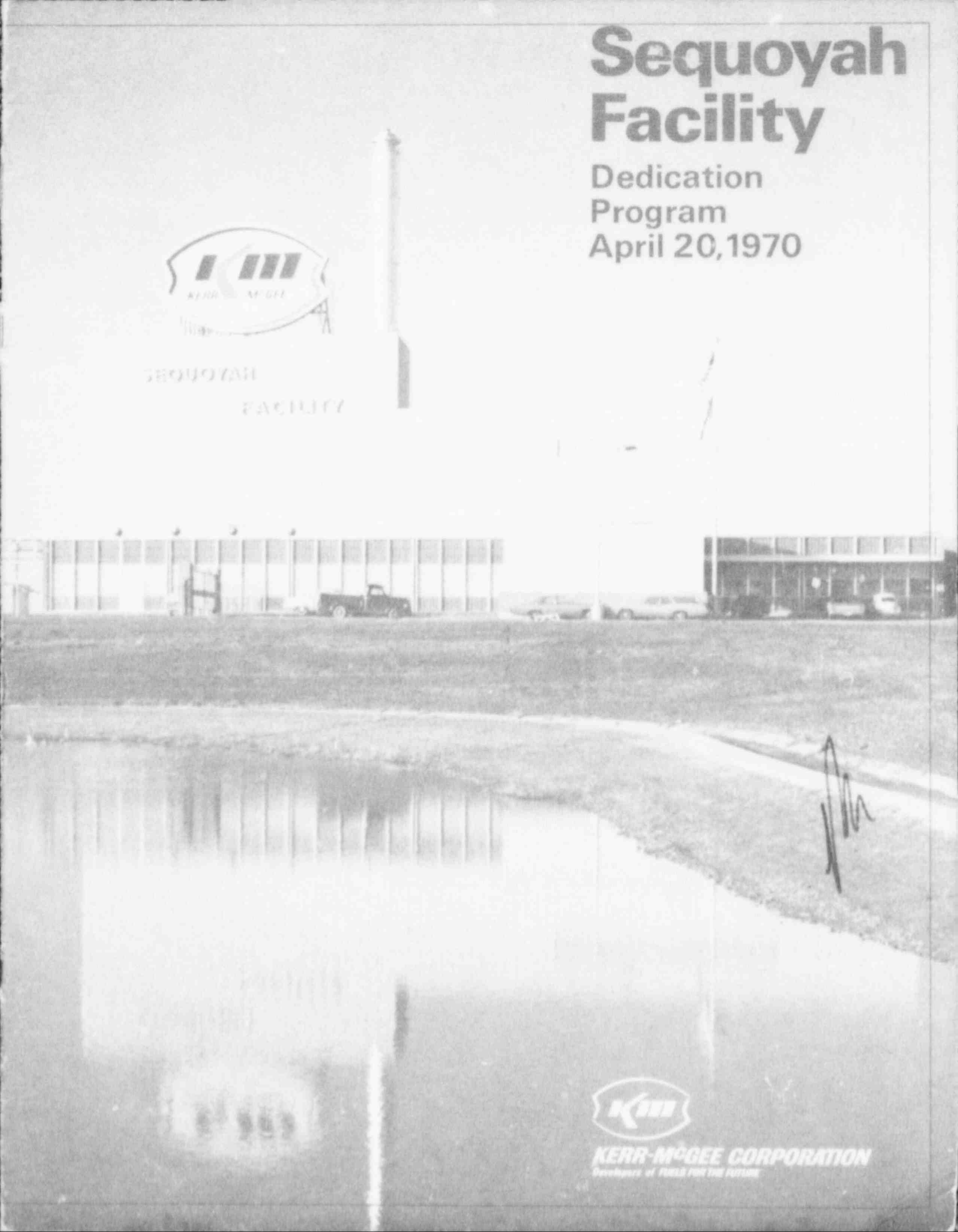
Don

FROM

Name	Div./Off./Br.	Date	Telephone
		9/28/74	

Sequoyah Facility

Dedication Program April 20,1970



KERR-McGEE CORPORATION
Developers of FUELS FOR THE FUTURE

Architect's drawing of Kerr-McGee's $25 million hexafluoride conversion plant located in Sequoyah County, Oklahoma.

DEDICATION PROGRAM

Invocation	The Rev. Daniel Leen, Rector, Grace Episcopal Church, Muskogee, Oklahoma
Presiding	F. C. Love, President, Kerr-McGee Corporation
Remarks	The Honorable Dewey F. Bartlett, Governor, State of Oklahoma
	The Honorable Ed Edmondson, Congressman, Second District of Oklahoma
Principal Address	The Honorable Chet Holifield, Congressman, State of California, and Chairman of the Joint Committee on Atomic Energy
Dedication of Facility	D. A. McGee, Chairman, Kerr-McGee Corporation
Tour of Facility	

THE NUCLEAR FUEL CYCLE

The nuclear fuel cycle describes the life of uranium from the time it is discovered as ore in the earth through its use as energy fuel. Normally, the fuel cycle is considered to consist of the following sequence of steps: exploration, mining, milling, conversion, enrichment, pelletizing, fuel element fabrication, electric power generation, spent fuel reprocessing and refabrication. Each step is briefly described in the following paragraphs.

EXPLORATION

Exploration for deposits of commercial-grade uranium is the first step in the nuclear fuel cycle. More experience, increased geological knowledge and improved techniques are discovering subsurface deposits whereas early exploration was for deposits on outcropping formations that could be found with Geiger counters. The nuclear industry must continue an intensive exploration program to find large, new deposits of uranium ore in order to meet the predicted requirements of the nuclear-generated electric power industry and the Atomic Energy Commission in the years ahead, especially the years after 1975.

Present estimates indicate that already proved reserves are sufficient to supply uranium for national defense and private industry for a period up to about eight years. Uranium for use beyond that period must be found in the next few years to give industry time to construct mining and processing facilities necessary to produce at rates needed to meet expected demand. Although an eight-year supply may seem a small reserve, it should be pointed out that since 1915, this country's petroleum reserves have never been more than 12 years nor less than 8 years. The reserve time is more an indication of the cost of inventorying a raw material than that of the availability.

An extensive exploration effort is now underway, searching for uranium not only around presently producing areas, but in territory where uranium has not been found previously. The supply of uranium beyond 1975 will depend almost entirely on deposits found in areas not associated with present production.

Uranium is relatively abundant in the rocks of the earth's crust. Geographically, in the United States ore has already been found and produced in seventeen states, mostly in the western part of the country. However, geological formations similar to those in which uranium has already been discovered underlie about 80 percent of the conterminous United States. Of this area, about 50 percent is covered by water, glacial drift, or other materials, which make exploration difficult or impractical with present technology. This leaves 40 percent of the country and parts of Alaska as prospective territory for uranium, only a small percent of which has been explored.

MINING

When the search for uranium began in earnest in the late forties, there were many lonewolf prospectors and small mining ventures. Today uranium mining is largely done on an industrial scale and is closely integrated with milling operations.

Some uranium deposits are shallow and mined by open-pit techniques, but the greater part of the ore being produced today comes from underground mines.

MILLING

The uranium mill recovers the uranium from the ore. The uranium concentration in the ore being mined today ranges from as little as 2 to as much as 20 pounds of U_3O_8 per ton of ore. The average is about 5 pounds per ton. The ore is first crushed and the uranium is then leached from the ore. The dissolved uranium is recovered from the "leach liquor" by solvent extraction or ion exchange techniques and is dried to remove excess water. The product is a crude uranium concentrate, known in the industry as "yellow cake," which usually assays between 70 and 90 percent U_3O_8.

CONVERSION TO UF_6

For use as reactor fuel, uranium must be refined to purity standards more characteristic of the pharmaceuticals industry than of normal chemical manufacture. The impurities are "excess baggage" in a nuclear reactor absorbing neutrons unproductively and detracting from the efficiency of the system.

The crude concentrates from uranium mills are purified by solvent extraction and calcined to form essentially pure uranium trioxide (UO_3), a fine powder of brilliant orange hue which is called "orange oxide." Interestingly, long before the atomic age was born, this same material was produced for use as a coloring agent in chinaware.

Orange oxide is first chemically converted by hydrogenation to uranium dioxide (UO_2), which is then converted to uranium tetrafluoride (UF_4), called "green salt," by reaction with hydrogen fluoride gas. The green salt is reacted with fluorine gas (F_2) to convert it to uranium hexafluoride (UF_6), a volatile compound of uranium used in the enrichment process.

Uranium concentrate also can be converted directly to uranium hexafluoride and then purified by a distillation process.

ENRICHMENT

Uranium enrichment is perhaps the most interesting step in the chain of nuclear fuel production and it is also a key step from the economic standpoint.

Natural uranium supplied to the enrichment step of the fuel cycle contains a mixture of isotopes (uranium atoms with different weights). Less than one percent is U_{235} with the balance being primarily U_{238}.

In uranium enrichment a partial separation of the uranium isotopes is accomplished, resulting in a product called enriched uranium that has a higher-than-normal concentration of the uranium-235 isotope, which is fissionable (the atom will split and release energy,) and a by-product called depleted uranium that has a lower-than-normal concentration of the U_{235} isotope and a non-fissionable isotope, U_{238}.

The fission process is the basis of the nuclear reaction, and it is necessary to concentrate the fissionable isotope, U_{235}, to provide the most efficient and economic reactor fuel material. Power reactors use uranium enriched to 2 percent to 4 percent U_{235}.

In the enrichment process, the UF_6 gas is forced through an intricate system of porous metal filters, which has the effect of concentrating the U_{235} isotope on one side of the filters. The enriched UF_6 is collected on one side of the filters and the depleted UF_6 on the other side. The percent enrichment can be controlled by the number of steps or stages.

Enrichment of uranium using the gaseous diffusion process is done by the Atomic Energy Commission in plants at Paducah, Kentucky; Portsmouth, Ohio; and Oak Ridge, Tennessee.

There are two additional fissionable isotopes, Pu_{239} and U_{233}, which have been utilized as reactor fuels. These are generated as by-products of a nuclear reactor and are not a part of the gaseous diffusion process.

PELLETIZING

Before the enriched uranium is ready for use in a reactor, the enriched UF_6 must be converted chemically to a more economical and efficient fuel form. Uranium dioxide (UO_2) is the most commonly used fuel for reactors today.

Enriched UF_6 gas is reacted with ammonia to form ammonium diuranate (ADU). The ADU is calcined to UO_2 powder, and the powder is milled and then pressed into cylindrical pellets. These are densified by sintering (high temperature furnacing). The surfaces are then ground to the final diameter to fit into a particular fuel element tube. Pellets range in size from 0.3 to 0.5 inch diameters and 0.5 to 1.0 inch lengths. A large reactor will contain about 8 million pellets.

FABRICATION

At the present time nuclear fuel is fabricated into fairly precise shapes which are fitted together to form fuel elements. These in turn are arranged in a carefully designed pattern to make up the "core" of a power reactor.

In the fabrication process, enriched UO_2 pellets are inserted into metallic tubes. These tubes are assembled into fuel element bundles which have fixed spacial distribution in the reactor core so the system can function properly. The tube also protects the fuel from corrosion by the water which flows through the core. The tubes are sealed to lock in the radioactive fission products which are formed as fuel atoms undergo fission.

ELECTRIC POWER GENERATION

It is in this step that nuclear fuel releases energy as a result of the splitting, or fission, of the U_{235} atom.

U_{235} atoms will fission naturally at a fixed (slight) rate. When this fission occurs, neutrons are released. Under the proper (reactor) conditions these neutrons can induce fission in other U_{235} atoms and a "chain" reaction occurs. Neutrons, also, interact with U_{238} atoms subsequently forming Pu_{239} atoms, which are fissionable, and contribute to the reaction.

This controllable reaction generates considerable radiation energy, and this heat energy converts water passing over the fuel tubes to steam, which, in turn, runs an electric generator.

This process has been developed to the point where, now, nuclear powered generation of electricity is competitive with power generated using other fuels.

REPROCESSING

During fission, fuel is consumed, radiation damages the fuel material and "nuclear fission products" accumulate soaking up neutrons and lowering "reactivity." Because of these effects the fuel must be replaced when only partially consumed. In most of the reactors being used today for civilian power generation, the fuel must be replaced when only 1 or 2 percent of the fuel atoms have been used up. Even with this limited amount of fuel burnup, the cores involved have a useful life of three or four years.

Part of the plutonium generated in the reactor is consumed during the reaction; however, the remainder represents a reactor by-product.

It is obvious, therefore, that it is desirable to reclaim the unused uranium and to recover the plutonium content.

In the reprocessing operation, after a period of storage under water to cool the fuel elements and reduce radioactivity, the useful uranium and plutonium are separated by a series of chemical separations accomplished by solvent extraction processes. This purification process is done remotely, utilizing radiation barriers, such as massive concrete, until the highly radioactive fission products have been removed.

The decontaminated uranium can be recycled through the enrichment process to restore the concentration of U_{235} or it can be converted to UO_2 and blended with material of higher U_{235} content.

REFABRICATION

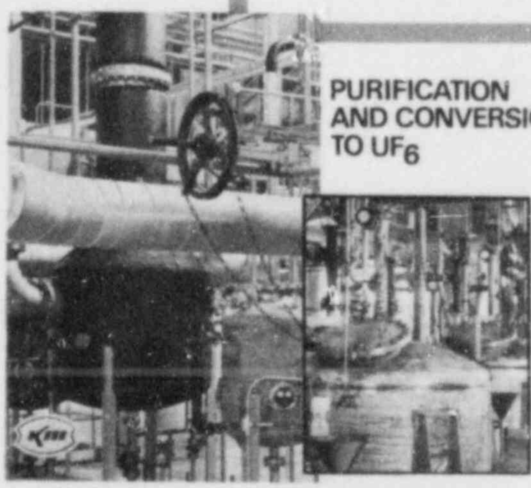
The uranium and plutonium are reformed into fuel pellets and fuel bundles by processes similar to those used for enriched uranium described previously.

NUCLEAR

MINING
Ore

EXPLORATION
For Uranium Ore

MILLING
To "Yellow Cake"

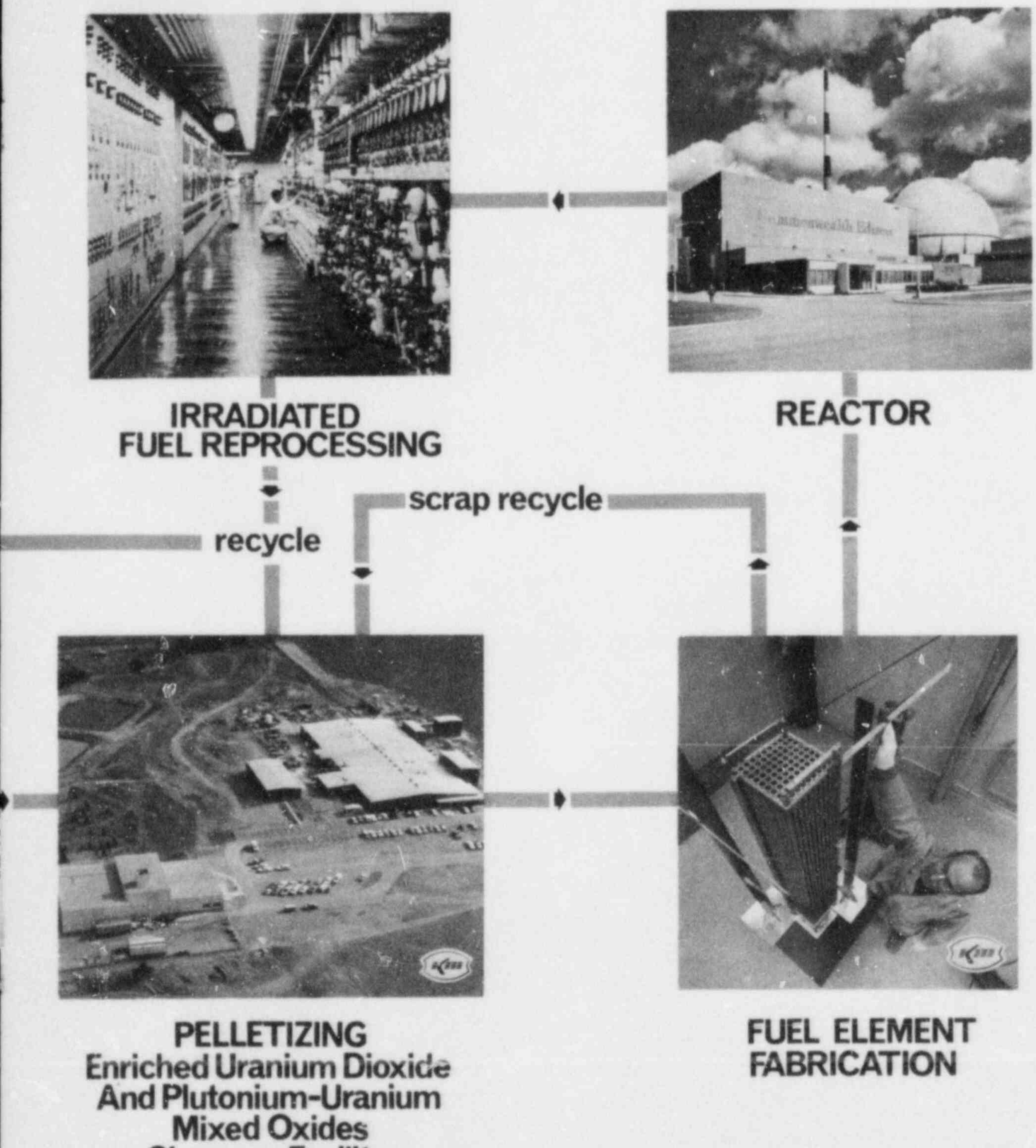


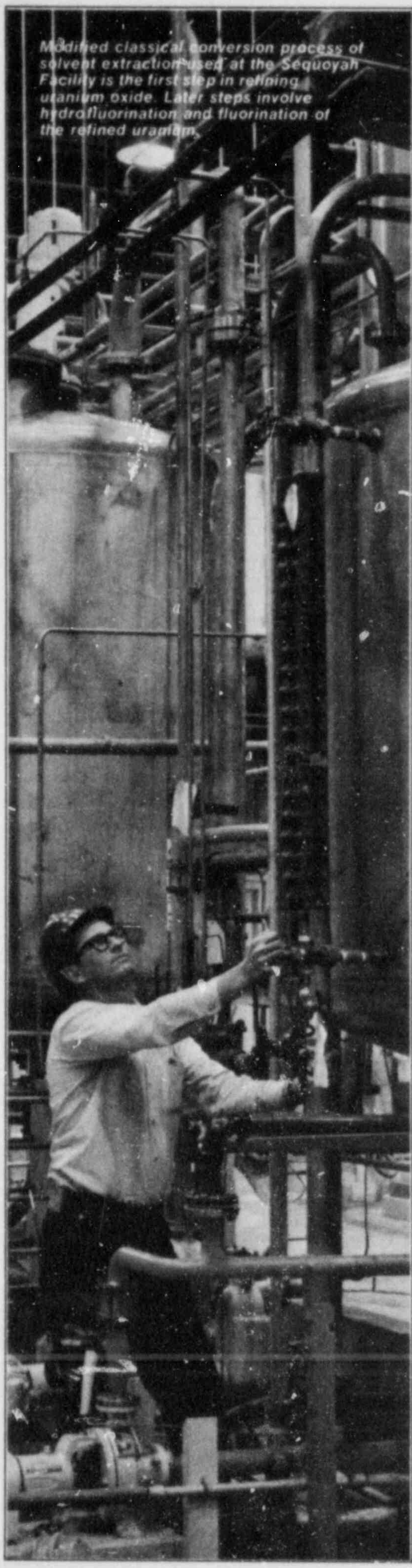
PURIFICATION AND CONVERSION TO UF_6

PURIFICATION & CONVERSION
Kerr-McGee's Sequoyah Facility

ENRICHMENT
AEC Diffusion Plant

FUEL CYCLE


IRRADIATED FUEL REPROCESSING
REACTOR
scrap recycle
recycle
PELLETIZING
Enriched Uranium Dioxide
And Plutonium-Uranium
Mixed Oxides
Cimarron Facility
FUEL ELEMENT
FABRICATION



Modified classical conversion process of solvent extraction used at the Sequoyah Facility is the first step in refining uranium oxide. Later steps involve hydrofluorination and fluorination of the refined uranium.

THE SEQUOYAH FACILITY STORY

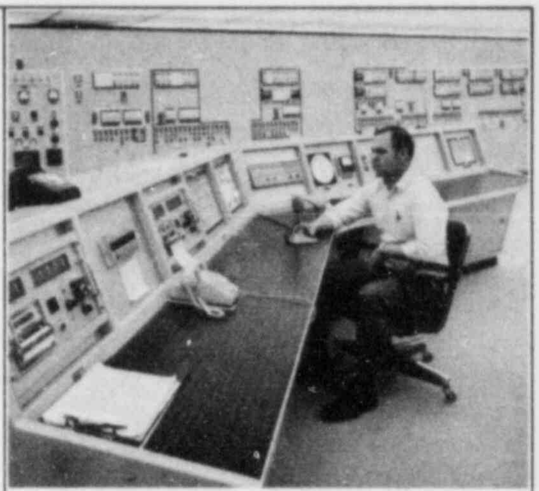
Kerr-McGee's Sequoyah Facility is helping link Oklahoma's colorful past with the State's economic potential in the nuclear age.

There is a nostalgia of bygone days when pioneers traversed by horseback, stagecoach and steamboat, the silent, sun-drenched area of eastern Oklahoma between the Illinois and Arkansas Rivers. Traces of old "Whiskey Road," which extended down to the ferry across the Arkansas River, are still visible on the 1,500-acre site where Kerr-McGee's newest nuclear facility is located. And there is drama in the revelation that man's imagination has caused to rise from the Oklahoma prairie a $25 million structure wherein man will work with one of the newest energy resources — uranium. The product from this plant will become fuel for nuclear reactors which are being built to supply the ever increasing demand for electrical energy.

Kerr-McGee announced in July, 1967, that construction of the uranium hexafluoride conversion plant would begin early in 1968. D. A. McGee, chairman of the board, said, "The construction of a UF_6 plant is a logical extension of our uranium mining and milling operations and is consistent with our objective to participate more fully in the rapidly expanding nuclear industry." Upon completion, Kerr-McGee's facility became the nation's second commercial uranium hexafluoride facility designed to convert uranium oxide, or "yellow cake," from both domestic and foreign mills into uranium hexafluoride.

Comprehensive studies of sites in several states were undertaken to determine the most feasible location for the facility. The site selected was in eastern Oklahoma, near Gore, Webbers Falls and Vian — and approximately 17 miles west of Sallisaw, the county seat of Sequoyah County. The property is bounded on the south by I.H. 40, on the west by the Arkansas and Illinois Rivers, on the north by U. S. 64, and on the east by the eastern section line of Section 22 which is approximately two miles east of the Arkansas River. The confluence of the Illinois and Arkansas Rivers, adjoining the western boundary of the property, forms the headwaters of the Robert S. Kerr reservoir, now nearing completion by the U. S. Corps of Engineers.

In announcing the site for the facility, F. C. Love, president, listed some of the factors influencing the plant site selection. Some of the considerations included the geographical location of the property between the principal yellow cake producing areas in New Mexico and Wyoming and the U. S. Atomic Energy Commission's gaseous diffusion plants in Paducah, Kentucky, Portsmouth, Ohio and Oak Ridge, Tennessee; the proximity to excellent transportation routes and facilities, including I. H. 40, the Missouri Pacific railroad which follows the north boundary of the property, and, upon completion of the Arkansas River Basin project, availability of water transportation to the Gulf of Mexico; an abundance of electrical power; and ample supplies of industrial water from the Illinois River.



From this control room, Sequoyah Facility's entire operation can be monitored. Hundreds of gauges are contained on the 80 foot long control panel in the background, and the employee sitting at the console is in radio contact with all points in the plant.

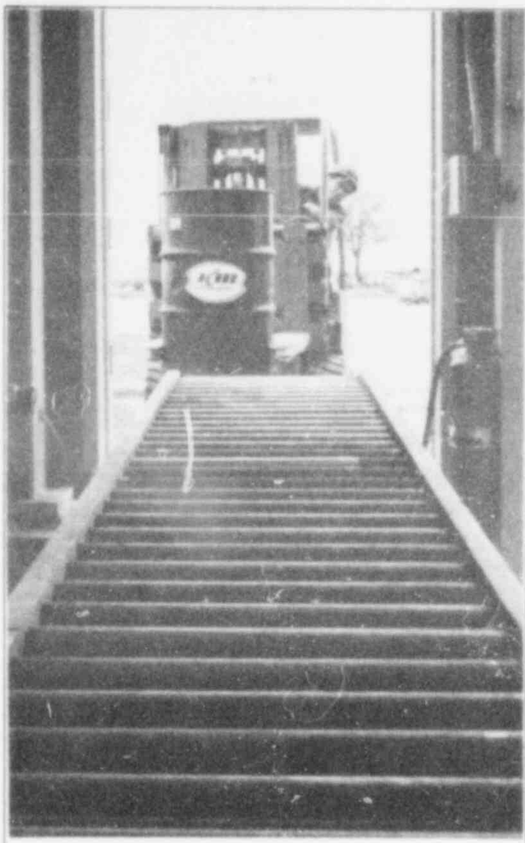
"In addition," Love pointed out, "the plant site is only two hours driving distance from Kerr-McGee's international headquarters in Oklahoma City, the company's technical center and the Cimarron nuclear fuel materials facility. Still another factor is that the property is located within commuting distance of Tulsa, Sallisaw, Muskogee and numerous other cities which offer excellent educational, cultural and recreational advantages to the families of the plant's future employees."

Announcement that the uranium conversion plant was to be located in Oklahoma was lauded by Governor Dewey Bartlett, Congressman Ed Edmondson and other Oklahoma governmental officials. It was their enthusiastic consensus that the new facility would be of tremendous technological and economic value to Oklahoma — and especially to the eastern area of the State. The rapidly growing nuclear industry holds the greatest potential for future energy development in the nation and it was their feeling that the plant, in addition to providing jobs and payrolls, would enable Oklahoma to take part in the development of an exciting, fast growing industry. The facility also could serve as a strong stimulant for attracting new business and creating new employment opportunities in Oklahoma.

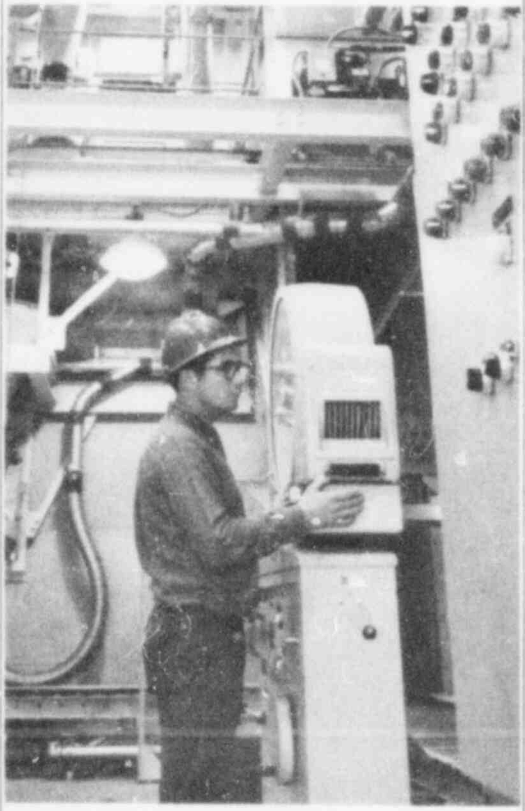
The Sequoyah Facility has a design capacity in the range of 5,000 to 10,000 tons of uranium per year. Operating initially at its minimum design capacity, the facility employs 110 persons — 90 of whom were recruited from eastern Oklahoma. New employees are given an intensive three months training period before beginning work. Total annual payroll at the Sequoyah Facility presently is approximately $1 million.

Raising this space age facility on the once quiet and wind-swept terrain of eastern Oklahoma required 250,000 engineering manhours, 770 tons of steel, 130,000 feet of pipe, 125,000 feet of conduit, approximately 200 miles of wire and 6,500 yards of concrete. Bechtel Corporation, San Francisco, California, designed and constructed the plant.

The old has been melded with the new in an exciting and mutually beneficial industry for Oklahoma and Kerr-McGee Corporation.



In the uranium yellow cake (U_3O_8) receiving area at Kerr-McGee's Sequoyah Facility, yellow cake is received in 42 gallon drums and placed on a large conveyor for weighing prior to being sampled and dumped into the receiving bin.



Kerr-McGee employee at the Sequoyah Facility is shown weighing in a uranium drum of yellow cake (U_3O_8) in the sampling and receiving section of the plant. The yellow cake is weighed, sampled and then dumped into a central receiving bin.

After conversion from uranium oxide, uranium hexafluoride is shipped to one of the Atomic Energy Commission's enrichment facilities in 10-ton cylinders such as these shown in the Sequoyah Facility storage area.

Historic "old Carlisle home," first constructed as a three-room house in 1878, was located on a site near where the Sequoyah plant was built. Home was moved one mile southeast to a spot overlooking the nearly completed Robert S. Kerr reservoir.

Log cabin, thought to be nearly one hundred years old, stands on Sequoyah Facility's 1,500-acre tract purchased by Kerr-McGee in 1967.