11-21-73

UNITED STATES OF AMERICA
ATOMIC ENERGY COMMISSION

IN THE MATTER OF	)	
	)	Amendment to Source
KERR-McGEE CORPORATION	)	Material License
Kerr-McGee Building	)	SUB-1010
Oklahoma City, Oklahoma	)	Docket No. 40-8027

BRIEF OF KERR-McGEE CORPORATION

Pursuant to the provisions of 10 CFR 2.754, Kerr-McGee Corporation, Applicant herein, files its brief in support of its proposed Findings of Fact and Conclusions of Law.

Kerr-McGee Corporation ("Kerr-McGee"), Applicant herein, has built and is operating a plant in the eastern part of the State of Oklahoma for the purification and conversion of yellowcake to uranium hexoflouride (UF_6) under an Operating License from the United States Atomic Energy Commission, being License No. SUB-1010, granted on February 20, 1970, based upon an application submitted on September 25, 1969.

As a part of its license application, Kerr-McGee requested that it be permitted to use a deep disposal well drilled adjacent to the plant facility for the purpose of disposing of acidic raffinate, which is a waste product or by-product of the operation of the plant. This portion of the application for license was denied by the Atomic Energy Commission ("Commission").

Kerr-McGee filed an application for license amendment, dated May 10, 1972 to permit the subsurface storage of the acidic raffinate in the deep disposal well adjacent to its plant. Filed with such application for amendment were the documents that have been admitted as Applicant's Exhibit 1-A through 1-I.

On September 29, 1972, the Deputy Director of the Commission advised Kerr-McGee that its request for amendment had been denied. Kerr-McGee requested that before the decision became final that it be given an opportunity to present additional information to sustain its position. On November 20, 1972, a meeting was held between representatives of the Commission and Kerr-McGee, at which time additional information was furnished the Commission, which has been admitted as Applicant's Exhibits 2-A through 2-I. The additional information was not considered sufficient by the Deputy Director and by letter dated March 14, 1973, he affirmed the denial of the application for amendment.

On April 5, 1973, Kerr-McGee requested a hearing on the matter of the denial pursuant to the provisions of 10 CFR 2.103. On July 10, 1973, the Commission issued a Notice of Hearing published in the Federal Register at 28 FR 18,921, directing that a hearing be held to consider the application of Kerr-McGee. Such hearing was held before

this Board on October 15 and 16, 1973.

The steps taken subsequent to the request for hearing have been in accordance with the applicable statutes and Code of Federal Regulations, and the jurisdiction of the Atomic Safety & Licensing Board ("Board") to hear and determine this cause is valid and subsisting.

I. BASIS FOR REFUSAL TO GRANT APPLICATION FOR AMENDMENT AND AUTHORITY OF BOARD

The Deputy Director of the Commission, in his denial of the application for amendment on March 14, 1973, limited his objections to three items which he alleged prevented conformity with the requirements set forth in 10 CFR 40.32(c) and (d):

1. Existing information is not adequate to demonstrate the presence, location, or nature of the faults that are purported to provide barriers to movement of fluid from the disposal formation, nor is there adequate information to demonstrate that known faults will act as barriers to such movement during continued operation of the proposed well;

2. The complexity of the geologic formation is such that there is no assurance as to the migration paths of the radioactive wastes and the brines which would be displaced; and

3. The complexity of the geologic and hydrologic system effectively precludes emergency recovery of the injected radioactive waste.

At the request of the Board, the parties reduced the objections of the Deputy Director to a series of eight questions which constitute a Joint Statement of Proposed Issues between the parties. The questions are as follows:

1. Whether the Webbers Falls fault exists and, if it does, at what distance is it located northeast of the proposed disposal well?

2. Whether the South fault exists and, if it does, at what distance is it located southwest of the proposed disposal well?

3. Whether additional faults exist within the disposal formation (fault block) that may act as either barriers to fluid movement within the fault block or conduits for fluid movement within the formation?

4. Whether the nature of the faults comprising the fault block are such that the faults will act as barriers to fluid movement under increasing fluid pressure?

5. Whether the five disposal zones composing the Arbuckle Formation can be assumed to be homogeneous, isotropic, and constant in thickness, porosity, and permeability, thereby permitting the calculation of the movement of the disposed waste fluid from the well bore?

6. Whether a three dimensional analysis of geohydrologic problems by the finite difference method, based on test data obtained from a single well, can accurately predict the nature and performance of the injection horizons?

7. Whether monitoring by pressure testing at the well head is adequate to detect fluid movement, or whether there is a need for direct monitoring of the recipient formation?

8. Whether in the event of a demonstrated leak in the retention reservoir or fault block the waste fluid can be recovered?

If the Board finds that Kerr-McGee has, by the evidence introduced by it at the hearing on October 15 and 16, 1973, affirmatively answered such questions, then Kerr-McGee is entitled to have the Board approve the amendment subject only to the determination of environmental matters by the Deputy Director.

However, the determination of whether Kerr-McGee has affirmatively answered the above questions, and is therefore entitled to approval of its amended application, is not the only authority or prerogative of the Board. Mr. Nussbaumer, in his testimony, pointed out that the Deputy Director, or whoever is authorized by him to approve amendments to licenses, has the authority to impose conditions which he thinks appropriate on licenses to be issued. Nothing in the applicable statutes or the Code of Federal Regulations prohibits the Board from the same authority as the Director of Regulation. In fact, 10 CFR 2.721(a) provides for the appointment of atomic safety and licensing boards "to preside in such proceedings for granting, suspending, revoking or amending licenses or authorizations as the Commission may designate***." This Board, then, (subject to the determination of conservation matters by the Deputy Director), may approve the amendment to the license as presented, or may approve the amendment to the license subject to such conditions as it thinks appropriate.

II. THE EVIDENCE PRESENTED

The proposed issues involve the existence and containment ability of the fault block into which Kerr-

McGee desires to dispose of the acidic raffinate waste from its facility, and the ability to recover such waste in the event of emergency. As evidenced by the testimony and exhibits produced, Kerr-McGee has made a comprehensive engineering and geological study of the area surrounding the disposal well. The engineering study included the combined applications of electric well logging, radioactive tracer and temperature profiling, pressure fall-off testing, regional geology and three-dimensional, single phase numeric modeling. The geologic investigation included studies of the surface and subsurface conditions in and around the fault block by field surveys, studies of well logs of wells drilled in the area, and other information available concerning the disposal formation and the area. In addition, Kerr-McGee had a study made by Dr. Charles J. Sternhagen concerning the possible radiological effects and the effect of a "worst accident" in the event of the escape of some part of the disposed material or reservoir fluid.

It is clear, however, from the testimony of the Staff that the Staff has made no independent investigation from either an engineering or geologic standpoint concerning this area. (Tr. pp. 295 and 353-354). The extent

of the investigation by the Staff is well summed up by the following two quotations from the testimony of Dr. Warner and Mr. Robertson:

"DR. WARNER: Not necessarily. I hope you don't have the impression that I tried to in fact go through the same procedure they did. This is a very time-consuming thing. There is an enormous amount of effort involved. However, it is quite easy to look at what was done and make judgments with regard to the general validity and the alternatives that might have existed in the interpretation as opposed to generating an original model oneself and going through all of the effort that is required and time that is required to do that. One can make simple calculations, look at the data and form judgments, which is essentially what I did." (Tr. p. 337)

"MR. ROBERTSON: My mechanism was to evaluate the Gruy testimony and attempt to see how the model was manipulated to arrive at the indicated boundaries and other parameters and to see if the conclusions made there were valid in my opinion.

"My conclusion was that the techniques, mathematical techniques used were accepted and valid techniques based on the equations they had, and that the

way boundaries and so forth are manipulated is an accepted way to manipulate the parameters but it is not the only way.

"The solution to the problem like this, to a complex problem like this with many variables, is not unique. You can get a black box. That is a term we use to indicate something that will manipulate a curve. That does not necessarily mean that the black box is representative over a longer period of time. That is the general overview I took of it." (Tr. pp. 353-354).

It is clear that the Staff and its consultants attempted only to find "weaknesses" in the engineering and geologic work performed by Kerr-McGee. No independent work was done, and there is no testimony that denies any of the findings of Kerr-McGee and its consultants. Their testimony, in essence, is that they do not agree with some of the interpretations made by Kerr-McGee and its consultants, but they have no independent interpretations of their own, either sustaining or contradicting those of Kerr-McGee and its consultants.

The testimony of Mr. ertson quoted above indicates that the numeric modeling tec.iique which was one of the principal techniques used by Kerr-McGee to discover reservoir parameters was a valid and accepted technique, and

that the manipulation of the boundaries was done in an acceptable way. Dr. Warner agreed:

"I don't think that the - I would have approached the model any differently than any other person working in the field would approach it. In the first place, in general, everyone works generally the same way. You have to. You are constrained by the constants that go in, or the parameters that go into the equation. You all have to determine those in order to make any calculations. So everybody's procedure would essentially be generally the same. The place that you might differ is in the details or perhaps not details - in the interpretation of the data that you have to work with." (Tr. p. 335).

Dr. Warner goes on to say, on Page 336:

"I can very well imagine if I had started out with the same data that Kerr-McGee had originally and constructed a model that I would not have come up with the same kinds of boundaries that they have, necessarily. Some of them perhaps you would have. It is quite clear in some cases that the reservoir is bounded. In other cases the reason for the boundaries is less clear." (Tr. p. 336).

Thus, it is quite clear that the engineering and geologic methods used by Kerr-McGee are valid and acceptable methods, and that while the consultants for the Staff may not fully agree with some of the interpretations of Kerr-McGee and its consultants, they have not testified that such interpretations are wrong, and they have not offered any interpretations counter to those put forward by Kerr-McGee and its consultants.

Based, then, on the testimony before the Board there are a number of "hard" facts, i. e., facts obtained by observation or measurement, such as the existence of bounding faults on the northwest and southeast sides of the fault zones, geological facts obtained by field surveys and examination of well logs and other measured information and reservoir facts obtained from measurement in the disposal well. From these "hard" facts consultants for Kerr-McGee have made interpretations and deductions, both from the geologic standpoint and from the numeric modeling standpoint, and it is certain of these interpretative facts which the Staff and its consultants have challenged. At no place have the Staff or its consultants stated that the interpretations made by Kerr-McGee and its consultants are wrong. They have merely stated that they might not have reached the same

interpretations, and they say this without having performed the work and without presenting any interpretations of their own.

III. THE CONTESTED ISSUES

Let us now examine the contested issues to see if they have been established in accordance with 10 CFR 40.32(c) and (d), which require that the licensee's equipment, facilities and procedures proposed for use are "adequate to protect health and minimize danger to life or property", and that issuance of the amendment will not be "inimical to the health and safety of the public." It should be noted that the requirements of 10 CFR 40.32(c) and (d) are not stated in the absolute, but require only that licensee's equipment, facilities and procedures are "adequate to protect health and minimize danger ***", and will not be "inimical (adverse or hostile [Webster]) to the health and safety of the public." (Emphasis added). The term "adequate" does not mean that there must be an absolute guarantee of the protection of the health of the public, but that the proposed procedures must be sufficient to protect the health of the public, and, of course, the word "minimize" recognizes that there will be some danger, but that it should be reduced to a minimum.

Such definitions become important in this cause for the reason that we do not have the fault block sitting on top of the ground where we can measure and guage the various parameters and come to a definitive conclusion concerning the containment possibilities of the reservoir. Because the disposal formation lies at a depth between 1445 feet and 3011 feet underneath the surface of the earth, we must base our conclusions on deductions from facts obtained from the best practices and procedures used in the industry.

A. Existence and Distance of Boundaries

Let us first look at the boundaries of the fault block to see what has been established concerning their existence and distance from the proposed disposal well, and whether said faults will act as barriers to fluid movement under increasing fluid pressure.

The existence of the South Fault of the Warner Uplift and the Carlile School Fault, northwest and southeast of the disposal well, is well known and their existence has never been called into question. The South Fault of the Warner Uplift is approximately six miles from the disposal well, and the Carlile School Fault is approximately one mile from the disposal well.

The Webbers Falls Fault, lying northeast of the disposal well, and the South Fault, lying to the south-

west of the disposal well, are not apparent on the surface and have been determined through analysis of the subsurface and surface conditions, and through the use of the numeric model.

An examination of Applicant's Exhibit C-E is a graphic explanation of the location of the two faults. As can be seen, Dr. Chenoweth had a great deal of information to utilize. He had logs of the Phillips No. 1 Hatcher Well, the Harris No. 1 Standifer Well, the Kerr-McGee No. 1 Sequoyah Well, and the Cobb No. 1 Wilson Well, together with the logs of other wells in the area. These four wells give a clear picture of the geology of the area. Using as a marker bed the Wapanucka Limestone, Dr. Chenoweth found that in the Phillips and Harris Wells the Wapanucka and the Arbuckle were much lower than would have been anticipated, based upon the regional trend of these zones, and in the Cobb Well he found that contrary to the indications of the Phillips, Harris and Kerr-McGee Wells that the Wapanucka had leveled out and did not surface until several miles further to the north than the regional trend and the trend shown in the Phillips, Harris and Kerr-McGee Wells would have indicated. This clear, factual picture requires the deduction that there has been a disturbance of these beds after the time that they were laid down.

Subsequent to the deposition, we find there was downwarping of the Arkoma Basin and the upwarping of the Ozark Uplift. Such tectonic movement resulted in faulting and the logical deduction from the hard facts available is that there is one fault between the Harris Standifer Well and the Kerr-McGee Well, and one fault between the Kerr-McGee Well and the Cobb Well.

The next question is the location of these faults within the area specified. The Webbers Falls Fault must, of necessity, be much closer to the Kerr-McGee Well than to the Cobb Well, otherwise the Wapanucka Limestone would have surfaced at the point indicated by the dashed line on Exhibit C-E. Within that area were found certain surface expressions indicated by a straight stream course, a precipitous bluff, a bend in the Illinois River, and anomolous "Round Mountains" near the Village of Gore and southeast of the Sequoyah Facility in Sections 24 and 26, Township 12 North, Range 21 East. (See KMX 3A [Exhibit C-D]). On Exhibit C-E can be seen a topographic profile showing the stream course and the precipitious bluff which mark the fault. This fault is also confirmed by the numeric model which located a boundary 1164 feet from the disposal well.

It is clear that the hard facts available and the deductions therefrom show the existence of the Webbers Falls Fault and clearly locate it in relation to the Kerr-McGee Well.

The exact location of the South Fault is likewise indicated by surface conditions. As can be seen from Exhibit C-D, the upper reaches of Dirty Creek run generally in a east-west direction, headed toward the Arkansas River. However, beginning in Sections 21 and 22, there are a series of sharp 180° bends, the creek turns in a southerly direction and runs parallel to the Arkansas River with additional 180° turns and it finally enters the river several miles to the southwest of its torturous course. These facts, combined with the abrupt escarpment partially paralling Dirty Creek, as shown on the topographic profile on Exhibit C-E, and a major change in the outcropping of the Hartshorne Sand Formation in the area, strongly indicate structural control - i.e., the following of a fault line - rather than gravity control - i.e., moving from a higher area to a lower area along the line of lowest elevation. The numeric model also contributed information toward locating the fault in that the investigation of the reservoir area by model revealed that in one direction in layers 3 and

4 they did not find a boundary at 29,578 feet. The fault, as postulated by Dr. Chenoweth, is approximately 29,500 feet from the disposal well.

The hard facts and the deductions therefrom make it clear that the South Fault exists, and it is at the distance indicated from the disposal well.

B. Faults As Barriers To Fluid Movement

Will such faults act as barriers to fluid movement under increasing fluid pressure? It must be admitted at the outset that there is no way any expert in the field can state categorically to the Board that these faults will not leak under pressure. The only way to make a final determination is to pressure up the formation by the injection of some fluid material to the maximum pressure anticipated. At this point, upon examination of the surface area on which the faults are located and performing numeric modeling on a pressure fall-off basis, a final determination can be made. However, there would have been pumped into the formation the same number of gallons of material that Kerr-McGee desires to put in the formation to begin with, and in order to put any waste material into the formation it would be necessary to pump the waste material in on top of the material already placed in the reservoir. This would result in a higher pressure on the reservoir boundaries. As can

be seen, the only absolute proof of the tightness of the reservoir would then lead to having to prove that the reservoir would not leak at an even higher pressure by the insertion of additional material. In the end we could prove that the reservoir would not leak at much higher pressures, but we would not have disposed of one iota of the waste material.

Let us view the information available to us concerning the ability of the faults making up this fault block to act as barriers to determine if this formation will not present sufficient evidence to show that leakage from such faults presents a "minimum" danger to life or property.

It was stated by both Dr. Chenoweth and Mr. Gruy that petroleum geologists and petroleum engineers uniformly consider all faults to be sealing simply because in the large majority of cases such faults have been found to be sealing. In fact, such faults are common areas in which to look for accumulations of oil and gas since the movement of the oil and gas is halted at the fault, because it is sealing, and the oil and gas is trapped against the fault. These trapped substances are generally present in the so-called fault traps under pressures much higher than any pressure that will be built up against the faults

surrounding the fault block. Dr. Warner has indicated, in his testimony, that the build up of 200 pounds of pressure in the formation over a five year period is a very small pressure increase. This means that the pressure increase on the faults will be very small, and the chances of breaking through the fault will be greatly reduced. When this fact is considered, together with the fact that most faults are sealing, the danger to life and property certainly becomes quite minimal.

Dr. Warner pointed out in his testimony, and developed in his cross-examination, as it was his responsibility to do, that some faults leak, and Dr. Chenoweth, Mr. Gruy and Dr. van Poollen, in being just as forthright, admitted that some faults do leak. It is interesting to note, however, that Dr. Warner never contradicted the fact that most faults do not leak, nor did he contradict the fact that it was standard practice in the petroleum industry to assume that faults do not leak because the overwhelming evidence gathered over many years of experience is that most faults do not leak.

Because it is impossible to determine whether faults will leak or not until such time as material is actually put into the formation under pressure, Kerr-McGee has proposed an extensive system of monitoring the surface and

shallow subsurface to determine if there is any escape of material from the formation. Kerr-McGee has further proposed an extensive system of further testing by placing measured amounts of neutralized raffinate into the formation under strictly controlled conditions, and then measuring the fall-off pressure in order that the greatest possible data can be given to Mr. Gruy to confirm his numeric modeling. Since all parties agree that such further testing will aid in rendering a better model of the reservoir, at the completion of the testing period there should be as accurate a reservoir model as the state of the art will permit.

Such transient pressure testing will give fall-off pressure curves which can be used to determine boundary leakage at all boundaries as Mr. Gruy has now done for the Webbers Falls Fault. In addition, the build up in pressure in the formation between injection periods will be on a straight line function if there is no leakage or on a different function if there is leakage no matter how far the leakage may occur from the injection well. Thus, at any time in the future it can be determined if leakage is occuring and remedial action can be taken.

Since no one can state categorically that such faults will not leak under pressure, surely the extensive investigation done to date, and the further extensive investigation

postulated by Kerr-McGee to determine if such faults are acting as barriers to increased pressure, and will act as barriers to the total pressure build-up in the formation, will minimize the danger to life or property.

C. Presence of Additional Faults in Disposal Formation and Calculation of Movement of Disposed Fluids From Well Bore

The determinations of the capacity of the reservoir within the fault block to store the raffinate waste and the rate and direction of flow of the disposed material were determined by numeric modeling using a three-dimensional numeric model. Numeric modeling is a well recognized and useful tool for determining reservoir parameters as was testified to by Mr. Gruy and Dr. van Poollen and Dr. Warner and Mr. Robertson.

There seemed to be a conflict in the written testimony of Mr. Robertson and Dr. Warner concerning whether such a numeric model could determine the rate and direction of flow of material pumped into the reservoir. A close comparison of such written testimony, and Dr. Warner's statements under cross-examination, reveal that Dr. Warner and Mr. Robertson were speaking of different types of modeling, and it seems quite clear that based upon the testimony of Mr. Gruy, Dr. van Poollen and

Mr. Robertson, that the modeling technique used by Mr. Gruy will reveal rate and direction of flow of fluids in the reservoir.

The model has been used by Mr. Gruy to determine barriers in the recipient formation or any preferential movement of material in the recipient formation, but Mr. Gruy's studies have not revealed any additional faults within the disposal formation that may act as either barriers to fluid movement or conduits for fluid movement. Further testing, as proposed by Kerr-McGee will confirm this information, and will further determine leakage at the boundaries by the fall-off pressure curve as was done for the nearest boundary at 1200 feet, or the Webbers Falls Fault, and in addition will determine leakage by the build-up in pressure in the formation during the additional testing period proposed by Kerr-McGee, as discussed above. Thus we now know that numeric modeling has revealed no additional faults within the disposal formation, and the geologic investigation of Dr. Chenoweth has revealed that those inferred faults shown on the photogeologic map in fact were not faults at all, but merely lines of vegetation on the ground. As a consequence, we have no indication of additional

faults within the fault block, and the additional testing proposed will further confirm this information.

The testimony of Mr. Gruy and Dr. van Poollen has further shown that heterogeneous zones can be represented by layered models using weighted properties for each of the layers. The numeric model used by Kerr-McGee's consultants was constructed using five layers to represent the reservoir. The model was also used to investigate the effect of heterogeneities within each layer. A significant change in property, either areal or vertical, such as a change in permeability, is reflected in the measured pressure behavior and the calculated value will properly consider these changes. Thus the engineering study has evaluated the areal and vertical heterogeneities which are dynamically significant in the reservoir.

Numeric models are initially assumed to have radial flow - i. e., equal flow in all directions from the well bore - based upon a reservoir that is homogeneous, isotropic and constant in thickness, porosity and permeability. However, if there is channelling or flow in a preferred direction the nature of the flow system will be linear. Linear and radial flow systems have different pressure behaviors which are easily detected in the

early time regions of pressure fall-off tests. No indication of linear flow was observed in the test data, and it was the conclusion of Mr. Gruy and his associates, confirmed by Dr. van Poollen, that the injected material will advance radially in the permeable zones. Once again, this information will be more positively confirmed by the additional testing proposed by Kerr-McGee which can also include the other parameters suggested by Dr. Warner such as density differences, dispersion, etc.

It should be pointed out that in connection with the new Johnsonville well, cited by Dr. Warner in his testimony as one in which there was flow in a preferred direction nearly five times the anticipated distance from the well bore, that the method of calculation of the rate and distance of movement was not based on pressure distribution, and that a numeric model was not used to predict the rate and direction of flow. As pointed out above, the numeric model will predict the rate and direction of flow, and the additional testing proposed by Kerr-McGee will further confirm the rate and direction of flow.

D. Monitoring

Is there the need for direct monitoring of the recipient formation and the overlying formation in addition to pressure fall-of testing of such formations?

It has been agreed by all engineering consultants that the primary method of monitoring the disposal formation is by the use of the numeric model established by Mr. Gruy. A comparison can be made of the observed performance of the disposal well as compared to the predicted performance, and a divergence from the predicted performance will be a warning to search for the cause of such divergence. In the event of a sharp divergence, or a sharp break in the observed performance, emergency action, including procedures to back flow the well, can be initiated.

Dr. Warner, in his written testimony, and confirmed in his verbal testimony, has suggested the drilling of three additional wells for the purpose of monitoring. The first well would be several thousand feet north of the disposal well and would be drilled to the nearest marker zone to confirm the existence of the Webbers Falls Fault. The second well would be drilled through the Simpson Formation at a point several hundred feet north of the present well and would be completed in such a way as to determine if there are any vertical leaks into the Simpson Formation. The third well would be drilled several thousand feet to the southwest of the disposal well, and would be completed in the Arbuckle Formation in the same way as the disposal well and would be used to monitor the Arbuckle Formation.

The cost of drilling these wells would vary between $290,000.00 and $361,500.00, depending upon the completion involved. For this additional sum of money what information would be developed? The first well will merely confirm what the geological facts have established, which facts are further confirmed by the numeric model. Further modeling, as proposed by Kerr-McGee will additionally confirm the existence of the boundary. Such well will merely confirm what we already know, which will be further confirmed by the additional engineering study.

The second well will be drilled to monitor the Simpson Formation. As pointed out by Dr. Chenoweth in his testimony, the bottom layer of the Simpson Formation, the Everton, has no porosity and therefore no permeability. The chances for vertical leakage through that formation are inconsequential. As shown by the studies of Mr. Gruy, the numeric model has investigated the nearby boundary, and the numeric model can determine leakage from that boundary of amounts down to slightly over four barrels per day. Further testing will improve the ability to determine leakage and, of course, it must be considered that the very small pressure increases even over a five year period make such leakage an insignificant element for consideration. The need for the well drilled to

the Simpson Formation is highly problematical.

The third well is to be drilled and completed into the Arbuckle Formation to monitor conditions in that formation. As has been pointed out, this will be a single point source of information. If the flow is radial from the well bore, this well will pick up the increase in pressure and it can be reported to confirm the transient pressure testing performed in the disposal well. This information, however, will be available from the numeric modeling involved. If there is flow in a preferred direction from the disposal well, unless the monitor well is drilled in the flow pattern it will not serve to confirm or deny the preferred flow direction. Thus, its chances of being within the confines of the preferred flow direction are rather small. The fact that the transient pressure testing and numeric modeling will reveal the rate and direction of flow makes the use of such a monitor well of very limited value, and the heavy cost of drilling and completing such a well makes it economically unfeasible considering the return of information from the well.

Dr. Warner, in his testimony at the hearing, placed the use of these monitor wells in their proper perspective when he stated that if "one were seeking a location for

additional ways to monitor for potential leakage that the next most logical thing to do after direct monitoring of the disposal well would be the drilling of additional monitoring wells," and that such monitoring wells would "be a useful addition to the monitoring which Kerr-McGee has recommended by themselves."

The monitoring program as proposed by Kerr-McGee, supplemented by the additional testing program, will be more than adequate, and the use of additional monitoring wells cannot be justified either based upon the information they will produce or the cost of such wells.

E. Recovery of Disposed Fluids

The final question concerns whether in the event of a demonstrated leak in the retention reservoir or fault block the waste fluid can be recovered. The uncontradicted testimony of engineers representing Kerr-McGee is that should recovery become desirable that the similar vicosities and gravities and the miscability between the fluids will allow a good recovery. When specifically asked how much of the injected material could be recovered, it was pointed out that approximately 85% of the injected material could be recovered, less, of course, those portions that may have precipitated out as a result of the chemical reaction of acid in the raffinate with the dolomite in the

formation. Initially, of course, using neutralized raffinate there would be no such chemical reaction. It is apparent that no one was particularly concerned about the remaining 15% that would be left in the reservoir since it would be impossible for it to have any adverse effect. The $Radium_{226}$ content of the reservoir fluid is already high enough that the remaining 15% would add little or no additional $Radium_{226}$ to the reservoir fluid.

The question of recovery becomes moot however when one considers that the consultants for both the Staff and Kerr-McGee agree that there is virtually no hazard to the public or to the environment from the disposal of the raffinate in the recipient zone. Dr. Warner, in his letter of December 22, 1972, in reviewing the presentation of Kerr-McGee on November 20, 1972, although postulating his statements on the drilling of the three monitor wells discussed above, states as follows:

> "After considering all of the presently available information, it is my opinion that, in the absence of any more satisfactory practical alternative, Kerr-McGee Corporation could be allowed to use the well that they have constructed for injection of up to fifty million gallons of waste water with no foreseeable significant hazard to the environment or public health."

The fifty million gallon amount of waste to be

disposed of is the amount that Kerr-McGee has requested to dispose of for the first five years of the use of the disposal well.

Sustaining the views of Dr. Warner and the other engineering consultants was the testimony of Dr. Charles J. Sternhagen, an eminent and well qualified radiologist. Dr. Sternhagen testified that $Radium_{226}$ is the radiologic toxic agent of primary interest. He points out that there are two primary methods of receiving the $Radium_{226}$. First, by direct ingestion by drinking material containing $Radium_{226}$, and secondly by breathing airborne particles containing $Radium_{226}$. Of the two methods, the second is the more dangerous because inhalation moves the radionuclide into the blood stream while when taken orally the system eliminates radium very rapidly the first week after ingestion. Seventy percent of the orally ingested radium is eliminated in the first 24 hours and ninety-five percent in five days.

However, Dr. Sternhagen's conclusions are very illuminating. He points out that in view of the solution concentration of the raffinate that the burning sensation and bad taste resulting from consuming the disposal liquid in its undiluted condition would make

it almost impossible to receive a dose of radionuclide of any significant level, and, in fact, the consumption of two liters of the undiluted material, if it could be ingested at all, would produce only negligible deposition in the body. In connection with inhalation of radionuclides that may have been released to the air by escape to the surface, Dr. Sternhagen pointed out that the dilution in the air would be such that there would be no danger to humans. (Tr. pp. 135-136).

Dr. Sternhagen further pointed out that consideration was given as to the effects of a worst possible accident. Attention was given to leakage into a well used for drinking purposes, leakage to the surface at a point away from the plant site and a massive leak into the Arkansas and Illinois Rivers of an amount equal to the raffiniate disposed of in the well each day as worst possible accidents. It was felt by Dr. Sternhagen that the massive leak into the rivers would be the worst possible accident.

In such case, however, the flow of the Illinois and Arkansas Rivers (except for one day in 1959) is such that there will be adequate dilution of either the raffinate or the formation water to concentrations generally below permissible limits. This would not be true for

a few feet below the entry of the raffinate into the stream because of the plume effect, and there might be some slight damage to aquatic life and vegetation growing in the river at the very point of entrance.

Dr. Sternhagen came to the following conclusion:

> "Based upon my understanding of the monitoring program proposed, and the precision with which a leak in the reservoir can be detected, I believe it to be incredible that an accidental release through failure of the well or the reservoir would result in significant exposure to the population in this area."

The testimony of Dr. Sternhagen, when combined with the testimony of the various witnesses for Kerr-McGee Corporation, make it very clear that the "equipment, facilities and procedures proposed for use pursuant to the requested amendment are adequate to protect health and minimize danger to life or property", and certainly the issuance of the amendment will not be "inimical to the health and safety of the public."

The Staff urged that the maximum permissible concentrations of $Radium_{226}$ would be reduced from the Appendix B values by virtue of the provisions of 10 CFR 20.106(e). However, a careful reading of such regulation indicates that such regulation applies to an area where there is a daily exposure resulting in a daily intake that can be averaged over a period of approximately one year. Under

such circumstances the Commission may limit the quantities of radioactive materials released in the air or water during a specified period of time. The regulation is inapplicable because first, we have no regular release of radioactive materials which would provide for a daily intake by a population group. The monitoring proposed by Kerr-McGee would detect any such releases and protective action, as has been previously outlined, would be taken. Secondly, the regulation has no applicability because the Commission has not acted to limit quantities of radioactive materials released into the air or water below the levels provided in Appendix B for the area involved in the application.

CONCLUSION

10 CFR 40.32 specifies the requirements for issuance of licenses, and states that an application for a specific license for purposes other than export will be approved upon compliance with the stated requirements. The only requirements that have been challenged by the Staff (other than the reserved environmental question) are as follows:

1. The licensee's equipment, facilities and procedures proposed for use pursuant to the requested amendment are adequate to protect health and minimize danger to life or property; and

2. The issuance of the license will not be inimical to the health and safety of the public.

The challenge to these requirements was made more specific by the Staff and by Kerr-McGee in their Proposed Issues for this hearing. The establishment of answers to these proposed issues sufficient to the Board means that Kerr-McGee has met the two requirements of 10 CFR 40.32 set out above.

Kerr-McGee would urge to the Board that the testimony and exhibits presented by it fairly answer the questions in the Proposed Issues. The waste disposal well and its equipment and the procedures proposed for its use are more than adequate to protect health, and they minimize danger to life or property. Certainly, also, the disposal of the acidic raffiniate in a contained underground reservoir in which there are no minerals of commercial value can only be beneficial to the health and safety of the public, since it provides a permanent disposal area in which the acidic raffinate with its radionuclides will be permanently contained.

Kerr-McGee prays that the Board make affirmative findings as to the two requirements of 10 CFR 40.32, set out above, and order that the Amendment to License No.

SUB-1010 proposed by Kerr-McGee Corporation be approved subject only to the environmental questions to be determined by the Deputy Director as provided in 10 CFR 40.32(e).

Kerr-McGee has proposed as a part of its monitoring program that it will do additional testing to confirm the model by the injection of neutralized raffinate from its storage ponds in a series of approximately five sequences, conducting a test for pressure fall-off subsequent to each sequence. Upon collection of this data the results of the fall-off curve would be matched against the model as were the original test results, and the model results could be further confirmed. If the Board would desire, the amendment to license could be conditioned upon Kerr-McGee's performing these tests and furnishing such information to the Staff and to the Board for their further evaluation.

Kerr-McGee feels very strongly that the underground disposal of the acidic raffinate waste from its Sequoyah Facility as proposed is the best answer from all view points to the disposition of these wastes. Kerr-McGee feels that it has been amply demonstrated that its application for amendment meets the requirements of 10 CFR 40.32, and that such application should be approved. If, however, the Board feels that such application should be

conditioned upon the results of the further testing as proposed by it (subject to determination of environmental questions) Kerr-McGee is willing to perform such testing and report the results to the Staff or to the Board as may be directed for further evaluation and confirmation that the fault block used for disposal of the waste material provides for disposal of the waste in a way adequate to protect health and minimize danger to life and property, and that such disposal will not be inimical to health and safety of the public.

Respectfully submitted,

Francis S. Irvine

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CERTIFICATE OF SERVICE

I hereby certify that true and correct copies of the above and foregoing instrument were mailed to the following by depositing in the United States Mail at Oklahoma City, Oklahoma on the 21st day of November, 1973:

John B. Farmakides, Esq.
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46-8027

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UNITED STATES OF AMERICA
ATOMIC ENERGY COMMISSION

In the Matter of	)	
	)	
KERR-MCGEE CORPORATION	)	Amendment to Source
	)	Material License
	)	SUB-1010

CERTIFICATE OF SERVICE

I hereby certify that copies of NOTICE AND ORDER dated November 14, 1973 in the captioned matter have been served on the following by deposit in the United States mail, first class or air mail, this 14th day of November 1973:

Kerr-McGee Corporation
Attention: Mr. George B. Parks
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