

UNITED STATES OF AMERICA  
ATOMIC ENERGY COMMISSION

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

REPLY BRIEF

Pursuant to the provisions of 10 CFR 2.754, Kerr-McGee Corporation, Applicant herein, files its Reply Brief in support of its Proposed Findings of Fact and Conclusions of Law and in answer to the Proposed Findings of Fact and Conclusions of Law filed by the AEC Regulatory Staff.

At the risk of superfluity, but because the correct concept is vital, Kerr-McGee would like to reiterate that the contested issues in this cause must be 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."

As previously pointed out, the term "adequate" is

not an absolute term in that it requires that there must be a positive guarantee that the health of the population will under no circumstances be affected by the requested action. Webster's Seventh New Collegiate Dictionary defines adequate as meaning "sufficient for a specific requirement", but immediately it goes on to point out that specifically such term means "barely sufficient". The word "minimize" clearly recognizes that there will be some danger, but that it should be reduced to a minimum. It is clear that the granting of an application is not grounded on an absolute guarantee of the protection of the health of the population in the area and positive determination that all danger to life and property have been removed, but that a license will be granted if the licensee's equipment, facilities and procedures proposed for use are sufficient to protect health and reduce danger to life or property to a minimum.

It is likewise abundantly clear that the position of the Staff throughout, and as revealed in their Proposed Findings of Fact and Conclusions of Law, is that Kerr-McGee must prove conclusively and absolutely that there will be no possible danger to the health, life or property of the population in and around the fault block into

which Kerr-McGee desires to dispose of the waste products from its Sequoyah Facility. There is no warrant for such position under the statutes or under the rules and regulations of the Commission.

If the fault block into which it is proposed to dispose of the waste products could be exposed, measured, examined and tested by direct observation, then the absolute finality desired by the Staff could be obtained, even though not required by the statutes or by the rules and regulations of the Commission.

Kerr-McGee asserts, however, that using the best industry practices available to it, that it has shown that the equipment, facilities and procedures it proposes for use are "adequate to protect health and minimize danger to life or property", and that the issuance of the amendment will not be "inimical to the health and safety of the public."

Let us then address ourselves specifically to some of the matters raised in the Proposed Findings of Fact and Conclusions submitted by the Staff.

#### ISSUES 1 AND 2

Issues 1 and 2 concern themselves with the existence and distance from the disposal well of the Webbers Falls Fault and the South Fault. In paragraphs 1-6 and 2-1 are

the proposed findings of the Staff in which the Staff states that the evidence submitted by Kerr-McGee does not "conclusively establish" the existence of the faults. Nor can any evidence conclusively establish the location of the faults unless a well is drilled which directly cuts the fault, or unless, as Dr. Chenoweth pointed out, a trench is dug which cuts such faults.

But is the drilling of enough wells to cut each individual fault, or the digging of trenches to cut the faults necessary? The "hard" evidence from the logs of the various wells examined by Dr. Chenoweth clearly show that such faults must exist. The surface formations indicate the locations of such faults. The numeric modeling has located one of such faults 1164 feet from the well and has established a point which is the nearest that the South Fault could be to the well.

None of the consultants or the Staff has taken the position that either a fault or a permeability barrier does not exist in the two areas pointed out by Kerr-McGee. They simply point out that it could be one or the other, and that it could vary slightly in location. It is interesting to note, however, that not one of the consultants disagrees with any of the hard evidence that Kerr-McGee presented, and this hard evidence sustains the interpretation

made by Kerr-McGee's consultants. The Staff has presented no contrary evidence, and no contrary interpretation, but merely the statement that other interpretations are possible, and then states that Kerr-McGee's evidence is not "conclusive".

Kerr-McGee asserts that the evidence submitted is well within the range of adequacy to protect health and minimization of danger to life or property.

The Staff further asserts, in paragraph 1.2, that the water injection tests and pressure fallout tests were inconclusive because "it is generally assumed that the reservoir is a one layer, homogeneous system." The Staff goes on to say that this reservoir consists of five layers, but that separate injection tests were not performed for each of the five layers.

Kerr-McGee's consultants did not assume that the reservoir was a one layer, homogeneous system. As a matter of fact, in their radioactive tracer testing, they established that the reservoir consisted of a number of layers with permeability, which could be grouped into five layers for testing purposes. The method of testing and the use of the numeric model to determine boundaries has been adequately discussed. Suffice it to say, that separate

injection tests were not performed for each of the five layers because such separate injection tests were not needed.

The Staff also challenged the number of computer runs necessary to complete the model, indicating that the number of runs reflected difficulty in arriving at a model. Considering, however, the number of parameters to be used, and the number of questions to be answered, certainly thirty-two computer runs is not an excessive number.

In paragraph 1.7 the Staff challenges the photogeologic analysis introduced as Exhibit C-F. It should first be pointed out that such interpretation is that of a well known geologist in Oklahoma, Mr. Frank A. Melton, and was not made by any consultant for Kerr-McGee. Dr. Warner first obtained a copy of the interpretation from the Oklahoma Geological Survey and attached it as an exhibit to one of his reports. Kerr-McGee had nothing to do with the location of the inferred faults cited by the Staff, and the fact that so few of them exist in the fault block area is another reason why the fault block is a satisfactory place in which to dispose of the waste material.

In addition, as pointed out by Mr. Gruy, Dr. Van Poolen and Mr. Robertson, if any of the inferred faults which appear in the fault block area (other than boundary

faults) affected the movement of liquid within the fault block, such information would have been revealed by the numeric model. Mr. Gruy categorically states that no such information was revealed.

### ISSUE 3

In connection with the existence of additional faults within the fault block, the Staff points to the branching of a fault from the Carlile School Fault into the fault block, and alludes to the two inferred faults shown on the photogeologic interpretation of Mr. Melton. Surface investigation of the two inferred faults shows that they are lines of vegetation resulting from joints, which are merely surface folds and are not faults in any sense of the word. The branch from the Carlile School Fault has been revealed as having no influence on the movement through the formation by the numeric model, which revealed that the direction of flow from the well was radial throughout the reservoir.

### ISSUE 4

In connection with possible leakage of the faults making up the fault block, apart from any consideration given to the extensive investigation by Mr. Gruy, the consultants for Kerr-McGee unanimously agreed (and none of the consultants of the Staff disagreed) that Petroleum

Geologists and Engineers consider all faults as sealing since they are almost universally so.

It is true that faults leak, and that they do provide pathways for mineral substances to travel to the surface in some instances. However, the reasonable inference to be drawn from the testimony is that for a fault to be leaking is the exception that proves the rule that most faults do not leak.

Further, there is no evidence of leakage of the faults at the present time. As pointed out by the consultants for the Staff, the rise in pressure of 200 pounds psig after five years of injection is very small, and, in fact, as compared to the pressure of many thousands of pounds found in oil and gas reservoirs discovered adjacent to faults (which do not leak) it is insignificant. The chances that such a pressure increase will cause the rupture of a fault are so small as to be incalculable.

As to another disposal well in the area which could raise the pressure in the formation to the rupture point, such disposal wells must be permitted by appropriate State agencies in Oklahoma and any such activity could be amply guarded against.



### ISSUE 5

In connection with Issue 5, Kerr-McGee would refer the Board to paragraphs 27 through 32 of its Proposed Findings and the various citations to the record contained therein.

However, concerning the new Johnsonville Wells alluded to by a consultant for the Staff, on which the Staff bases a great deal of its objections to the method of determining direction and rate of movement of liquid waste from the well bore in the disposal well, Kerr-McGee would point out that although various methods were alleged to have been used to determine the rate and direction of movement in the new Johnsonville Wells, numeric modeling was not used. Consultants for both the Staff and Kerr-McGee have clearly pointed out that numeric modeling will determine the rate and direction of movement from the well bore, and therefore Kerr-McGee asserts that the experience of the new Johnsonville Wells is not relevant, since Kerr-McGee did use numeric modeling to make such determinations.

In addition, it should be pointed out that at no point in the testimony was any information given us concerning the new Johnsonville Wells except that one of them had movement of disposed liquids in a preferred direction which was not determined beforehand. What were the parameters of the well or wells? What were the testing

procedures? What was the result of the testing? These and many other facts are necessary before it can be determined that the new Johnsonville experience is relevant to the problem at hand. Therefore, Kerr-McGee asserts that the new Johnsonville experience provides no basis for determining the issues at bar.

#### REMAINING ISSUES

As to the remaining issues, Kerr-McGee would refer to its Findings of Fact and its Brief filed herein.

#### CONCLUSION

The use of the disposal well is important to Kerr-McGee. It has put much time and effort and much money into the preparation for and presentation of evidence in support of its amendment for the use of such well. Kerr-McGee believes that it has presented evidence that its equipment, facilities and procedures proposed for use are "adequate to protect health and minimize danger to life and property", and that the issuance of the amendment will be not be "inimical to the health and safety of the public."

The Staff throughout has demanded, contrary to the provisions of CFR 40.32(c) and (d), that Kerr-McGee present absolute proof not that its equipment, facilities and procedures were adequate to protect and minimize danger, but

that there would be absolute protection and no danger.  
Kerr-McGee asserts that such proof is not required, and re-iterates its prayer set forth in its initial brief heretofore filed with this Board.

Respectfully submitted,

  
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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 19th day of December, 1973:

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UNITED STATES OF AMERICA  
ATOMIC ENERGY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

GET IN FACT  
THAT WASTE  
CONTAINS Ra<sup>226</sup>  
AND INDICATE ITS  
HALF-LIFE

In the Matter of

Kerr-McGee Corporation  
Kerr-McGee Building  
Oklahoma City, Oklahoma

Amendment to Source Material  
License SUB-1010

Comments  
to hearing  
11/21/73

AEC REGULATORY STAFF'S PROPOSED  
FINDINGS OF FACT AND CONCLUSIONS OF LAW  
IN THE FORM OF A PROPOSED INITIAL DECISION

File Temp  
Gore/Hearings

The AEC Regulatory Staff requests pursuant to 10 CFR 2.754 that the following proposed findings of fact and conclusions of law in the form of a proposed initial decision be adopted by the Atomic Safety and Licensing Board in this proceeding.

I. PRELIMINARY STATEMENT

1. On May 10, 1972, the Kerr-McGee Corporation ("the Applicant") filed an application with the Atomic Energy Commission ("the Commission") to amend its Source Material License No. SUB-1010 for authorization to utilize deep well disposal of liquid radioactive wastes generated from its solvent extraction uranium purification process at its Sequoyah facility. <sup>1/</sup>
2. On September 29, 1973, the Regulatory Staff of the Atomic Energy Commission ("the Staff") denied the Application after determining that issuance of the license amendment would not conform with the requirements set forth in 10 CFR 40.32(c) and (d) because:

<sup>1/</sup> App. Exh. 1 passim.

- "(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.
- (3) The complexity of the geologic and hydrologic system effectively precludes emergency recovery of the injected radioactive waste." <sup>2/</sup>
3. After consideration of additional information submitted by the Applicant, the Staff reaffirmed the denial referenced in paragraph 2 on March 14, 1973.<sup>3/</sup> On April 5, 1973, the Applicant requested a hearing on the denial.<sup>4/</sup>
4. On July 10, 1973 the Commission published a "Notice of Hearing" in the FEDERAL REGISTER (38 F.R. 18921). Subsequently, an Atomic Safety and Licensing Board ("the Board") was established by the Commission and the Chairman of the Atomic Safety and Licensing Board Panel pursuant to the Atomic Energy Act of 1954, as amended, ("the Act") and the regulations of the Commission. The Board is composed of three members whose signatures appear on this decision. The Board issued a "Notice and Order for Prehearing Conference, and Evidentiary Hearing" on July 19, 1973 (38 F.R. 19853) setting

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<sup>2/</sup> Staff Exh. A, p. 14

<sup>3/</sup> Id., p. 3

<sup>4/</sup> Id., p. 4

the time and place for a prehearing conference held on August 14, 1973 in Washington, D.C. After consideration of a "Petition to Require Publication of Proper Notice of Hearing" submitted on behalf of the Natural Resources Defense Council, 5/ the Board issued a "Prehearing Conference Order and Notice of Extension of Time to Intervene" on August 14, 1973 (38 F.R. 22175) inviting interested persons to file petitions for leave to intervene pursuant to 10 CFR 2.714 within 30 days from date of the Order's publication in the FEDERAL REGISTER. On September 21, 1973, the Board issued a "Memorandum and Order" which set the time and place for an evidentiary hearing held on October 15 and October 16, 1973 in Washington, D.C.

*No petitions  
filed within  
30 day period.*

5. The "Notice of Hearing" of July 10, 1973 (38 F.R. 18921) directed this Board to consider and decide whether, pursuant to the Act and in accordance with 10 CFR 40.32(c) and (d):

- "(1) The licensee's equipment, facilities and procedures proposed for use pursuant to the requested amendment are adequate to protect health and minimize danger, life or property, and
- (2) The issuance of the amendment will be inimical to the health and safety of the public." 6/

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5/ Tr. 7-29.

6/ Tr. 3

The Notice further provided that if the Board makes an affirmative finding with respect to Item 1 above and a negative finding with respect to Item 2, the Applicant's application is to be remanded to the AEC Deputy Director for Fuels and Materials for such further action on environmental matters as may be required by 10 CFR 40.32(e).

6. The Board held a prehearing conference in this proceeding in Washington, D.C. on Tuesday, August 14, 1973. The Board requested that the Applicant and the Staff frame a joint statement of the issues reflecting those issues on which the parties were in agreement and those issues on which the parties were not in agreement. <sup>7/</sup> Pursuant to this request, the Applicant and the Staff filed with the Board on September 21, 1973, a "Joint Statement of Proposed Issues" proposing the following issues for consideration in the proceeding:

- a. Whether the Webers Falls fault exists and, if it does, at what distance is it located northeast of the proposed disposal well?
- b. Whether the South fault exists and, if it does, at what distance is it located southwest of the proposed disposal well?
- c. 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.
- d. 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.



- e. 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.
  - f. 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.
  - g. 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.
  - h. Whether in the event of a demonstrated leak in the retention reservoir or fault block the waste fluid can be recovered.
7. The Board held an evidentiary hearing in Washington, D.C. on October 15 and 16, 1973 at which time the Applicant and the Staff presented evidence with respect to the issues referenced in paragraph 6.

## II. FINDINGS OF FACT

ISSUE 1: WHETHER THE WEBERS FALLS FAULT EXISTS AND, IF IT DOES, AT WHAT DISTANCE IS IT LOCATED NORTHEAST OF THE PROPOSED WELL?

- 1-1 The Applicant presented evidence consisting of injection tests, pressure fall-off tests, computer modelling, and a topographical analysis of surface conditions to demonstrate the existence of the Webers Falls fault as a hydrologic boundary at a distance of 1164 feet northeast of the well. <sup>8/</sup>

The existence of this fault as a hydrologic boundary was believed to have been established by the Applicant from the results of the pressure fall-off tests. <sup>9/</sup> The exact location of the boundary was calculated by a computer, in which the location of the inferred impermeable boundary was adjusted to that distance from the well which produced a pressure fall-off curve best matching the curve obtained in the actual pressure fall-off test. <sup>10/</sup>

1-2 Although the Applicant indicated that a best fit had been achieved, there is a significant difference between the measured pressure fall-off curve and the calculated pressure fall-off curve. <sup>11/</sup> The calculated points do not fall-off as rapidly as the measured points during the first 60 hours of pressure fall-off. After 60 hours of pressure fall-off, the calculated points fall off more rapidly than the measured points. <sup>12/</sup> The significance of this difference, if any, can only be ascertained by additional and longer injection testing. <sup>13/</sup>

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<sup>9/</sup>

<sup>10/</sup>

<sup>11/</sup> Tr. 351-352.

<sup>12/</sup> Tr. 351-352.

<sup>13/</sup> Tr. 352.

1-3 The Applicant had to make 32 computer runs to obtain the best-fit pressure curve referenced in paragraph 1-2, which indicates difficulty in making proper adjustments to obtain desirable results. <sup>14/</sup> Other combinations of geological properties could have been introduced into the model and achieved similar pressure curves. <sup>15/</sup>

1-4 Where relatively major faults are found, there are usually also smaller features found having the same direction as the major features. <sup>16/</sup> Such smaller features usually consist of joints, fractures, and small faults. <sup>17/</sup> The Applicant's photogeologic analysis of the surface of the disposal formation shows numerous additional faults, both actual and inferred, in the area between the Carlile School fault and the Marble City fault. <sup>18/</sup> In an area where two faults intersected, such as the Carlile School fault and the Webers Falls fault, it is probable that one would find additional smaller faults. <sup>19/</sup> The Applicant's photogeologic analysis of the surface of the disposal formation shows no additional faults to exist in the vicinity of the Carlile School and Webers Falls fault intersection. <sup>20/</sup>

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<sup>14/</sup> Staff Exh. C, p. 5.

<sup>15/</sup> Staff Exh. C, p. 5.

<sup>16/</sup> Tr. 81.

<sup>17/</sup> Tr. 81

<sup>18/</sup> Tr. 80-81, App. Exh. 3C (C-B), (C-F).

<sup>19/</sup> Tr. 80-81.

<sup>20/</sup> App. Exh. 3C (C-B), (C-F).

- 1-5 With respect to the surface analysis of the disposal formation, there are no conclusive points of topographical evidence establishing the existence of the Webers Falls fault. The Applicant bases the existence of the fault on wholly circumstantial evidence. 21/
- 1-6 One reason for inferring the existence of the Webers Falls fault was because of the differences in elevation of the various identifiable formation layers between the Applicant's disposal well and the Bennet-Wilson well some six miles northeast of the disposal well. 22/ If the Webers Falls fault exists, it could lie anywhere in the six mile line separating the two wells. 23/ The anticipated point at which the Wapanuka limestone outcrops at the surface may narrow this distance to a line of two miles because the Webers Falls fault, if it exists, would have to lie between the disposal well and the Wapanuka outcrop, which is about 2 miles northeast of the disposal well. 24/
- 1-7 Based on the foregoing, the Board finds that there is inadequate evidence to conclude that the Webers Falls fault exists. Even if the fault does exist, there is inadequate evidence demonstrating its location of 1164 feet northeast of the disposal well.

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21/ Tr. 103

22/ Tr. 101

23/ Tr. 101

24/ Tr. 101-102

ISSUE 2: WHETHER THE SOUTH FAULT EXISTS AND, IF IT DOES, AT WHAT DISTANCE IS IT LOCATED SOUTHWEST OF THE PROPOSED DISPOSAL WELL

- 2-1 The Applicant presented evidence consisting of injection tests, pressure fall-off tests, and computer modelling, together with an analysis of surface conditions, to demonstrate the existence of the South fault at a minimum distance of 29,000 feet southwest of the well. 25/
- 2-2 The results of the Applicant's injection testing showed water moving on one side in two of the five layers of the Arbuckle at a distance of approximately 29,000 feet southwest of the well. 26/ The reservoir area investigated during injection and pressure fall-off testing is contained within a maximum distance of 30,000 feet from the well and any boundary located beyond this distance remains undetected. 27/
- 2-3 The suggested location of the fault at a distance of 29,500 feet from the well, based on an analysis of topographical features, is a matter of interpretation. 28/ The fault has not been precisely located in any way.
- 2-4 It is common for faults to exist in brittle lower horizons and then to die out upward into shales in the form of folds and eventually not be apparent at all. 29/

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25/

26/ Tr. 157

27/ Tr. 336, App. Exh. 1 A p. 5.

28/ Tr. 76

29/ Tr. 90

- 2-5        The Board finds that there is inadequate evidence to conclude that the South fault exists. The fault's existence and location is based solely on an interpretation of surface conditions. The Applicant's interpretation is neither unique nor dispositive of the existence of the fault.

ISSUE 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

- 3-1        The Applicant's photogeologic interpretation of the disposal formation shows an inferred fault branching off to the west of the Carlile School fault and shows 2 parallel inferred faults running northwest and perpendicular to the Carlile School fault. 30/
- 3-2        Faults are commonly thought of as vertical channels permitting migration of fluids from reservoirs to the surface. 31/ While faults may form a boundary plane of a pool of gas or oil, this is more commonly due to higher fluid potentials within the channels and updip across the fault than it is to the fact that the fault is tightly sealed. 32/ In addition, faults serve as channelways for mineralizing solutions, and they form and drain petroleum reservoirs. 33/

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30/ App. Exh. 3C (C-B), (C-F).  
31/ Tr. 83.  
32/ Tr. 83.  
33/ Tr. 86-87.

3-3 Based on the evidence presented, the Board finds that at least three additional faults have been inferred within the disposal formation and that it is common for faults to serve as pathways to fluid migration.

ISSUE 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

4-1 The Applicant presented evidence in the form of pre-injection testing, pressure fall-off testing, and computer modelling to show that the boundaries comprising the disposal formation would not leak under increasing fluid pressure. <sup>34/</sup> The Applicant presented further evidence that it could detect leakage equivalent to a tenth of a millidarcy but not one equivalent to a hundredth of a millidarcy. <sup>35/</sup>

4-2 In calculating detectable leakage, the Applicant assumed that only the east boundary (Webers Falls fault) was permeable (leaking). <sup>36/</sup> The other three more distant boundaries were assumed to be impermeable (not leaking). No calculations were performed assuming the east boundary to be impermeable and assuming varying permeabilities in the other three boundaries. <sup>37/</sup> Thus, the calculation for detectable leakage equivalent to a tenth of a millidarcy is applicable only to the east boundary.

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<sup>34/</sup> App. Exh. 1-A pp. 11-12, Tr.

<sup>35/</sup> App. Exh. 1-A p. 12, Tr.

<sup>36/</sup> Tr. 361.

<sup>37/</sup> Tr. 249

The Applicant made no calculations for detectable leakage at the other three boundaries because additional injection testing would be necessary. <sup>38/</sup>

4-3 When the east boundary was assumed to be permeable (leaking), no readjustment of the boundary location was made to achieve a closer fit with the measured data. <sup>39/</sup> Such readjustment of the location of the boundary could have achieved a better fit. <sup>40/</sup> Had such a better fit been achieved, it would have meant that the boundary could be a leaking one. Furthermore, had leakage first been assumed and the computer then used to locate boundaries producing the best fit to the measured data, the boundary would have been located at a point other than the location of the boundary calculated for the impermeable (no leak) case. <sup>41/</sup>

4-4 The difference between pressure fall-off curves for the calculated no-leakage case and the calculated leakage case assuming a permeability of 0.1 millidarcy is insignificant. <sup>42/</sup>

4-5 The <sup>radioactive</sup> raffinate wastewater could escape from the disposal formation if sufficient pressure were built up in the

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<sup>38/</sup> Tr. 248.  
<sup>39/</sup> Tr. 240.  
<sup>40/</sup> Tr. 344.  
<sup>41/</sup> Tr. 345.  
<sup>42/</sup> App. Exh. 1-A, figure 14; Tr. 348.



formation to rupture a fault. 43/ Injection into another well drilled in the disposal formation could cause sufficient pressure build-up to rupture a fault. 44/ The Applicant neither owns nor controls all of the surface area over the disposal formation such that someone else at some later date could drill another injection well into the disposal formation. 45/

4-6 Based on the foregoing, the Board finds that the Applicant has not adequately demonstrated that the faults comprising the fault block, both actual and inferred, will act as barriers to fluid movement. The Board further finds that additional injection tests are necessary to determine if the three faults other than the east boundary leak and at what rate leakage, if it occurs, would be detectable.

ISSUE 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 BASE

5-1 The porosity and permeabilities used in the Applicant's model are based on in-hole measurements from a single

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43/ Tr. 168, 228.

44/ Tr. 229-230.

45/ Tr. 229-230.

well. <sup>46/</sup> Such measurements represent an area of only a few inches to a few feet around the well. <sup>47/</sup> The disposal reservoir extends over a thousand feet in all directions from the well bore and several thousand feet in three directions. <sup>48/</sup>

5-2 In limestone aquifers, it is not uncommon for permeability to vary by several orders of magnitude in a short distance. <sup>49/</sup> It is also common for porosity to vary by factors of 2 to 5 in a small area. <sup>50/</sup> Where permeability is heterogeneous, it is possible that fluid will move in a preferred direction rather than radially from the well bore. <sup>51/</sup>

5-3 The phenomenon of hydrodynamic dispersion, which occurs if concentration gradients are set up between the different salinities of the displacing and displaced fluids, was not taken into account by the Applicant in calculating distance of fluid migration. <sup>52/</sup> This phenomenon will result in fluid movements of distances greater than the Applicant calculated. <sup>53/</sup> An increase of 300 feet over that calculated by the Applicant would not be unreasonable. <sup>54/</sup> Distances of fluid migration

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<sup>46/</sup> Staff Exh. C, p. 3.  
<sup>47/</sup> Id., p. 3.  
<sup>48/</sup> App. Exh. 1-A, figure 1.  
<sup>49/</sup> Staff Exh. C, p. 3.  
<sup>50/</sup> Id., p. 3.  
<sup>51/</sup> Id., p. 3.  
<sup>52/</sup> Tr. 173-181.  
<sup>53/</sup> Tr. 173-181, 326-327.  
<sup>54/</sup> Tr. 327.

would increase even more in the presence of large differences between permeabilities in narrow zones. 55/

5-4 In a dolomite formation similar to the Arbuckle formation, the difference between the calculation and the actual distance of fluid migration over a five year period was off by a factor of five. 56/

5-5 Based on the evidence presented, the Board finds that there is reason to believe that the wastewater will migrate further than the 900 feet calculated by the Applicant. The Board further finds that the wastewater may move in a preferred direction rather than radially away from the well bore because of the characteristic heterogeneous permeability of dolomite-limestone formations.

ISSUE 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

6-1 If properly used, computer models utilizing the mathematical technique of finite differences to approximate the solutions to equations are valid, accurate tools for reservoir studies. 57/  
The injection and pressure fall-off tests and mathematical modelling procedures used by the Applicant are valid, accepted

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55/ Tr. 327

56/ Tr. 328

57/ Staff Exh. C, p. 3.

techniques. In question, however, are the interpretations which the Applicant gave to the testing and computer results.

6-2 The Applicant's computer model was essentially manipulated to yield results comparable to the measured data obtained from actual tests performed on the injection well and the formation was then assumed to be similar to the model. <sup>58/</sup> The disposal formation is a complex, five-layered limestone-dolomite reservoir, and such reservoirs are characteristically quite heterogeneous. <sup>59/</sup> Because of heterogeneity, there may possibly be significant variations in permeability which could result in fluid movement in a preferred direction as opposed to radial movement. <sup>60/</sup> As a result, data from a single well cannot be considered representative of the entire reservoir and thus, a computer model based on such data is not realistic. <sup>61/</sup>

6-3 The Board finds that because of the characteristic heterogeneity of formations such as the Arbuckle, data derived from a single well and subsequently used in a computer is not a reasonable representation of the formation <sup>and its characteristics</sup> and, thus, cannot reasonably predict fluid performance within the formation after injection.

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<sup>58/</sup> Id., p. 3.

<sup>59/</sup> App. Exh. 1-A, Staff Exh. B. p. 9.

<sup>60/</sup> Staff Exh. B, p. 9. Tr. 181.

<sup>61/</sup> Staff Exh. C p. 3.

ISSUE 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

- 7-1 The Applicant has proposed to monitor the injection well by pressure testing at the well-head and by weekly and monthly sampling of area surface waters and shallow subsurface wells. <sup>62/</sup> The Applicant proposes to conduct this monitoring during the period of injection and for some unspecified period of years thereafter. <sup>63/</sup>
- 7-2 The Applicant presented evidence that based on computer calculations, leakage equivalent to a tenth of a millidarcy could be detected at the well-head but that leakage equivalent to a hundredth of a millidarcy could not be detected. <sup>64/</sup> This translates into maximum effluxes of 40 and 4.4 barrels of fluid per day respectively. <sup>65/</sup> As indicated in paragraph 4-2, the Applicant's calculations for detectable leakage were based on the assumption that only the nearest boundary (Webers Falls fault) was permeable. Additional injection testing would be needed to determine rates of detectable leakage at the other three boundaries. Since these boundaries are more distant than the Webers Falls fault, presumably the detection calculations will be less sensitive resulting in higher values for the amount of leakage detectable.

<sup>62/</sup> App. Exh. 3 E, p. 2.

<sup>63/</sup> Tr. 227.

<sup>64/</sup> Tr. 247.

<sup>65/</sup> App. Exh. 1-A, p. 13.

7-3 The Staff has recommended that the Applicant conduct certain monitoring in addition to that proposed by the Applicant. <sup>66/</sup> The recommendation is that a second well be drilled to the top of the Arbuckle formation and cased to the top of the Simpson formation approximately 500 feet north by northeast of the well in order to detect any vertical leak. <sup>67/</sup> Such a well would detect increasing pressure in the Simpson formation resulting from vertical leakage of the wastewater. <sup>68/</sup> Depending upon confirmation of the existence of the Webers Falls fault referenced in paragraph , the Staff recommended the necessity of a second monitoring well at approximately 2000 feet southwest of the well. <sup>69/</sup>

7-4 Because of the nature of the radioactive wastewater, the complexity of the disposal formation, and the uncertainties of the Applicant's interpretation of the data derived from the reservoir studies, the Board finds that additional monitoring would be necessary if disposal is ultimately permitted. At a minimum, the Applicant should drill the monitoring well proposed by the Staff 500 feet north by northeast of the well to detect vertical leakage from the disposal formation.

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<sup>66/</sup> Staff Exh. B, p. 12.

<sup>67/</sup> Staff Exh. B, p. 12. Tr. 338-341.

<sup>68/</sup> Tr. 338-341.

<sup>69/</sup> Staff Exh. B, (letter of December 22, 1972).

ISSUE 8: WHETHER IN THE EVENT OF A DEMONSTRATED LEAK IN THE RETENTION RESERVOIR OR FAULT BLOCK THE WASTE FLUID CAN BE RECOVERED

8-1 The Applicant presented testimony that it did not intend to recover any of the injected wastewater except in the event of a demonstrated accident or leak. <sup>70/</sup> Although the uranium and thorium cannot be recovered due to precipitation after neutralization in the formation, the Applicant estimates that 85 percent of the wastewater can be recovered by pumping out a volume of water equal to that injected. <sup>71/</sup> However, the Board finds that the 85 percent figure may be unrealistically high due to greater than predicted mixing of the wastewater and the formation water. To recover all of the wastewater injected, the Applicant would have to pump out a greater volume of fluid than was injected. <sup>72/</sup> Should this ever become necessary, ~~the Applicant's retention ponds, which are presently nearly at capacity,~~ <sup>there be sufficient available</sup> ~~would not have the storage capacity~~ to hold the fluid.

*assuming all of the geophysical conclusions of the Applicant are correct*

*The applicant has not demonstrated that*

<sup>70/</sup> Tr. 222-224.  
<sup>71/</sup> Tr. 223-224.  
<sup>72/</sup> Tr. 223-224.



File  
Kerr McGee  
Hearings

R. E. Kinsey

## CORRECTIONS TO KERR-MCGEE HEARING TRANSCRIPT

Cover                      Docket No. shown as SUB-1010. This is actually  
Source Material License No. The AEC Docket No.  
is 40-8027.

Page 107, }  
Line 22 to } Dr. Babcock's references to the "dry" study should  
Page 108, } be corrected to read the "Gruy" study in three  
Line 7 } places.

Page 108, Line 19      Spelling - application

Page 111, Line 3        Spelling - siliceous rather than ~~salicious~~

Page 152, line 18        Should read "layers" in place of "lawyers"

Page 155, Line 20        "Pressurable" should read "measurable"

Page 163, Line 23        "pitch-outs" should read "pinch-outs"

Page 182, Line 22        Should read "Kerr-McGee"

Page 183, Line 22        Phrase "calculated power space" not understood

Page 186, Line 20        "every" should read "ever"

Page 195, Line 1        "precisition" should read "precision"

Page 200, Line 21        "shapre" should read "shape"

Page 204, Lines 20 }  
and 22 } "miliedarcy" should read millidarcy"

Page 206, Line 4        "leakabe" should read "leakage"

Page 214, Line 11        "solumble" should read "soluble"

Page 216, Line 5        "expressed" should read "compressed"

Page 216, Lines 7 }  
and 15 } should read CO<sub>2</sub>



Page 241, Line 1      Should probably read "areal" in place of "aerial"  
Page 244, Line 10     Should read "curve-fitting"  
Page 285, Line 10     "geological" should read "radiological"  
Page 285, Line 8      "consultant" should read "consultants"  
Page 285, Line 22     strike out words "activity, again"  
Page 285, Line 23     Remove comma after "water"  
Page 287, Line 1      "ghen" should read "then"  
Page 290, Line 21     "not" should read "no"  
Page 296, Line 13     "Mallaro" should read "Malaro"  
Page 297, Line 25     strike out entire line.  
Page 298, Line 1      Strike out entire line.  
Page 304, Line 8      "thig" should read "thing"  
Page 313, Line 3      Should read "a large error in"  
Page 313, Line 5      "five" should read "phi"  
Page 360, Line 6      "porposed" should read "proposed"  
Page 363, Line 1      "can" should read "can't"

*JER*  
JERothfleish

cc: L. C. Rouse

D. A. Nussbaumer

Comments on Kerr-McGee Hearing Transcript

Page 82, Lines 7 - 8 - Witness claims traps are found at depths of 3000 to 5000 feet with well at 3100 feet. While well bottom is at 3128 feet, the fine "porous" disposal layers being considered are located at depths ranging from 1762 to 2860 feet.

Page 95, Line 3 - Witness indicates concentration in the well at 83000 parts per million sodium chloride. Actual concentration reported was 88300 parts per million chlorides. This would be equivalent to 145500 ppm sodium chloride.

Page 121, Lines 11 - 12 - Statement is in error. Concentration of  $5 \times 10^{-3}$  uCi/ml refers to uranium concentration of Great Salt Lakes.

Page 142, Line 5 - I do not recall ~~exak~~ the witness being sworn in.

Page 185, Line 20ff - Testimony referred to appears on page 117, line 2 and reads, "The lowest permeable and porous zone would be the Simpson sands." No mention was made of which portion of the Simpson was porous and permeable.

Page 211, Lines 16 - 18 - Mr. Shelley implies that value of  $2100 \times 10^{-8}$  uCi/ml was calculated in 1970 as the "maximum number that this could ever be" yet the February 3, 1970 application revision indicates that the R<sub>0</sub>-226 concentration could be  $7 \times 10^{-5}$  uCi/ml as did Appendix B Exhibit V of the April 10, 1970 application revision which was withdrawn.

Page 231, Lines 17 - 21 - Mr. Shelley's testimony implies that formation water radium concentration ( $1400$  pCi/l or  $140 \times 10^{-8}$  uCi/ml) is higher than that ~~to the~~ <sup>of the</sup> "typical" injected wastes i.e.,  $340 \times 10^{-8}$  uCi/ml.

Page 269, Line 19ff - Contrary to Mr. Shelley's testimony, area is classified as Zone One by USGS - very low seismic risk. Strong earthquakes causing minor damage may occur at any particular place in Oklahoma once every 2000 years. Also, damage corresponding to M. M. VII (Modified Mercalli Intensity) i.e., "damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures ... some chimneys broken ... may occur on an average of once each 27 years in the El Reno - Nemaha Ridge area and once every 55 years elsewhere in Oklahoma per the "Algermissen (1969) Seismic Risk Map"

Page 346, Lines 18 - 19 - Mr. Farmakides interpretation that Messrs. Robertson and Warner are in agreement does not appear to be correct since Robertson said that the computer results would probably be different for the leakage versus the non-leakage case while Warner said that the results would be the same in both cases.

*J.E.R.*  
J. E. Rothfleisch