KERR-McGEE NUCLEAR CORPORATION
KERR-McGEE CENTER • OKLAHOMA CITY, OKLAHOMA 73125

DOCKET # 40-8027

September 27, 1976

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Mr. J. E. Rothfleisch
Fuel Cycle Licensing Branch 1
Division of Materials and Fuel Cycle
Facility Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Rothfleisch:

During a recent trip to your office, the question of heavy metal contamination of forage by the use of treated raffinate was raised by Mr. Hanson.

As a result of this question, our consultant at Oklahoma State University examined the results of analysis of the forage for copper, molybdenum and nickle and has prepared the attached report.

This report concludes that, at the levels found in samples of the forage removed from the test plots, animals fed this forage would not be affected.

Please let me know if you need additional or more detailed information.

Sincerely yours,

W. J. Shelley, Director
Regulation and Control

WJS:ml

Attachment

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OKLAHOMA STATE UNIVERSITY • STILLWATER

Department of Agronomy
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September 22, 1976

Mr. W. J. Shelly, Director
Regulation and Control
Kerr-McGee Nuclear Corp.
Kerr-McGee Center
Oklahoma City, Oklahoma 73125

Dear Mr. Shelly:

I received the elemental analyses for copper, molybdenum and nickel of the oven-dry forage samples from the raffinate study at Gore.

These analyses show that the elements are present at safe levels for animal consumption. Furthermore, concentrations of these elements in the raffinate have not been detrimental to bermudagrass production on the plots to date. These conclusions are based upon the following:

Copper - Excess copper in soils results in reduced growth and iron chlorosis symptoms. Bermudagrass is quite sensitive to iron deficiency and readily develops chlorosis whenever available soil iron is limiting. The raffinated treated plots at Gore produced very high yields in 1975 and iron chlorosis has not developed.

Sufficiency ranges for copper in bermudagrass is generally set in the range of 5 - 20 ppm. The bermudagrass from the raffinate study averaged from 3.6 to 6.8 ppm copper which is around the lower end of the sufficiency range. Although, copper in the soil can be at high enough levels to be detrimental to plant growth no information is available indicating toxic levels can be present in forages and feeds for livestock consumption.

The availability of copper in soils for plant growth is strongly dependent upon soil pH. When copper is added to high pH soils it forms compounds which are highly insoluble, therefore, only a small portion of that added is available for plant uptake. Only in highly acid soils (pH 4.0 to 5.5) can available copper levels be large enough for excessive plant uptake.

Molybdenum - Molybdenum toxicity to plants is observed only under extreme experimental conditions. It has been so rarely observed that reliable data for toxic soil levels cannot be found. Researchers at the University of California, Riverside, (who have conducted much of the molybdenum toxicity research) indicate that soil test levels must be well over 100 ppm before any loss in forage production occurs. Here again the high yields and lack

of visual abnormalities obtained from the grass plots at Gore in 1975 indicates soil levels of molybdenum were not affecting plant growth. However, plants may accumulate large tissue concentrations of molybdenum and induce molybdenosis in ruminants consuming such material. The most recent research from the University of California indicates that whenever ruminant animals are consuming forage as a large portion of their diet with over 10 ppm molybdenum, the disease can occur. Above that concentration the Cu:Mo ratio of 1:1 to 2:1 is essential for helping alleviate molybdenosis. The relationship of copper to molybdenum is important. Whenever sheep graze on pastures of normal copper content, but low in molybdenum (less than .1 ppm), copper accumulates in their livers. This sometimes results in chronic copper poisoning, followed by death. On the other hand, when pasture or forage contains a normal copper content but high molybdenum (10 ppm or more) copper deficiencies may occur. Thus, there seems to be some reciprocal relation between copper and molybdenum in animal nutrition.

The bermudagrass from the Gore study ranged from 0.54 to 1.0 ppm molybdenum which is well below any toxic levels. The Cu:Mo ratio ranged from 5.0 to 7.6.

Molybdenum sufficiency ranges for bermudagrass is not known but published information for corn (an annual grass) gives values from 0.6 to 1.0 ppm which corresponds to those found in the bermudagrass from the Gore study.

Much of the molybdenum added to soils is unavailable for plant uptake. Chemical processes for molybdenum in soils is obscure but such things as soil pH and the presence of sulfates, phosphates and manganese affect availability. Availability of soil molybdenum increases with increasing soil pH but high phosphates and sulfates decreases availability.

<u>Nickel</u> - Because nickel is not an essential element for plant growth only limited information is available concerning its reactions in soils and plants. The total nickel content of soils is high ranging from 5 to 500 ppm. The exchangeable nickel concentration in soils rarely exceeds 1 ppm even where rather large amounts of high nickel sludge have been applied.

Excessive uptake of nickel by plants usually produces a chlorosis similiar to an iron deficiency and where the toxicity is severe, necrosis develops and the plant dies.

Because the bermudagrass from the Gore plots showed no chlorosis or abnormalities it is assumed that excess nickel was not present. Soane and Saunder[1/] reported nickel concentrations from 9 to 56 ppm in various grass species growing on high serpentine soils. Soils derived from serpentine are known to contain excessive available nickel levels. The nickel concentrations found in the bermudagrass from the plots at Gore (1.2 to 2.0 ppm) are somewhat higher than those reported from other grasses at many locations. Most reports show concentrations about 1 ppm or less. However, the bermudagrass from the Gore experiment is far below that reported from high serpentine soil.

[1/] Soane, B. D. and D. H. Saunder, 1959 Nickel and chromium toxicity of serpentine soils in Southern Rhodesia. Soil Science 88:322-330.

Nickel availability in soils can be greatly reduced by liming because availability is less on high pH soils.

I could find no published reports implicating high nickel contents of forage as a causative agent for nutritional disorders in animals.

Conclusions - Based upon the literature review of these elements, (Cu, Mo and Ni) I must conclude that from the data collected there is no reason to suspect any deleterious effects to the forage production or animals consuming the forage grown on the raffinate treated plots at Gore.

Recommendations - I suggest that the 1976 grown forage be analyzed for these three elements to ascertain whether applications for the three year period have changed elemental concentrations.

It is further suggested that soil samples be collected at the end of the 1976 season and the soils analyzed for available copper, molybdenum and nickel. Analysis should be made on each 6 inch increment to a depth of 24 inches.

If you have further questions concerning this evaluation don't hesitate to contact me.

Sincerely,

Billy B. Tucker

Billy B. Tucker
Professor, Soil Fertility

BBT:md

cc: W. J. Robinson
Frank Presler