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Department of Energy
Nevada Operations Office
P. O. Box 98518
Las Vegas, NV 89193-8518

JAN 15 1988

Joseph Dryden, Director, Pacific Area Support Office, NV
Oscar deBrum, Chief Secretary, Republic of the Marshall Islands,
Majuro, MI

RECOMMENDATIONS FOR TREATMENT OF CERTAIN MARSHALL ISLANDS

I asked Dr. William Robison, LLNL, to prepare remedial recommendations to treat the soil at Bikini, Enjebi, and possibly other locations so as to mitigate the uptake of radionuclides into the food chain. The enclosed letter is his preliminary response based on data analyzed to date. These recommendations have been reviewed and concurred with by Dr. Earl Stone of the BARC Committee.

We are encouraged by this scientific effort and the promising results. You will be promptly notified as to future findings, and additional recommendations will be forthcoming as warranted.

Harry Brown

Harry U. Brown
Assistant for
Off-Continent Operations

Enclosure:
Ltr., Robison, LLNL, to Brown, DOE,
dtd 1/7/88

cc w/encl:
John Rudolph, MA, HQ (DP-224) GTN
Larry Morgan, DOI, Washington, DC
James Berg, EA/FAS, DOS, Washington, DC
Jonathan Weisgall, Washington, DC

cc w/o encl:
W. L. Robison, LLNL, Livermore, CA

DOE
John Rudolph's Files
D-File
Marshall Islands 1986

Lawrence Livermore National Laboratory

ENVIRONMENTAL SCIENCES DIVISION

January 7, 1988

ACTION A/OCO
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AMA ✓
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AMOE

Mr. Harry Brown
Department of Energy
Nevada Operations Office
P.O. Box 98518
Las Vegas, NV 89193-8518

Dear Harry:

In response to your letter of December 15, 1987, I am outlining our current recommendations on salutary methods for altering the uptake of ^{137}Cs into food crops at atolls in the northern Marshall Islands.

As you know we have been evaluating three basic methods:

1. Soil removal (excavation)
2. Potassium (K) treatment
3. Saltwater irrigation

The soil removal option is effective in reducing ^{137}Cs in the environment but has severe environmental impact as we all know. This of course led to our research efforts which have become focused on items 2 and 3.

The initial saltwater irrigation experiment indicates that there is a significant block in uptake of ^{137}Cs in plants grown in the irrigated area. However, a crucial second experiment is under way in which mature coconut trees have been irrigated with seawater. We will not have results for this experiment for several months. Thus, we do not at this time recommend the use of salt water as part of a remedial scenario. Perhaps at a later date, and for an island with high concentrations of ^{137}Cs in the soil, saltwater irrigation could be incorporated as part of the overall plan. We will keep you informed on the outcome of our ongoing experiment.

The treatment of food crops with K has proven very effective at reducing the uptake of ^{137}Cs. Our experiments have included treatment of coconut trees, vegetable crops, breadfruit and *Pandanus* fruit. We have evaluated the effectiveness of various rates and total amounts of K on the reduction of ^{137}Cs in coconuts and vegetables. These experiments have evolved to the point that we can make recommendations on the amount of K which we think will produce the desired reduction in ^{137}Cs uptake at Eneu Island, Enjebi Island and Rongelap Island.

Based on our data through December 1986 we recommend 1200 lbs of K per acre be applied to a mature coconut grove and to areas where breadfruit and *Pandanus* are growing. Coconut roots, and those of breadfruit and *Pandanus*, can extend to distances of 60' or so from the tree trunk. Therefore, K should be applied over the entire surface area where trees are growing so that all of the root system of a tree will receive added K.

Our results to date show that three years after the last application of K the ^{137}Cs concentration in coconuts has remained at the low concentration produced by the added K. Thus, we would expect that the application of K would not have to be repeated for at least three years. Our experiments are continuing to determine the duration of the reduced ^{137}Cs uptake and we will be able to give more advice on this question over the next two or three years.

The K may be applied in the form of potassium chloride (KCl) or in the form of a complete fertilizer such as 16-16-16, which has 16% nitrogen (N) and 16% phosphorus (P) in addition to the 16% K. The reduction in uptake of ^{137}Cs into food crops occurs with either. The advantage of the KCl is that it is less expensive and a lesser amount needs to be applied relative to the 16-16-16 (see attachment). The advantage of a complete fertilizer such as 16-16-16 is that you get the addition of two of the other major nutrients required by plants - namely N and P.

We will keep you informed of the results of our continuing experiments all of which are designed to provide a better basis from which to recommend a salutary program. If we feel in the future, based on data from our continuing experiments, that changes in rate or total amount of K may be beneficial, or that other methods may be combined to produce the desired results, we will inform you immediately.

Also find attached an example calculation of the different costs for KCl and 16-16-16 assuming an area of 200 acres needs to be treated. The prices are F.O.B. Oakland, CA, and the shipping costs are by Matson from Oakland to either Kwajalein or Majuro.

If you feel you need any further information, or more detailed results of our experiments, please let me know.

Best regards,

Bill

William L. Robison
Terrestrial and Atmospheric Sciences

WLR:sm

Attachment

cc: Earl Stone

ATTACHMENT 1

Assume 200 acres to be treated with 1200 lb K per acre.

$$200 \text{ acres } 1200 \frac{\text{lb K}}{\text{acre}} = 2.4 \times 10^5 \text{ lb K}$$

$$= 120 \text{ tons of K}$$

230 tons of 60% coarse KCl will provide 120 tons of K.

904 tons of 16-16-16 fertilizer will provide 120 tons of K.

Purchase Costs

KCl costs $200 per ton F.O.B. Oakland, CA

$$230 \text{ tons KCl } \frac{\$200}{\text{ton}} = \$46{,}000 \text{ for KCl}$$

16-16-16 costs $250 per ton F.O.B. Oakland, CA

$$904 \text{ tons } \frac{\$250}{\text{ton}} = \$226{,}000 \text{ for 16-16-16}$$

Shipping Costs

Shipping costs are $235 per ton or per 40 ft^3 from Oakland to Kwajalein or Majuro.

In our case we can use the tonnage.

$$\text{KCl: } 230 \text{ tons } \frac{\$235}{\text{ton}} = \$54{,}050 \text{ to ship KCl}$$

$$\text{16-16-16: } 904 \text{ tons } \frac{\$235}{\text{ton}} = \$212{,}440 \text{ to ship 16-16-16}$$

Total cost (excluding labor to apply the material)

	KCl	16-16-16
Purchase	$ 46,000	$226,000
Shipping	54,000	212,000
	$100,000	$438,000

I have not tried to ascertain what KCl or 16-16-16 might cost somewhere in the Pacific region. This could affect purchase price and would obviously affect shipping costs if a source could be found to procure such quantities near the Marshall Islands.