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PRODUCED COBALT-60

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L. E. Kusler

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This document consists of
5 pages.

STUDY OF APPLICATION FOR HANFORD PRODUCED COBALT-60
(A Proposal for Management of Facility Capability Project)

L. E. Kusler

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STUDY OF APPLICATION FOR HANFORD PRODUCED COBALT-60

Demands for cobalt-60 have been relatively small as long as the principal applications were for radiography and gaging. The accumulated production in the entire United States is less than ten megacuries, although the Hanford plant is capable of producing about 150 megacuries every year using uranium enriched to 0.95 percent, and greater amounts with higher enrichments.

The new developments brighten the prospects for large-scale utilization of cobalt-60. First is the possible use of cobalt-60 as a heat-producing radio-isotope. Although shielding weights make cobalt-60 unattractive for space applications, the general size of thermal applications can be appreciated by noting that 32 megacuries of cobalt-60 would be required to provide the 500 kw of isotopic heat which NASA reports they will need by 1980; terrestrial applications may be an order of magnitude larger. This application of cobalt-60 has been promoted primarily by Savannah River and utilization of high activity cobalt-60 (200-500 curies/gram) as a heat source is being investigated by them under MFC 5.

The second new development is the progress being made in irradiation processing, especially irradiation processing of food. The size of this potential market is suggested by noting that 27 megacuries of cobalt-60 would be needed to give a sprout-inhibiting dose of 10^5 roentgens to the 27 billion pounds of potatoes raised annually in the United States (Reference 1), if all of the radiation were absorbed in the potatoes, and if the irradiations were done uniformly during the year. In practice, of course, only a fraction of the potatoes would be irradiated, but the irradiation would be less efficient and would be seasonable.

The Hanford reactors have a demonstrated capability for producing various special products. They are especially well suited for large-scale production of Co-60 either by itself or in conjunction with other products, such as U-233, Po-210, Pu-238, Tm-170. Program cutbacks and the phase-out of various production commitments have forced the shutdown of several expensive reactors which could be utilized in the production of Co-60. In addition, a sizable pool of highly specialized technical personnel is available to work on a study pertaining to Co-60 applications. To retain this technical pool and to more fully utilize the large capital investment in reactors, it is necessary to assist in developing applications for products which will require significant reactor space to produce. Co-60 is such a product.

It is important to factor Hanford capability into these new applications for cobalt-60 at an early date. One method for Hanford to produce large quantities of cobalt-60 would be by use of cobalt-bearing process tubes as described in Reference 2. Potential advantages of the cobalt-bearing process tube as compared to the standard BNL strip are configuration, length, and low cost. The cylindrical shape could prove advantageous in chemical processes using radiation. Long flattened tube strips anywhere from 2 to 20 feet in length could also prove advantageous, over the present 12-inch BNL strips, in applications where a continuous source is being used. The irradiation of cobalt-bearing process tubes becomes increasingly advantageous to reactor operation as the U-235 content of the driver fuel is increased to support larger production of products other than plutonium. By this procedure, the lattice would be blackened, the graphite

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moderator would be less effective in competing for neutrons, and the reactor conversion ratio would increase by several percent. Substantial safety advantages would be obtained: There would be no possibility of accidentally discharging poison; because the heat transfer surface in the reactor is unchanged, there would be no need to increase the coolant water inventory in the reactor and loss-of-water accidents would not be aggravated. Preliminary studies (Reference 3) indicate a cost for cobalt-60 from Hanford reactors of less than ten cents per curie, exclusive of encapsulation costs.

The process tubes are located in a region of the reactor where the thermal flux is depressed, and will require about three years of irradiation to build up a specific activity of 100 curies per gram of cobalt or 35 curies per square inch. This assumes the process tube has a uniform cobalt layer of 2.5 mils. Each foot of process tube would have an activity of 2,300 curies. A BNL strip with 30 curies per gram specific activity would have an activity of 1,500 curies per foot. It should be recognized that the quantity of cobalt applied on the process tube can be varied to provide higher or lower activity levels. The ultimate activity with present reactor and fuel technology activity is in the order of 200 curies per gram for a normal tube life of about six years. Currently, an average of approximately 700 aluminum process tubes are removed each year and buried. Coating these tubes with cobalt would provide a useful product which would further enhance the utilization of existing facilities and also provide a method of meeting the potential demand of megacurie quantities of Co-60.

Another advantage of producing Co-60 using cobalt-coated process tubes is that it further reduces the potential of accidental discharge of Co-60 in the river. Cobalt is not concentrated in specific locations as it would be if BNL strips were being irradiated. If a process tube were damaged mechanically, the Co-60 released would be detected and measured with existing monitoring equipment and corrective action could be taken to remove the defective tube. It is questionable if any Co-60 would be released to the river in that the small quantity discharged from the reactor would settle out in the settling basin.

It is proposed that a study be initiated to evaluate present and potential applications of Co-60 produced by irradiating cobalt coated process tubes. To best serve the needs of industry and government, we need to expand our knowledge of the details of various applications. Most of the published data on uses of Co-60 have been concerned with feasibility studies and contain little or no design details. We intend to gather information on the results of any detailed studies and to determine the extent and direction in which the current studies are going. In so doing, we would also accumulate information on the needs of the designers now and what they project for the future. With this information, we will be in a position to evaluate our position and the unique advantages of cobalt coated process tubes. A report will then be prepared giving information on the activity levels, potential availability and costs to stimulate interest in supporting a program to produce production quantities.

This study will require skilled personnel who are knowledgeable in market analysis, hazards associated with handling irradiated cobalt, cobalt encapsulation, and detailed knowledge of operating costs. Experienced personnel in each of these fields are currently available within Battelle-Northwest and Douglas United Nuclear, and would be available for this study without interference of the 02 Program work.

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The proposed studies must continue for one year before a clear picture of market demand can be obtained.

Requirements

The estimated breakdown of the costs between the various organizations is given below:

	FY-1967	
	<u>Estimated Cost</u>	<u>Many years</u>
BNW	\$ 10,000	1/3
DUN	<u>10,000</u>	1/3
Total	\$ 20,000	

References

1. Chemical Economics Handbook, issued by Stanford Research Institute, reports U. S. annual potato product, in billions of pounds.

1960	25.7
1961	29.4
1962	26.8

2. Invention Report by L. W. Lang, January 28, 1964, HW-80754, (Secret).
3. DUN-961, "Alternate Co-60 Production Methods," by L. E. Kusler, April 13, 1966, (Secret).

Conformance to MFC Criteria

Comments on the MFC as it relates to the criteria considerations for acceptance are as follows:

1. It must be programmatically related to the AEC. This study, if successful, will lead to production of large-scale quantities of radioisotopes using AEC reactors.
2. It must definitely show that it will eventually broaden the utilization of the unique capabilities of highly skilled personnel and the specialized facilities at cutback-affected sites. To the degree that Co-60 uses can be exploited, diversification potential of the reactors is increased.
3. It must have a cut-off date. The study is limited to one year, within which time and evaluation can be made as to production incentives.
4. It must have a reasonably good potential for being picked up by another program at a later date. The realization of even a part of the objectives will result in application of interest to, and likely support by, DOD, NASA, DID, and others.

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5. It must not be a substitute for Program 02 Process Development work. This type of study is excluded from 02 Process Development work because it is application oriented and not production oriented.
6. It must not interfere with significant 02 Program work. This study will not interfere with significant 02 Program work.

L. E. Kusler

L. E. Kusler, Senior Engineer
Advanced Concepts and Planning

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