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Page 1

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

Compiled By:

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STUDY OF APPLICATIONS 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 200 megacuries every year using uranium enriched to 0.95 percent, and greater amounts with higher enrichments.

Two 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 meacuries 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 pushed 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 seasonal.

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. This method becomes increasingly advantageous 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 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.

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Before embarking on such an irradiation program, it is necessary to study applications for this product. The process tubes are located in a region of the reactor where the thermal neutron flux is depressed, and it will require about three years of irradiation to build up a specific activity of 100 curies per gram of cobalt; the ultimate activity is less than 200 curies per gram for a normal tube life of about six years. Are there customers who are interested in cobalt-60 of this activity and who are willing to wait this long for delivery? In what form must the cobalt-60 be delivered? Is the tubular shape of value, or should the tube be crushed, or should strips or rings be cut from the tube? What re-encapsulation is required? How low must the cost be in order to compete with high-activity cobalt-60?

It is proposed that a study be initiated of the various applications of Co-60 now under development to determine the relative advantage of using Hanford-irradiated cobalt. To best serve the needs of the industry and government, we need to expand our knowledge of the details of the various applications. Most of the published data on the uses of Co-60 have been concerned with feasibility studies and contained 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 being sponsored by the AEC 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 then be in a position to evaluate our position and the unique advantages of Co-60 produced at Hanford. It is highly likely that by appreciation of the details of the various applications, Hanford would be in a position to more easily assist the designers and to meet the needs of the industry. Since many of the applications are still in the conceptual design stage, this is the ideal time to acquaint the designers with the variety of sizes and shapes which can be irradiated at Hanford and the range of specific activity levels which can be produced. Some of the cobalt shapes that can be produced (in addition to cobalt-bearing process tubes) include strips, pellets, or rods either in conventional target-driver type reactor loadings, in cross-coolant channels at N Reactor, or in test facilities in the small or K Reactors. Specific to this study will be an investigation of the extent to which national requirements for cobalt-60 can be met by use of power reactors or other commercial reactors, and the conditions under which output of cobalt-60 from the plutonium production reactors is required.

This study will require skilled personnel who are knowledgeable in market analysis, design of process irradiators, types of reactor loadings that are feasible, 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 either the Battelle-Northwest, Douglas United Nuclear, General Electric, or Vitro organizations and would be available for this study without interference of the 02 Program work.

The proposed studies must continue for a couple of years before a clear picture of both market demand and power reactor response to this demand can be obtained. Hence, it is proposed to pursue this investigation vigorously in FY-1967, and at a slower pace in 1968.

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Requirements

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

	FY-1967		FY-1968	
	<u>Estimated Cost</u>	<u>Manyyears</u>	<u>Estimated Cost</u>	<u>Manyyears</u>
BNW	\$10,000	1/3	\$10,000	1/3
DUN	15,000	1/2	15,000	1/2
GE	15,000	1/2		
Vitro	10,000	1/3		
Total	<u>\$50,000</u>		<u>\$25,000</u>	

References

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

1960	25.7
1961	29.4
1962	26.8

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2. Invention Report by L. W. Lang, January 28, 1964, HW-80753 (Secret).
3. DUN-961, "Alternate Co-60 Production Methods," by L. E. Kusler, April 13, 1966.

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 two years, within which time an 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 applications of interest to, and likely support by, DOD, NASA, DID, and others.

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.

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