Box A3

SECRET
SECURITY INFORMATION

NY. 1 2.23.7 2.23.19 NY.19 NY.7

TO : H. B. Fry, Manager, NYOO Date: June 26, 1953

FROM : S. H. Brown, Chief, Process Development Branch, Production Division

NY.19-4 Front & Back

SUBJECT: DETAILED REPORT - ADDENDUM TO "SUMMARY OF EVALUATION OF POWDER METALLURGY PROJECT" - JUNE 23, 1953

SYMBOL: PP:ABB

## Purpose

In February 1953 you requested us to evaluate the Powder Metallurgy Project from both the technical and economic viewpoints in order to provide information for your decision regarding the future development program after July 1, 1953. This project is being conducted by the Sylvania Electric Products, Inc., under Contract AT(30-1)-1293 (Hicksville Operation) with support from Contract AT(30-1)-GEN 366 (Bayside Research).

This report presents our evaluation of the project and of the program proposed by Sylvania for the next fiscal year. This evaluation covers the technical aspects and the relative economics of the proposed powder metallurgy facility in comparison to present facilities at FMPC, and briefly mentions other intangibles to be considered in your decision. Our recommendations cover the general goals for the future development work.

## Introduction

Studies of the potential of powder metallurgy as a means of producing fuel elements for reactor operation were begun late in 1947. At this time the Hanford reactor operation was being troubled by serious fuel element failure, in the order of 10-20 failures per 50,000 slugs charged. It was hoped that a powder metallurgy slug would be able to reduce these failures and thereby effectively increase the production of fissionable materials. It was because of this serious slug failure rate that major emphasis was placed on this and other activities which could conceivably improve this situation.

A preliminary evaluation, NYO-162, was prepared by S. B. Roboff (then with the NYOO) on the basis of laboratory scoping studies. This evaluation indicated that substantial cost savings, in the order of $1,000,000 to $5,000,000 per year, (depending upon the extent the existing processes would be changed), might be realized

CLASSIFICATION CANCELLED
~~OR CHANGED TO~~
BY AUTHORITY OF DOE
BY [illegible] 9/26/80
[illegible] 9/24/80

ORO 51103

SECRET
~~SECURITY INFORMATION~~

from the full scale operation of a plant using the proposed processes. When laboratory studies showed the technique was promising, a pilot plant was constructed at Hicksville in 1952 to produce test quantities of powdered metal slugs for pile operation as well as to demonstrate some of the laboratory techniques on a larger scale.

By January 1953 the Hicksville Pilot Plant was in operation producing 4" Hanford slugs. Simultaneously, the process was being developed at Hicksville with the assistance of the Bayside Laboratory, and certain engineering and design activities were also in progress.

By the time the pilot plant operations began, the failure rate at Hanford had been reduced to a level considered quite acceptable to Hanford - approximately 1 failure per 50,000 slugs charged, presumably because of improvements in the NYOO fabrication techniques and the Hanford canning operations.

Hanford has studied the reduction of slug failures and the nature of the remaining failures and recommended that the FMPC wrought metallurgy process produces metal slugs acceptable for present power levels and that the proposed powder metallurgy production facility could not be founded on need for improved metal but would have to be justified solely on the basis of slug production economics.

It is timely now to reevaluate the overall project solely from the standpoint of relative economics and the technical feasibility.

The Process Development Branch has studied the laboratory and pilot plant development activities, the preliminary design of the proposed production plant, the estimated capital and operating costs for the proposed facility, and the techniques for mechanization used by Sylvania in their commercial activities. Also, we have reestimated the operating costs for the FMPC facilities which would be replaced by the proposed powder metallurgy operations.

This report summarizes our activities on this project. The technology of the process is briefly discussed, the economics of both the proposed facility and the FMPC facilities are estimated and analyzed, and conclusions are drawn regarding continued development, construction and operation of the proposed plant are discussed. As a result our findings and recommendations for future development activities are presented.

## Discussion

### Technology

The chemical and metallurgical processes for the proposed new facility are presented in detail in Sylvania's Report No. DCF-259H dated May 26, 1953. The process, changed in minor respects by us to keep the same process criteria as for FMPC processes, consists of the following steps:

1. Cast ingot or derby is cleaned by acid pickling and dried.

2. The cleaned ingot or derby is hydrided to $UH_3$ under hydrogen at 450°F.

3. The hydride powder is decomposed at 900°F to uranium metal powder under vacuum or inert gas.

4. The metal powder is blended and cold pressed into compacts.

5. The compacts are hot pressed at 630°C and 12TSI under vacuum to a solid uranium slug of specification density.

6. The pressed slugs are cooled, then cleaned by acid pickling or surface grinding.

7. The ground slug is contour ground, and the end radii are machined.

8. The cleaned slugs are inspected and packed for shipment.

Sylvania envisions the process as automatic in operation with a minimum of manual operation. The proposed process is based upon the laboratory and pilot plant development activities and upon Sylvania's commercial engineering "know-how".

The pilot plant operations have produced satisfactory 4" solid slugs using batch operations. The yield of acceptable densities has been as high as 90% of the total number of slugs pressed although shippable slugs presently represent only about 40% of the as-pressed slugs. (This low yield in the Hicksville operations is understood to be due to the severity of present inspection methods). The equipment used is actually a scale-up version of the laboratory equipment (multiple instead of single units) with the exception of the ingot hydriding equipment which produces hydride powder continuously.

We have reviewed the powder metallurgy technology and believe that the projected facility could be operated as proposed, both metallurgically and mechanically, with a fairly good chance for success.

Product Testing

The acceptability of the finished product for pile operation has not been completely demonstrated. Statistically, in the order of 100,000 to 200,000 slugs would have to be subjected to pile operating conditions before the powdered slug could be finally proved equal to or better than the present rolled slugs. Such a large scale activity is not now envisioned so that from a statistical viewpoint we shall not be able to determine that the powdered slug would equal or better the rolled slug performance.

Preliminary evaluations by Hanford, utilizing such tests as thermal cycling, reflectoscope ultrasonic tests, complete visual examination, and small scale tests in the piles, have indicated that the powdered slug may be equivalent to rolled slugs. It is planned to test 5,000 powdered 4" slugs in the piles. This test of slugs, which are being prepared under ideal conditions, could indicate whether the powder metallurgy process produces metal inferior to present production methods.

For the purpose of this report it has been assumed that the product is equivalent technically and economically to the rolled slug in pile operation. We believe that the 5000 test slugs can only be considered a preliminary examination of slug quality. In addition to the statistical requirements noted above, it should also be noted that the test is for four-inch solid slugs made by end-pressing in laboratory type equipment using ingot feed. If derby feeds were to be used, (which would most certainly have to be the case for an economic plant operation) and 8 inch slugs were to be made by side-pressing in production size equipment, another pile test would have to be made. Without knowing positively what risk Hanford would assume in accepting a new product, it appears advisable to consider the possibility of extensive product testing in future work.

In the production of the 5000 slugs to date, SEP has been restricted by Hanford's desire for a consistent product which requires constant process conditions. Such restrictions limit seriously the process changes which can be made to improve the process and to test process variables. The amount of useful development information which can be obtained for this portion of the project, therefore, is low in relation to the cost of the work in both time and money.

It would appear desirable to critically review the test slug project in light of its limited value to NYCO development activities and of the statistical significance that 5000 slugs would have in a pile test. It is proposed that consideration be given to testing lots of 1000 slugs prepared under slightly different processing conditions.

Economics

The economics of both the powder metallurgy and the FMPC processes were determined using the same process criteria:

1. Plant Site: FMPC

2. Plant Capacity: 10,200,000 lb. uranium per year, steady-state conditions.

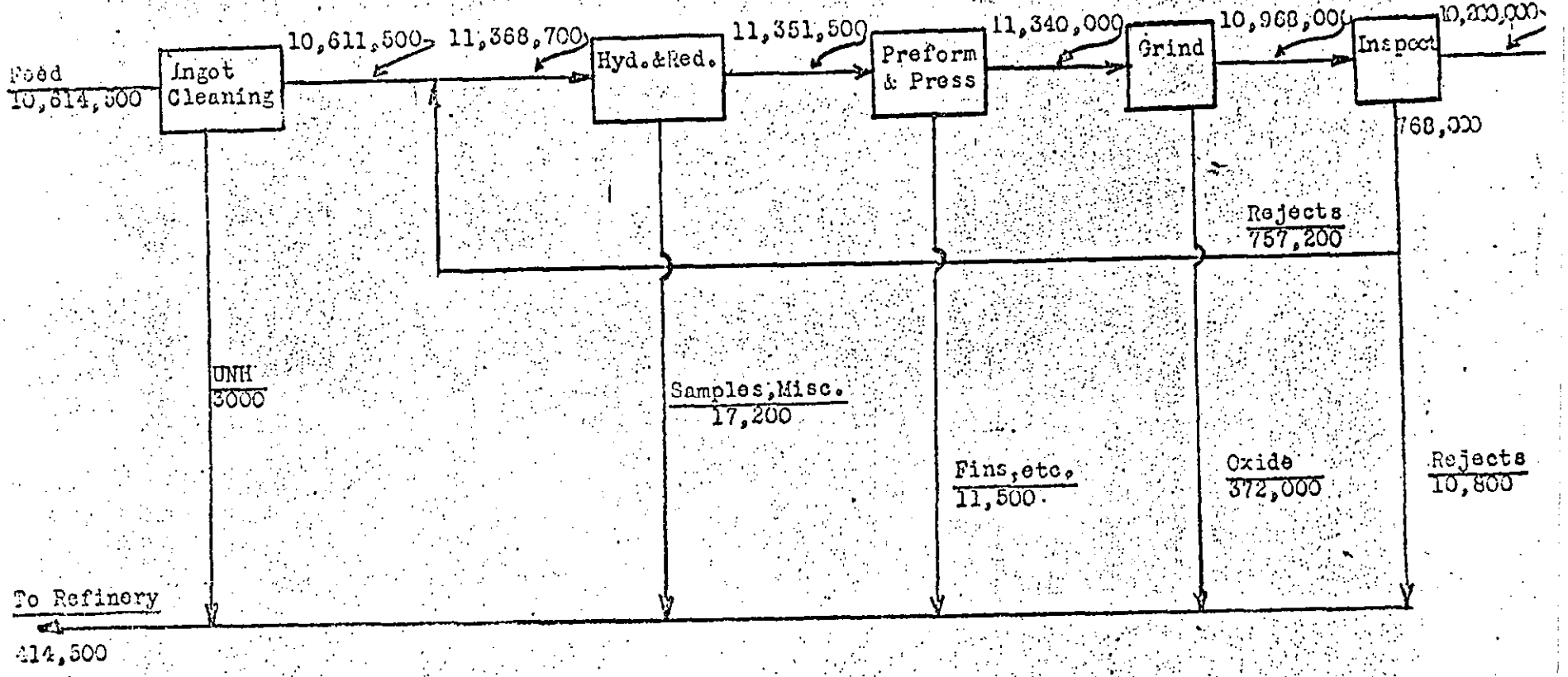
3. Product: either solid Hanford 4" or 8.4" slug of standard specifications including contour. (We have assumed that the need for a contoured surface would be independent of the process by which the slug was made).

SECRET

Figure 1

Material Flowsheet for SEP Process

(4" or 8.4" HEW Slug)

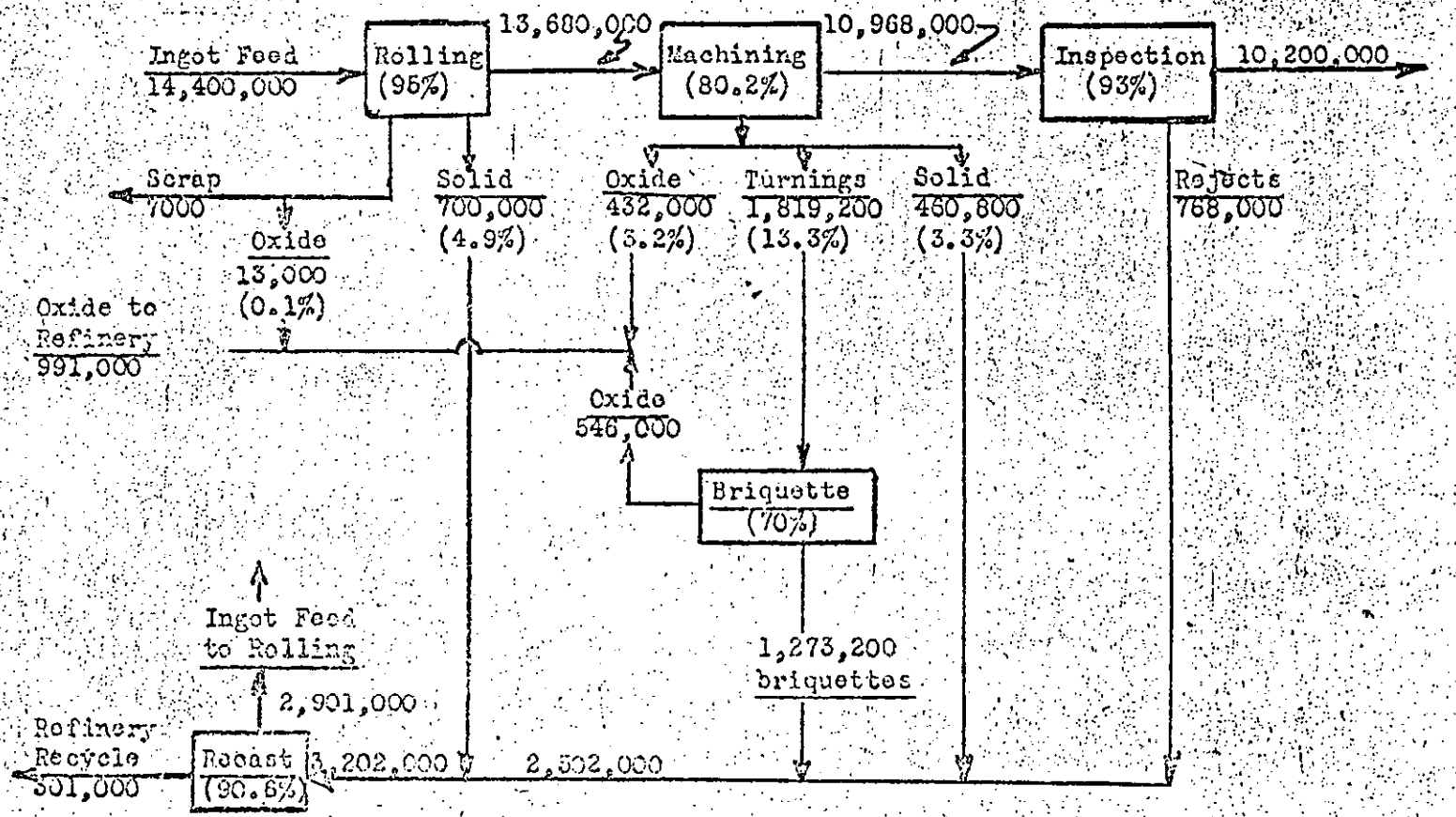



Rates are lb. per year

Figure 2

Material Flowsheet for FMPC Process

(4" or 8.4" HEW Slug)




Rates are lb. per year.