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AEC RESEARCH AND
DEVELOPMENT REPORT

INTEGRATED SAFEGUARDS EXPERIMENT

FIRST QUARTERLY REPORT

MAY-AUGUST 1970

D.C. WADEKAMPER
L.T. HAGIE

U.S. ATOMIC ENERGY COMMISSION
CONTRACT AT(30-1)-68

BREEDER REACTOR DEVELOPMENT OPERATION • GENERAL ELECTRIC CO
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compiled by:

D. C. Wadekamper and L. T. Hagie

Approved:

E. F. Kurtz, Manager
Plutonium Laboratory

B. F. Judson, Manager
Plutonium Fuels Development

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CONTENTS

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ABSTRACT

Work was initiated on the Integrated Safeguards Experiment during May, 1970. The program is directed toward evaluating the usefulness to safeguards of material balance techniques which employ only measured data. The available historical data are summarized, and accomplished experimental planning is defined. The first experiment was started.

I. INTRODUCTION

The General Electric Company has entered into a contract with the United States Atomic Energy Commission, Contract Number AT(30-1)–68, to support technical activities associated with the Integrated Safeguards Experiment. The program is sponsored by the Office of Safeguards and Materials Management and administration is provided by the Brookhaven office. The definition of program technical objectives as well as technical direction are provided through the Brookhaven National Laboratory – Technical Support Organization.

The purpose of the Integrated Safeguard Experiment is to evaluate the usefulness to safeguards of material balance techniques which employ data based completely on measurements. Normal production and product certification data for special nuclear material will be coupled with information obtained from nondestructive assay measurements accomplished with equipment provided on the General Electric portion of the Plant Instrumentation Program. (The purpose of the United States Atomic Energy Commission's Plant Instrumentation Program is to demonstrate the usefulness to safeguards of nondestructive assay measurements on special nuclear material.) The necessary material balance information will be compiled under actual fuel fabrication conditions during three processing campaigns. Over-all program objectives were formulated to demonstrate to the nuclear industry the usefulness of material balance accounting for safeguards.

During most of the contract period, Integrated Safeguards Experiment personnel will be onsite at the General Electric Company Vallecitos Nuclear Center, Pleasanton, California. These personnel, Integrated Safeguards Experiment – Technical Representatives, will work jointly with General Electric personnel during planning and data evaluation of test experiments.

Pursuant to the program objectives, the initial phases of the Integrated Safeguards Experiment consisted of evaluation of historical data and planning for future testing. The following guidelines were established to provide for administration of the program:

Task 1 – Historical Data and Experimental Planning
Task 2 – Experimental Testing
Task 3 – Program Evaluation and Final Report

Technical effort was initiated by the General Electric Company in May, 1970, in the areas of Task 1 and 2. The existing scope of work includes: (a) evaluation of historical data applicable to material balance accounting, (b) planning and testing during production runs in which material balance accounting is accomplished with only measured quantities, (c) demonstration of a mechanized accountability system, and (d) preparation of a nonproprietary file on the accuracy and precision of all measurements.

This is the first in a series of quarterly progress reports written in partial fulfillment of Contract Number AT(30-1)–68. The reporting period is May – August, 1970.

II. SUMMARY

Work efforts were initiated during May, 1970, under Brookhaven National Laboratory – Technical Support Organization technical direction to evaluate available historical data and plan experimental test designs for future activities. Part of the experimental testing was initiated near the end of the reporting period. A synopsis of the evaluated historical data and experimental planning accomplished during the reporting period is presented.

III. TASK 1. HISTORICAL DATA AND EXPERIMENTAL PLANNING

A. TASK 1A. HISTORICAL DATA

The Integrated Safeguards Experiment – Technical Representatives were familiarized with the historical data accumulated during two fabrication compaigns. The data reviewed served to provide a basis for planning and evaluating future test experiments. The following is a summary of the information reviewed; details of much of this material are General Electric Company Proprietary and limited in distribution by the contractual agreement:

1. Blueprints of Plutonium Laboratory – the location of each piece of equipment and glove box in the Plutonium Laboratory.

2. Laboratory Photographs – A series of 15 photographs illustrating either unit operations or pieces of processing equipment.

3. Process Flow Sheet – A diagram of the unit operations performed in the Plutonium Laboratory.

4. Process Operating Instructions – Operating instructions for the Plutonium Fuel, Plutonium Cladding, and Plutonium Analytical Laboratories.

5. Material Balances – Balances from two historical campaigns.

6. Fuel Rod Travel Cards – Records which contained the weight of mixed oxide in each production rod.

7. Chemical Analysis Summary – A summary of all fuel certification data. The original analysis reports were also available for examination.

8. Waste Barrel Inventory Sheets – Records from each waste barrel which contained a summary of discards, either estimated or measured.

9. Batch Makeup Sheets – Records of the amount of special nuclear material added to each fabrication master blend.

10. Vendor Certification – Information obtained from the vendor (*e.g.*, chemical analysis and weights) upon receipt of special nuclear material.

11. Physical Inventory – A record which shows amount, location, and ownership of all special nuclear material in the Plutonium Laboratory.

12. GEAP-4271, "The Measurement of Oxygen-to-Metal Ratio in Solid Solutions of Uranium and Plutonium Dioxides," May 31, 1963 – A development report used as a basis for the present oxygen-to-metal ratio determination technique.

13. Process Study in Pu/Pu+U Variations – A report on the Pu/Pu+U analysis for one plutonia enrichment performed during a historical campaign.

14. Quality Control Plan for the Plutonium Analytical Laboratory — A report documenting the quality control requirements during the period of time when the historical data were analyzed.

15. NAC — A Mechanized Nuclear Materials Accounting System — A report which documents the type of accounting system in operation at the start of the Integrated Safeguards Experiment as well as the operational details of the planned mechanized system.

B. TASK 1B. EXPERIMENTAL PLANNING

1. General

The experimental testing has been divided into three separate fabrication campaigns. Each campaign was scheduled so that the generated data can be used during planning for the next campaign.

2. Mechanized Accounting System

The report, "NAC — A Mechanized Nuclear Accounting System," provided in Task 1A (Historical Data) summarizes the necessary planning to develop a system to store, edit, and retrieve data required under the program.

3. Program Goals

Program goals have been discussed among the General Electric Company and the Integrated Safeguards Experiment personnel.

4. Experimental Test Designs

Each test design was developed and jointly evaluated by Integrated Safeguards Experiment — Technical Representatives and the General Electric Company. After a finalized test design was agreed upon, it was presented to the Integrated Safeguards Experiment — Management Team (a combination of both General Electric and Integrated Safeguards Experiment personnel) for final evaluation and approval. A summary of the test designs prepared during the reporting period follows:

1. Task 2A — Fabrication Campaign Material Balance. This test design, as approved for the first of three campaigns, consists of measuring all the material streams which either enter or leave the glove box line. The feed, product, recycle, and "clean" scrap streams will be defined with normal production samples as well as nondestructive assay measurements accomplished with equipment provided on the Plant Instrumentation Program. Waste and "dirty" scrap streams previously characterized only by weights or estimates will also be evaluated with nondestructive assay measurements. The resulting material balances will provide a firm basis for future campaigns and suggest areas which require additional refinement.

2. Task 2B — Data Handling Methods. Before the Integrated Safeguards Experiment contract period, the General Electric Company initiated development plans for the routine handling of special nuclear material data. Continuation of the development resulted in a test plan for Task 2B. The plan includes a description of a NAC MASTER FILE for the storage of historical data, a machine PRE-PROCESSOR for editing the punched paper tape and adjusting the format to be compatible with the file updating routines, and a special file of INVENTORY TRANSACTIONS which is the basis of a perpetual inventory. In addition, the Plutonium Analytical Laboratory has executed a measurement calibration plan designed to control the quality of accounting measurements.

   Initial planning for a limit of error model and the initial development of computer logic to process the data has begun. The inputs for accurate limit of error calculations are being defined and methods for the orderly collection of these data are being developed.

3. Task 2C – Establish Criteria for Comparative Evaluation of Present and Experimental Control Systems. The experimental plan presently under joint review by the Integrated Safeguards Experiment – Technical Representatives and the General Electric Company suggests various points for analysis. These analysis points can be used to compare the present accounting system with the experimental system. The experimental system is described in the report "NAC – A Mechanized Nuclear Accounting System," which was transmitted in Task 1A – Historical Data.

4. Task 2E – Weight Loss by Unit Operation. This task is intended to provide a material balance on each applicable unit operation in the Plutonium Laboratory. The plan proposed by the General Electric Company for evaluation provides for a material balance on each unit operation based on mixed oxide weight measurements. During joint evaluation of this test design, it was suggested that the results of this experiment would be more meaningful if the plutonium content of the mixed oxide was measured directly. At the present, several alternatives are under review.

5. Task 2F – MUF (Material Unaccounted For) Calculations. This test design, as submitted for consideration, was planned to establish the source and magnitude of deviations which contribute to MUF during normal processing. The calculations will be made on two campaigns in Task 2A, Fabrication Campaign Material Balances, and the Unit Operations in Task 2E, Weight Loss by Unit Operation. A special attempt will be made to define the real loss which can occur during normal processing as well as the apparent loss which results from an improper mathematical model or large uncertainties which mask the true value.

IV. TASK 2. EXPERIMENTAL TESTING

A. TASK 2A. FABRICATION CAMPAIGN MATERIAL BALANCES

1. General

After approval of Task 2A was obtained from the Integrated Safeguards Experiment-Management Team, the necessary Laboratory Plan for Campaign 1 was prepared and implemented in the Plutonium Laboratory. During this campaign 28 plutonium fuel rods will be fabricated for subsequent irradiation in the Vermont-Yankee nuclear power reactor under the joint Edison Electrical Institute – General Electric Company Program for Utilization of Plutonium in Boiling Water Reactors – Phase II. Campaign 1 was initiated the first week in August with sampling of the plutonia feed. Fuel processing was started in mid-August.

2. Laboratory Plan

In addition to the fabrication plan required for normal operation, a special laboratory plan was prepared to assist the Plutonium Laboratory Operations personnel in meeting the requirements of the Integrated Safeguards Experiment. This laboratory plan provided special forms for recording initial, interim, and final cleanup data; methods for obtaining and monitoring standardization data; and procedures for packaging scrap and waste to be measured nondestructively.

3. Fabrication and Processing Data

Fabrication information and processing data that pertain to material balance accounting were transmitted to the Integrated Safeguards Experiment – Technical Representatives. The following is a summary of the information transmitted during the reporting period; details of much of this material is General Electric Company Proprietary and limited in distribution by contractual agreement:

1. EEI-II (Vermont-Yankee) Fabrication Plan. This document contains all the sampling requirements, analysis technique, and accept/reject criteria for both process and quality control.

2. EEI-II (Vermont-Yankee) Product Sampling Criteria. A summary of the sampling requirements, degree of control, and the specifications of EEI-II (Vermont-Yankee).

3. Plutonia Sampling Plan. Sampling instruction for the plutonia utilized during fuel fabrication for EEI-II (Vermont-Yankee).

4. Process Operating Instruction Changes. New or revised operating instructions either tentative or final in effect during the fabrication run.

5. Normal Processing Forms. Forms developed to accumulate and compile processing data.

6. Transfer Records (Hood Inventory Sheets). Records of all box-to-box special nuclear material transfers were provided on a weekly basis.

7. Batch Makeup Records. Blending records for the two master blends of the same plutonia enrichment were provided.

8. Chemical Analysis. Individual analysis results for the metal content of the plutonia feed as well as the plutonium content obtained for the blend qualification (batch release) samples.

9. Plutonium Analytical Laboratory Method of Analysis Spread Sheet. A report prepared by the Plutonium Analytical Laboratory which summarizes the accuracy and precision data available for each analytical technique. The measurement methods and type of standards utilized are also included.

10. Campaign 1 – Calorimetry Feed Data. A summary of the calorimetry measurements made on the plutonia feed for Campaign 1.

B. TASK 2D. PROGRAM REVIEW

Before the start of Integrated Safeguards Experiment – Campaign 1, a program review was held by the General Electric Company and the Integrated Safeguards Experiment-Management Team. The following topics were discussed at this meeting:

1. Summary of provided Historical Data.

2. Acceptance of Task 2A – Fabrication Campaign Material Balance for Campaign 1.

3. Integrated Safeguards Experiment-Management Team's comments on Task 2E – Weight Loss by Unit Operation.

4. Discussion of over-all program goals.

V. MISCELLANEOUS

A. TRIPS

E. F. Kurtz and L. T. Hagie travelled to Brookhaven National Laboratory during May 14-15, 1970 to discuss the scope of work for the Integrated Safeguards Experiment with United States Atomic Energy Commission, Brookhaven National Laboratory, and National Bureau of Standards personnel.

B. VISITORS

The following is a summary of the personnel who visited the General Electric Company Vallecitos Nuclear Center to observe and discuss portions of the Integrated Safeguards Experiment:

1. United States Atomic Energy Commission

   N. Ovuka
   J. Williams

2. Brookhaven National Laboratory

   L. Epel
   W. Marcuse
   R. Parsick
   S. Suda

3. National Bureau of Standards

   W. Murphry
   W. Penn
   F. Perella
   J. Rowen
   C. Smith

CONTRIBUTORS

The following General Electric personnel contributed to the work performed on the Integrated Safeguards Experiment during the quarter ending August 31, 1970:

Task 1 – L. T. Hagie, E. A. Hartman, E. J. McAlpine, M. N. Robles, and D. C. Wadekamper

Task 2 – E. A. Aitken, D. M. Bishop, L. T. Hagie, M. N. Robles, J. L. Simpson, and D. C. Wadekamper

Other Contributors – B. F. Judson, E. F. Kurtz, W. W. Sabol, and M. L. Thompson

REFERENCES

1. Plant Instrumental Program First Quarterly Report, April 1970 – June 1970, GEAP-12114-1.

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Lyman Bryan, Area Manager U. S. Atomic Energy Commission Brookhaven Area Office Upton, New York 11973	1
H. S. Potter, Chief New York Patent Group U. S. Atomic Energy Commission Upton, New York 11973	1
William Marcuse Brookhaven National Laboratory Upton, New York 11973	3