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# A TECHNICAL PLAN FOR THE DEVELOPMENT OF AN ASSAY SYSTEM FOR INEL STORED TRU WASTE



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WASTE ASSAY--TECHNICAL PLAN

# 1. INTRODUCTION

Beginning in 1970, the Department of Energy began storing containers of transuranic waste in retrievable above-ground storage at the Idaho National Engineering Laboratory. Since that time approximately 104,000 55-gallon drums, 7,000 4 x 4 x 7 ft wooden boxes, and 500 steel bins have been stored. These containers are filled with TRU contaminated material ranging from dry paper and rags to large steel machinery.[1] The containers also typically contain an average of about 3-5 grams of TRU material, principally Pu-239.

The current method for managing the stored waste is to stack the containers in individual cells covered with a layer of plastic sheeting and about two feet of soil. This practice will continue until 1986, when the Stored Waste Experimental Pilot Plant (SWEPP) becomes operational.

The purpose of the SWEPP will be to certify that the stored waste is in compliance with the Waste Isolation Pilot Plant (WIPP) Waste Acceptance Criteria (WAC)[2], which have been specified by the WIPP. In order to certify the waste, the containers will be weighed, examined by x-ray and (possibly) neutron radiography to identify acceptable waste forms, checked to see that the container is still sound by ultrasonic or eddy current techniques, and assayed to determine the amount of fissile material in the container and its thermal power density. Waste shown by these tests to be in compliance with the WAC will be labeled accordingly and shipped to the WIPP.

Waste which does not meet the WAC will be sent to the Processing Experimental Pilot Plant (PREPP), at the INEL, where it will be processed and then returned to the SWEPP for final certification and shipment.

The purposes of this technical plan are to (1) describe plans for the development, construction, and testing of a system to assay the waste for fissile inventory and estimate the thermal power density of the waste, and (2) to identify the decisions to be made and the tasks that will generate the data necessary to make each decision.

## 2. PROGRAM OBJECTIVES

The objective of the waste assay development program is to develop a system which can be used by the SWEPP to determine the fissile inventory of the waste containers. This assay information will be used both for waste certification and for nuclear criticality control in the PREPP. Additionally, the system must provide an estimate of the thermal power density of the containers. This system must be operational within the SWEPP by the end of FY 1985.

The WIPP WAC, with regard to the assay system, are:[2]

1. "The fissile isotope content of individual CH (contact handled) TRU waste containers shall be no more than 200g of fissile isotope per 55-gallon (0.21 $m^3$) or larger drum, 100g per 30-gallon (0.11 $m^3$) drum, 500g per DOT 6n container, 350g per 4 x 4 x 7 ft (1.2 x 1.2 x 2.1m) FRP DOT 7A box or 5g in any $ft^3$ (0.028 $m^3$) in other boxes."

2. "Individual CH TRU waste packages in which the average thermal power density exceeds 0.1 watt/ft$^3$ (3.5 w/m$^3$) shall have the thermal power recorded in the data package."

The system must be able to accurately assay a variety of waste matrices, from low density material such as paper, rags, and plastic to high density materials such as steel, soil, or lead. The material will be contained in 30-, 55-, and 83-gallon steel barrels, 4 x 4 x 7 ft wooden boxes, or 4 x 5 x 6 ft steel bins. In order to fulfill the SWEPP objective of a total operating campaign of ten years, the system will have to examine an average of 60 barrels and 4 boxes or bins each day (based on 220 operating days/year).

## 3. GENERAL PROGRAMMATIC AND TECHNICAL APPROACH

### 3.1 General Approach

The objectives of Section 2 will be met by upgrading and enlarging an existing system developed by LANL to assay 55-gallon barrels.[3] This system uses an active neutron interrogation technique called Differential Die-Away Technique (DDT). In the DDT, a pulse of fast (14 Mev) neutrons is introduced into an assay chamber made of polyethylene lined with graphite, which thermalizes the pulse. These neutrons have a characteristic lifetime called the system die-away time. If there is fissile material present in the chamber, some of the neutrons will cause fissions. Prompt neutrons from these fissions are detected in specially designed neutron detectors which "sense" these fast neutrons but are insensitive to the interrogating thermal neutrons.

The capabilities of the DDT system will be expanded to include passive assaying. Passive assaying is discussed in more detail in Section 3.3.2.

Because the DDT system was initially designed and built to assay only barrels, some experimental work must be performed before the system can be enlarged to assay large boxes. The modifications identified by these experiments will be incorporated into a prototype DDT crate assayer. This prototype system will then be tested and upgraded to an operational system.

## 3.2 Technical Approach

Certain technological decisions regarding the waste assay system have already been made. Studies performed for other projects have shown that the best method, in general, for assaying INEL waste is an active technique such as photon or neutron interrogation.[4] Active techniques were recommended because the presence of high photon and neutron backgrounds within the waste masked the signal from the fissile material and because the passive techniques were too slow.

The assay system was to be used in a Slagging Pyrolysis Incinerator (SPI) facility. The material to be assayed (TRU waste) would move under the assayer loose, on a conveyor, and then be put into a charging container, reassayed, and incinerated.[5] These conditions required a fairly accurate and fast assay system which was relatively insensitive to varying waste matrices. Photon interrogation was chosen over neutron interrogation as the primary assay system because it would satisfy these design parameters better.

Photon interrogation is a technique in which the matrix containing the fissile material is exposed to a high energy (8-16 Mev) photon beam. The photons will cause some of the fissionable material to fission. The resulting fission neutrons are counted and used to determine the amount of fissile material present.

Because of the extremely high beam intensity, and because the interrogating media (photons) is different from the signal (photo-fission neutrons), photon interrogation was thought to be inherently more accurate than neutron interrogation.[6] Therefore, even though the technology for photon interrogation was undeveloped, the decision was made to use it in the SPI facility.

Neutron interrogation techniques, on the other hand, are well developed and currently represent the "state of the art" in assaying for fissile inventory of containers of waste. Therefore, when system requirements changed from high accuracy, high speed assay of loose material on a conveyor, to a lower accuracy, lower speed assay of whole containers of waste in a chamber (for SWEPP), the decision was made to use active neutron interrogation instead of photon.

The most accurate active neutron technique available is the DDT technique developed at LANL. This system has been demonstrated for use in assaying 55-gallon barrels of TRU waste at Oak Ridge National Laboratory. In addition to this, LANL has developed a passive neutron assay system to determine the fissile inventory of large crates.[7] It is the intent of this program to merge the DDT barrel assay system with this crate assay system to produce a DDT crate assay system. Because passive techniques are more accurate when the fissile material is present in large particles, the passive capabilities of the system will be retained. The status of both of these tasks is discussed in Section 3.3.

It is anticipated that all waste containers will be assayed by both active DDT interrogation and by passive neutron coincidence counting. The technique which results in the highest fissile content will generally be judged to be most correct.

Passive neutron counting will also serve as a means to estimate the gross alpha activity and, hence, the thermal power density of the waste package. It will be assumed that all single (noncoincidence) neutrons are produced by $\alpha$,n reactions within the matrix. Once the neutron production rate is known, the alpha activity which produced it can be calculated.

The technology for photon interrogation of large waste containers is still about two years behind DDT, and the extra reliability of a redundant assay system--using photon interrogation--in the SWEPP is not worth the additional cost and developmental risk. Therefore, only the neutron assay system will be used. There will be only one DDT assay system in the SWEPP to handle boxes, bins, and drums.

## 3.3 Present Status of DDT Development

### 3.3.1 The Oak Ridge Drum Counter

A DDT assay system has been built by LANL for Oak Ridge National Laboratory (ORNL).[3] This system has been designed specifically to assay 55-gallon barrels of TRU waste. The ORNL system has been checked with a few test matrices: sand and vermiculite; aluminum scrap; aluminum scrap and polyethelyene; aluminum scrap, polyethylene, and borated glass beads; concrete, scrap iron; and wet and dry rags. The assay system was able to determine the amount of Pu-239 present to within about 25% for all of the test matrices. The test results did not require any external matrix compensation adjustments. The system has been successfully field-tested with 21 barrels of unknown waste which contained from less than 2 mg to 2 kg of fissile material.

A more rigorous testing sequence, using barrels of simulated waste provided by ORNL, will be performed during FY-82. These test matrices will contain various quantities of TRU nuclides (fissile and nonfissile) unknown to LANL. These matrix tests will serve as a final performance check on the DDT system before it is delivered to ORNL.

Periodically during its use at ORNL, random drums of actual waste which have been examined by the DDT system will be destructively analyzed for fissile content. These destructive analysis tests will start in the last quarter of FY-82 and continue through FY 1985. The purpose of both this test and the previous examination of prepared standards is to define the accuracy of the system with actual waste and also to determine which (if any) waste types must be preprocessed before assaying.

### 3.3.2 The RFP Crate Counter

LANL is presently designing and building a passive crate counter for the Rocky Flats Plant (RFP). This counter will be fully operational by June 1983. The RFP crate counter will be an improved version of a modular assay system previously developed by LANL to assay 1.2 x 1.2 x 2.4 meter crates.[7] This system has been shown to be accurate to within about 50% for crates containing less than 10 nCi of TRU per gram and about 20% for crates containing larger amounts of TRU nuclides. The system measures the spontaneous fission rate from the even isotopes of Pu to determine the total TRU inventory, hence, the isotopic composition of the TRU in the waste must be known.

Budget and time permitting, LANL intends to build an active interrogation capability into the passive RFP system. Proof-of-principle measurements with a large chamber have been made for the active system. These preliminary tests have shown a lower detection limit of about 10 mg of fissile material.

## 3.4 Decisions Which Have Already Been Made

Table 1 lists the major decisions which have been made, as well as the major decisions yet to be made, and applicable tasks which will provide the information needed to make them.

Based on the work which has already been done with DDT and the studies discussed in Section 3.2, the decision has been made to use DDT as the primary assay technique in the SWEPP.

The system will incorporate the passive assaying capabilities mentioned in Section 3.3, and will include both the active and passive phases in the same chamber. This has been proven to be the most feasible approach to the problem of assaying large crates on a production scale.

TABLE 1. WASTE ASSAY DECISIONS

| Problem | Decision Made or to be Made | Applicable Tasks | Completion Date |
|---|---|---|---|
| Use active or passive | Use both active and passive | NA (Section 3.2) | Oct. 81 |
| Which type of interrogation | use both DDT and passive neutron methods | NA (Section 3.2) | Nov. 81 |
| Best method for moving containers through system | 1. Single entry chamber | NA (Section 3.4) | Nov. 81 |
| | 2. Choose best method for opening chamber | Evaluate chamber design alt. (waste assay tech. plan) | Apr. 82 |
| | 3. Choose best container handling system | Container handling (SWEPP CDR) | May 82 |
| Can noncoincident neutrons infer thermal power | Choose method for calculating power | Thermal power density experiments | Mar. 82 |
| Will system work for all INEL waste | 1. Which waste forms are most difficult | Evaluate INEL waste matrices (waste assay tech plan) | Feb. 82 |
| | 2. What is best accuracy, sensitivity for difficult waste form | | July 82 |
| How will assay data interface with SWEPP | 1. Choose acceptable data interface requirements | Test analysis algorithms (tech plan) | Aug. 82 |
| | 2. Choose appropriate system software | DMS (SWEPP CDR) | Aug. 8[illegible] |
| What is best neutronics subsystem design for the assayer | Optimize neutronics design | Evaluate neutronics subsystem design | Sep. 83 |
| How well does the system work with actual INEL waste | NA | Operational checkout and calibration | Sept. 85 |

The assay chamber will not be "pass through" because of the need for a $4\pi$ counting geometry. All six sides of the chamber contain neutron detectors, and the incorporation of the detectors into moving doors decreases the reliability of the system. Therefore, more than one door is not warranted.

### 3.5 Future DDT Development and Decisions to be Made

No actual DDT crate assay system has yet been built. Consequently there are some technical uncertainties. Most of these center around the effects of scaling up a proven, smaller, system to crate size.

The optimum number and geometry for the bare (passive) and shielded (active) detectors is not known.

The accuracy and matrix dependence of the larger system is not known.

Also, it is not known how accurately the total noncoincident neutron count rate will reflect the gross alpha activity within the container.

These questions will be resolved by the experimental work performed in conjunction with the system design, and by evaluation obtained from the ongoing ORNL tests (Section 3.3.1). Data from the RFP system will also be used if applicable. This work will be complemented by a computer model of the crate assayer. The model will be used to predict system response to a variety of detector configurations and waste compositions. This model is currently being developed as a part of the ORNL and RFP projects.

Because the system is to be used in a production scale environment, the optimum means for opening and closing the chamber to accommodate the required throughput must be determined. This task will be accomplished during the design work done in FY-82.

The data collection and management system (DMS) which will be used in the SWEPP must be able to communicate with the assay system. As a minimum, the assay system must be given the container weight and identification from the DMS and return to the DMS the fissile inventory and thermal power density of the container. The exact type of system electronics and interface hardware needed to accomplish this will be established as a part of the prototype design work in FY-82.

It is not known how well the system will respond to certain INEL waste matrices (i.e., sludges, beryllium, etc.). An upper limit to system accuracy will be established in FY-82 by examining simulated INEL waste in the barrel counter. This will be performed in conjunction with the ORNL tests. After the system has been installed in the SWEPP, actual INEL waste and about 20 mockups of the various "generic" waste forms stored at INEL will be examined. This will finally establish how well the system can be expected to work in a production environment.

The work which is to be performed this year is shown in Figure 1. The 1982 work will consist of the following major tasks:

1. Thermal power density measurement. Several drums of waste containing known amounts of TRU nuclides will be assayed to determine the gross alpha activity (Section 3.2) in the container. The calculated activity will be checked against the actual activity to determine the accuracy of this method of determining the thermal power density of the waste containers.

2. Evaluate INEL waste matrices. A few typical waste compositions, neutronically similar to what which will be encountered during SWEPP operation, will be tested by LANL. The response of the assay system to these mock-ups will be calculated and then verified experimentally. The exact composition of the test matrices will be decided by mutual agreement between EG&G and LANL. Two sets of evaluations will be performed.

3. Evaluate design alternatives. Several alternative methods for opening the assay chamber to receive waste containers exist. The optimum method will be chosen by LANL, with the cooperation of EG&G.

4. Assemble and test detectors. The assay system will contain both shielded and unshielded neutron detectors. At least one set of each type will be assembled and tested to determine the optimum number and configuration for the neutron detectors.

5. Test analysis algorithms. The computer algorithms which will be used to calculate the grams of fissile material and thermal power density from the neutron detector signal will be written and verified. Total and coincidence passive neutron assay and active interrogation algorithms will be used.

6. Evaluate neutronics subsystem design. The working design for the neutronics subsystem (detector arrays, amplifiers, etc.) will be developed and evaluated by computer modeling techniques. The results of the evaluation will be checked by experimental models.

7. Produce working design. Preliminary design drawings and specifications for electronics and mechanical (i.e., door opening

mechanism, assay enclosure, etc.) subsystems will be developed and checked for compatability with the neutronics subsystem and the SWEPP.

8. Produce draft prototype final design. The results of tasks 6 and 7 will be combined to produce a draft of the final design report for the prototype system.

## 4. PARTICIPANTS

The waste assay program will be a cooperative effort by LANL and EG&G, Idaho. Both laboratories were involved in preparing this technical plan. The exact responsibilities of each participant are detailed in the scope of work document for this project.

In general, LANL will design and construct the assay system itself. EG&G will be responsible for the overall program direction and will be responsible for all SWEPP interfaces (i.e., container handling, utilities, data acquisition, etc.) with the assay system. This is to ensure propoer integration of the assay system with the SWEPP.

## 5. RELATIONSHIP TO WASTE CERTIFICATION PROCEDURES

As was mentioned in Section 2, the primary objective of the waste assaying system is to certify that containers of waste shipped to WIPP meet the applicable WIPP-WAC. DDT systems have already been developed which have some--if not all--of the necessary assay capabilities. The purpose of this section is to define these existing capabilities, describe the anticipated future system capabilities, and discuss the proposed approach to certifying the INEL waste.

## 5.1 Current System Capabilities

### 5.1.1 DDT Barrel Assayer

During the development of the DDT barrel assay system, some test waste matrices have been examined. These matrices are comparable to many common INEL waste forms. The results of the tests which have been done so far are shown in Table 2. The table also lists the INEL waste content codes which compare to each of the test matrices.

LANL has successfully used the barrel assay system to examine eight barrels of ORNL waste. The exact composition and TRU inventory of this waste is not yet known. These barrels will be returned to ORNL, opened, and examined with standard analytical techniques in late FY 1982. The results of the destructive examinations can then be compared with the results of the DDT assay.

The complete DDT barrel assay system will be delivered to ORNL by 1 April 1982. Between then and the end of FY 1982, 12 more barrels of actual ORNL waste will be assayed and then examined by ORNL.

TABLE 2. DDT BARREL ASSAY SYSTEM TESTS

| Test Matrix | (Pu-239) Sensitivity/Accuracy | | INEL Waste Form Analogue |
|---|---|---|---|
| Sand (440 lbs.) | 0.5 mg | 20% | 90, 105, 370, 371, 372, 374, 842, 391, 392, 393, 422, 440, 990, 810, 813 |
| Dry rags | 0.5 mg | 20% | 10, 153, 202, 203, 330, 335, 338, 360, 361, 490, 801, 805, 847 |
| Concrete | 5.0 mg | 50% | 102, 152, 204, 290, 292, 376, 420, 421, 960 |
| Dry rags with rashig rings (90 lbs.) | 8.0 mg | 50% | 100, 150, 320, 410, 411, 412, 416, 441, 442, 970, 814 |
| Wet rags (50% water) | 5.0 mg | 50% | 300, 301, 310, 311, 336, 337, 460, 802, 804 |
| Scrap iron (407 lbs.) | 1.5 mg | 30% | 0, 20, 101,155, 200, 201, 480, 481, 980, 803, 824, 825 |
| Polyethylene chips (72 lbs.) and rashig rings (21 lbs.) | 2.0 mg | 40% | 30, 40, 104, 151, 154, 302, 339, 463, 464 |

ORNL has also supplied LANL with standard sources representing TRU isotopes which are typically found in their waste. The sources are Am-241, 243; U-233, 235; Pu-238, 239, 240, 242; Cm-244; and Cf-252. These sources will be used by LANL to further assess the capabilities of the assay systems they are developing for ORNL, and to calibrate the system. The sources will also be used to develop and test methods for estimating the thermal power generation in INEL waste forms. The tests with the ORNL sources are scheduled for completion in March 1982.

The remaining development work with the DDT barrel counter is summarized in Table 3.

TABLE 3. DDT BARREL ASSAYER DEVELOPMENT

| Task | Completion date |
|---|---|
| Test and calibrate (at LANL) | March 1982 |
| Deliver working system (to ORNL) | April 1982 |
| Assay and examine 12 waste barrels | September 1982 |
| Destructively examine 8 waste barrels already assayed | September 1982 |

5.1.2 Large Crate Assayer

Tests and operatins with crates of actual waste have shown that the passive neutron assay system is capable of accuracies and sensitivities comparable to those of the active system.[7] However, no crate-sized mockups have yet been examined with this system. The laboratory in which this system is being developed does not have the facilities to routinely handle crates of waste. System tests with crate mockups will not be performed until the crate counter being developed for RFP is delivered to Rocky Flats, in early FY 1983. Limited tests with INEL mockups can probably be performed then, with the RFP system.

Initial scoping tests have been performed which show that the large crate counter should be capable of sensitivities of about 10 to 15 mg of U-235, when in the active mode. The corresponding accuracy has not yet been determined.

Earlier work with the passive crate counter indicated that the system is capable of some spatial resolution within the chamber. If it can be demonstrated that this resolution is good enough to partition the fissile material into individual barrels within the chamber, barrels can be assayed simultaneously. Throughput could thus be increased substantially, while adding almost nothing to the cost of the system. Assay system spatial resolution experiments will be performed (budget and time permitting) periodically during the remainder of FY 1982 and throughout FY 1983.

## 5.2 Anticipated INEL Waste Assay System

### 5.2.1 Assay Procedure

The general assay procedure will be to assay each container either individually or, for drums, possibly in groups of two to six. Containers will be assayed by both the active DDT method and by passive neutron counting. Available information about the waste form, obtained from the previous NDE and weighing processes, will be used with the neutron data to determine the fissile inventory and thermal power density of the container. If there is a discrepancy between the fissile inventories obtained from the active and passive modes, the higher value will be used (unless it can be proven that the higher value is wrong).

It is not considered feasible to develop separate calibration algorithms for each stored waste content code. Rather, an "operating envelope" will be determined (see Section 5.2.2) which will establish the system accuracy and sensitivity for the most difficult waste form. These limits will then be taken as being the limits for all waste forms. Pending further testing and evaluation, the worst expected sensitivity and accuracy is thought to be about 10 mg and 40% (for Pu-239). The fissile inventory of the container will be recorded as the assay value plus the expected accuracy error. For example, an assay value of 100 mg of fissile material would be recorded as 140 mg.

### 5.2.2 INEL Waste Form Tests

The work which has already been done with DDT and passive neutron assay techniques has shown that the most difficult waste forms to assay are those which contain dense moderators (polyethylene, graphite, etc.) mixed with neutron absorbers (boron, cadmium, U-238, etc.). These waste forms were simulated by mixing neutron absorbing rashig rings with the dense moderator polyethylene. Tests with this simulated worst case waste showed that even it was well within the requirements imposed by the WIPP-WAC. There are only a few INEL waste forms which constitute moderator/absorber matrices. These waste forms correspond (loosely) to content codes (to be determined). These waste forms will be mocked-up and analyzed in two sets. Data from the first set, plus any available data from the ORNL experiments, will be used in determining the composition of the second set. The INEL tests are planned as shown in Table 4. The results of these tests will be submitted to WIPP for review as they become available.

TABLE 4. INEL WASTE FORM TESTS

| Waste Form | Completion date | WIPP |
|---|---|---|
| First Set | | |
| 900, 950, 836 | March 1982 | May 1982 |
| Second Set | | |
| 995, 1, 2 | July 1982 | September 1982 |

The results of these tests will be used to develop the "operating envelope" spoken of in the previous section.

### 5.2.3 Thermal Power Density

The thermal power generated within a waste form is directly related to the gross alpa activity it contains. If the alpa-emitting nuclide is present as an oxide, then the alpha activity can be directly related to the production of neutrons via the $(\alpha,n)$ reaction with 0-18. These $\alpha,n$ neutrons will be detected as uncorrelated neutrons by the thermal neutron detectors in the assay chamber walls.

The thermal power density for a container will be determined by first determining the alpha activity and then using the formula:

$$TPD = \frac{(A)(E)(C)}{V}$$

where

A = the total alpha activity in disintegrations/sec.

E = the average energy/disintegration (about 5.5 Mev)

C = a conversion factor (watt-sec/Mev)

V = the container volume

The alpha activity to measured neutron count rate ratio will be determined by experiments with the ORNL TRU standards mentioned in Section 5.1.1. If it is known that the TRU nuclides are not present in their oxide form, the power density can be calculated by using the assay value for the total weight of fissile material present. If the waste form contains non-fissile TRU, not in its oxide form, the generator value will be used.

## 5.3 Quality Assurance

Quality assurance for the waste assay system will be achieved by extensive calibration checks with prepared standards during the operational checkout phase and by regular calibration checks during normal operation thereafter.

Daily, prior to operation, the system will be checked for operation with a standard container. In addition to this, a "constant" check of the neutron background from cosmic ray ($\gamma$,n) reactions will be used to assure proper system performance.

# 6. COST AND SCHEDULE

## 6.1 Schedule

The waste assay project must interface properly with the SWEPP project. These interfaces are shown in Figure 2. Since the SWEPP schedule calls for installation of the certification equipment at the start of FY 1985, the complete assay system must be available by that time. Also, the certification project requires that the final version of the waste assay design be completed by the beginning of FY 1983. The exact method for assaying (with its inherent limitations, accuracy, etc.), must be known before the actual certification procedures and specifications are developed. This information is also needed for the SWEPP final design.

The overall schedule for waste assay development is also shown in Figure 2. The major tasks to be completed are:

1. Design the assay system--This task will be performed in FY-82. It will result in a draft final design report, issued in September 1982, and a final design report in December 1982. (The time lag is to allow for LANL and EG&G internal reviews.) This report will contain information needed to construct the prototype assay system. During construction of the system there may be minor changes, however, none of the changes will affect the assay system/SWEPP interfaces (i.e., container handling, utility and space requirements, data acquisition system). The questions discussed in Section 3.5 will be resolved during this phase of the system development.

The assay system design must be reviewed by DOE-ID, EG&G Safety, Quality, Design Engineering, Waste Programs, and Applied Physics divisions. These reviews will be accomplished by the middle of the first quarter of FY 1983.

2. Construct the assay system. A prototype assay system will be constructed during FY 1983 and early 1984 at LANL. Commencing in mid 84, this system will be tested and modified as necessary to become the production assay system to be used in SWEPP.

These tests will consist of the usual experiments with bare and shielded test sources and some limited work with mocked-up waste containers. The test waste will be one crate (a 4'x4'x7' metal overpack, if available) of "worst case" waste and six barrels of the same. The tests will be used to optimize the system design and to define, on a preliminary basis, the system accuracy and sensitivity.

The actual operating parameters for the system will be established during the operational check and calibration phase in FY-85. Then, each mockup waste form which is examined by the NDE radiography system will be "spiked" with fissile material and assayed. Some actual waste will be assayed as well.

As discussed in Section 3.3, LANL has already constructed a DOT barrel counter for Oak Ridge National Laboratory. This counter will become operational at ORNL this year (1982). Also, a crate-sized assay system, similar to the one which will be developed for INEL, is currently being developed for the Rocky Flats Plant by LANL. Information gained during the testing and operation of these two systems will be used to modify and improve the prototype INEL system. Thus, the INEL waste assay system will incorporate the best features of both the ORNL and RFP systems and will be "state-of-the-art".

During the test phase at LANL, training of the EG&G technicians and scientists who will ultimately be responsible for maintenance and operation of the assay system will begin. This training will continue until LANL releases the assay system to EG&G at the end of FY 1985. System final documentation (schematics, blueprints, operating manuals, etc.), will be issued at the end of FY 1984.

3. Install and test assay system in SWEPP. During the first quarter of FY 1985, the assay system will be transferred to the INEL and installed in the SWEPP NDE building. The system will be tested to insure that it is functioning properly and then the operational checkout phase will start.

During the operational checkout phase the proper operation of the container handling and data acquisition interfaces will also be checked. At the end of FY 1985, LANL formal involvement with the waste assay program ends. Beginning with the last quarter of FY 1985, the system will be calibrated with prepared standards which represent a variety of stored waste matrices. This calibration phase will be completed by the end of FY 1985, at which time the assay system will be ready for operational use in the SWEPP.

## 6.2 Cost

The total cost for this project, from FY-82 through a fully operational system in FY-85, is estimated to be $1.8 million. This funding will be as shown in Table 5. The entire project will be funded through the Transuranic Waste Systems Office.

TABLE 5. WASTE ASSAY FUNDING ($1000)

| | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|
| Operation (EG&G) | 150 | 80 | 155 | 250 |
| Operation (LANL) | 110 | 150 | 150 | 150 |
| Capital Equipment (LANL) | -- | 600 | -- | -- |
| | 260 | 830 | 305 | 400 |

The LANL operating and capital equipment funding is what is required by LANL to design, construct, and test the assay system and to train EG&G technicians. The EG&G operational funding is required for EG&G project engineering and for technical support to ensure smooth functioning of the equipment after LANL involvement ends.

## 7. CONCLUSIONS

The proposed waste assay development is an adaptation of existing, proven, techniques to determine the fissile inventory of TRU waste containers. The passive assay capabilities of the system have already been demonstrated with 1.2 x 1.2 x 2.4 m crates. The active (DDT) capabilities have been demonstrated with 55-gallon barrels but not with crates.

Consequently the only major technological uncertainties in the waste assay development program center around the effect on system assay time and accuracy of scaling the DDT barrel counter up to a counter which will handle INEL boxes, bins, and drums. These uncertainties will be resolved by experimental and development work performed in FY 1982. Further development and modifications to an operating prototype system will be accomplished during FY 1983-84 so that a fully operational DDT crate assay system will be available to the SWEPP in FY 1985.

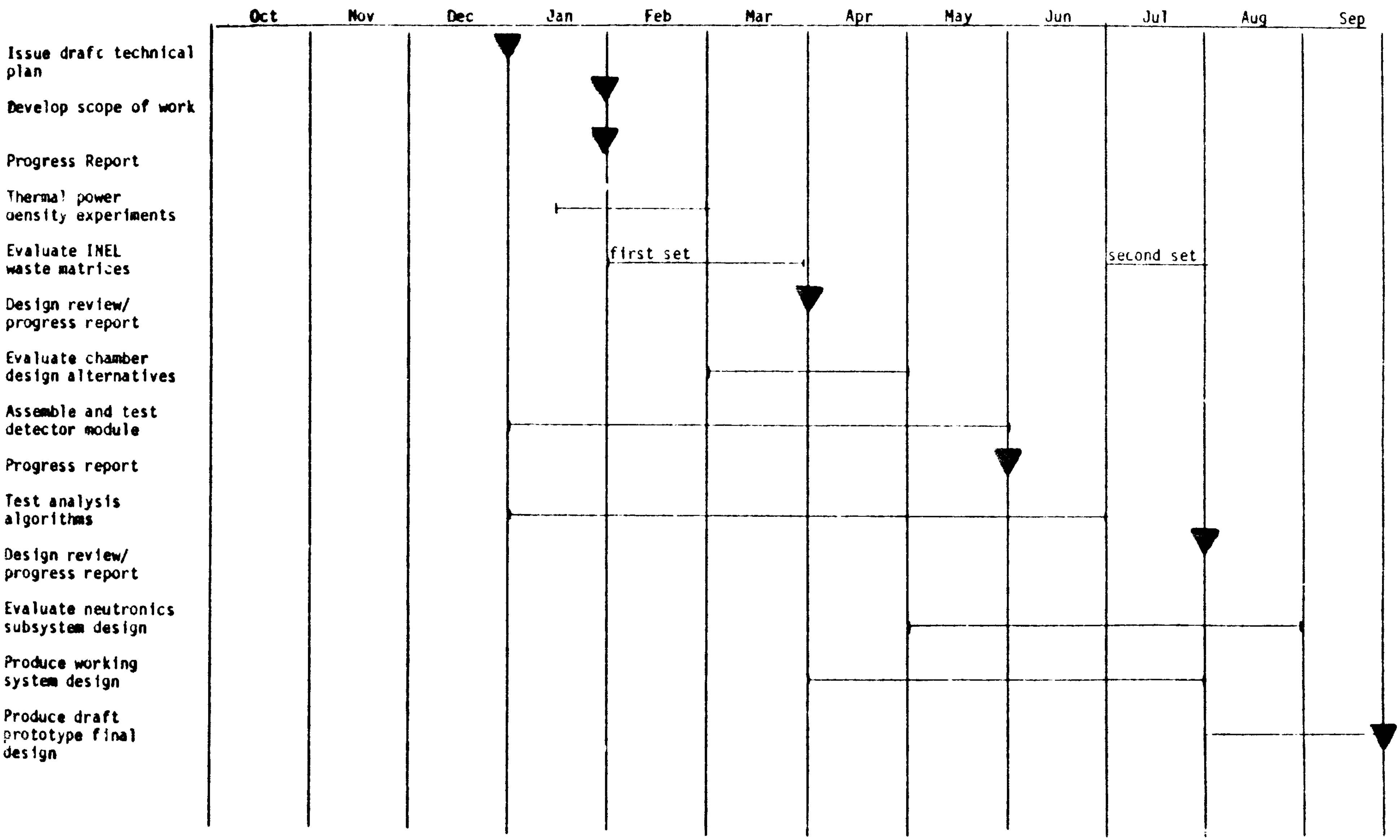
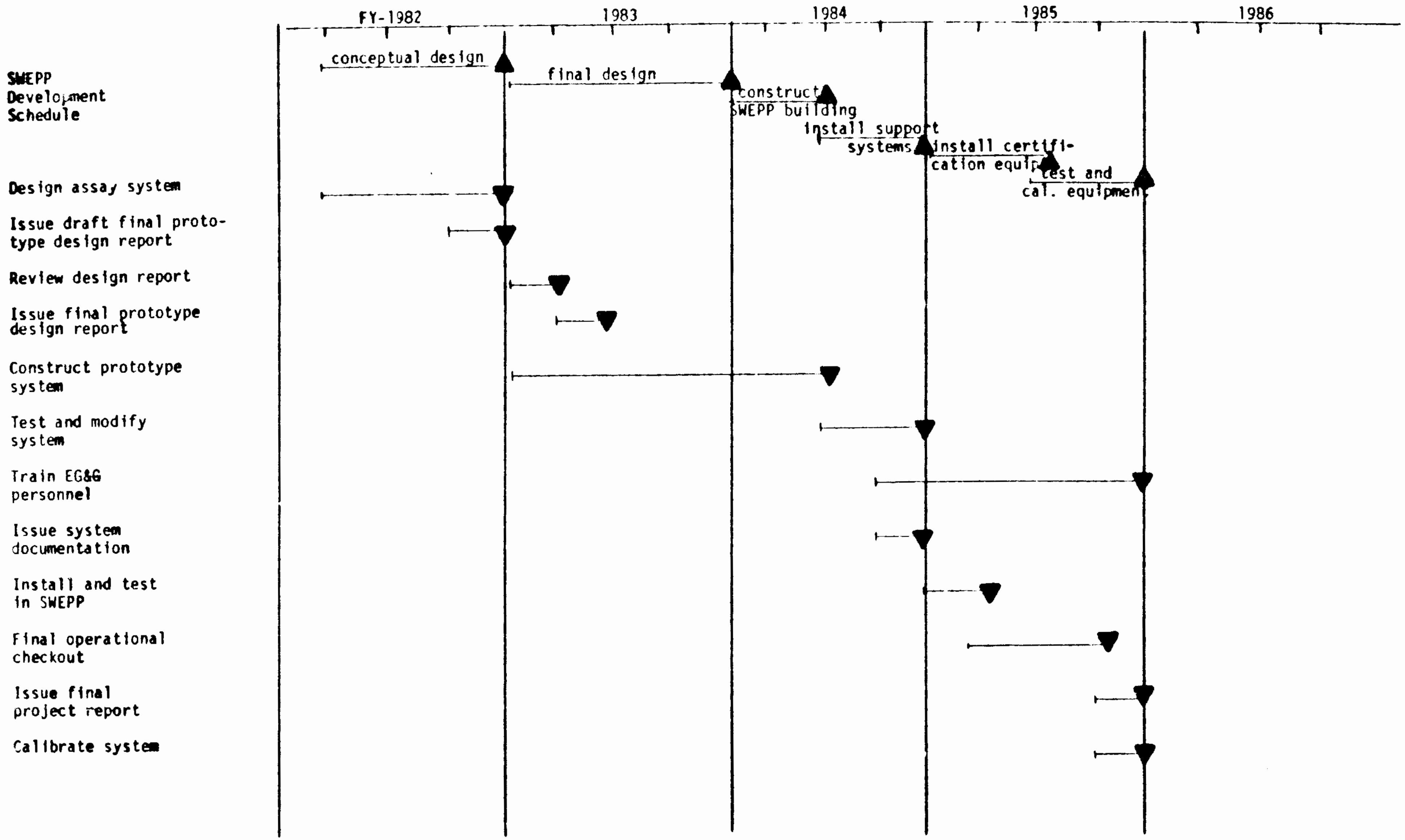



FIGURE 1. WASTE ASSAY DEVELOPMENT FY 1982

FIGURE 2. WASTE ASSAY GENERAL SCHEDULE



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2. TRU Waste Acceptance Criteria for the Waste Isolation Pilot Plant, WIPP-DOE-069, September 1981, pp. 16, 17.

3. W. E. Kunz et al., A 1-mg-Sensitivity Fissile Assay System, LA-UR 81-1358.

4. E. B. Nieschmidt and S. H. Vegors, Jr., Selection of a Criticality Monitoring Technique for a Transuranic Waste Incinerator, TREE-1277, June 1978.

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