383-85-098

Box 2

LN: 02/73; 52-4-3

Lot 77046 box 7216

SECRET
RESTRICTED DATA

This document consists of 129 pages.
Number 63 of 150 copies, Series A

FILE

051

FIELD TEST PROGRAM

FINAL REPORT - VOLUME I

FIELD TEST FT-34

DEMONSTRATED DESTRUCTION OF NUCLEAR WEAPONS (U)

January 1969

UNITED STATES ARMS CONTROL AND DISARMAMENT AGENCY

RESTRICTED DATA

THIS DOCUMENT CONTAINS RESTRICTED DATA AS DEFINED IN THE ATOMIC ENERGY ACT OF 1954. ITS TRANSMITTAL OR THE DISCLOSURE OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED.

5761

SECRET
RESTRICTED DATA

GROUP 1
EXCLUDED FROM AUTOMATIC DOWNGRADING AND DECLASSIFICATION

[redacted]

FINAL REPORT - VOLUME I
FIELD TEST FT-34

DEMONSTRATED DESTRUCTION OF NUCLEAR WEAPONS (U)

JANUARY 1969

Field Operations of the Weapons Evaluation and Control Bureau assumes overall responsibility for the development of this document. The Sandia Corporation, under a Working Arrangement with the U.S. Atomic Energy Commission, contributed to its contents.

This document reports on part of a broad program of research on inspection and verification and does not necessarily express a U.S. position.

The Final Report on FT-34 has been prepared in three volumes. Volume I is a summary report of the test; Volumes II and III are a compilation of seven annexes containing more detailed treatments of the same material.

Prepared By

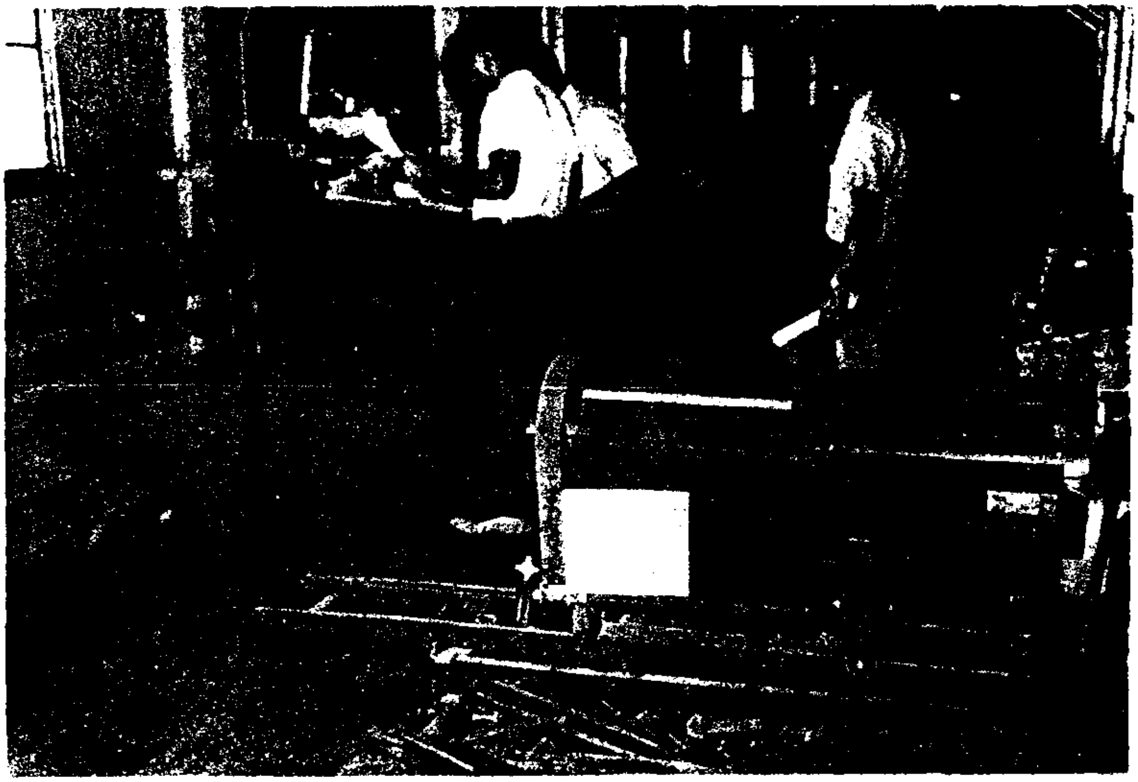
FIELD OPERATIONS
WEAPONS EVALUATION AND CONTROL BUREAU
UNITED STATES ARMS CONTROL AND DISARMAMENT AGENCY

[redacted]

[redacted]

[redacted]

[redacted]



ABSTRACT

Field Test FT-34 was conducted at four U.S. Atomic Energy Commission plants in mid-1967. The purpose of FT-34 was to develop and test inspection procedures to monitor the demonstrated destruction of nuclear weapons. Forty nuclear weapons scheduled for normal retirement and 32 fake weapons were used during the test. Inspection teams of different sizes and at different levels of access monitored the destruction of these weapons and assayed the fissionable material derived from them. Information was obtained concerning the amount of classified information revealed and the credibility of the demonstration under the conditions tested.

[redacted]

SYNOPSIS

A. BACKGROUND

The United States has proposed before the Eighteen Nation Disarmament Committee at Geneva to transfer weapons grade U-235 to peaceful uses under international safeguards provided the Soviet Union would do likewise. More specifically, through its Ambassador to the United Nations, the United States has stated that it would be willing to transfer 60,000 kilograms of weapons grade U-235 and the associated plutonium to nonweapon uses if the Soviet Union would be willing to transfer 40,000 kilograms. Each country would destroy nuclear weapons so as to make available for peaceful purposes such amounts of fissionable material. Field Test FT-34, "Demonstrated Destruction of Nuclear Weapons," was conducted as a part of the consideration of these proposals.

B. SCOPE

This report summarizes the operations, results, and evaluations of Field Test FT-34. Details are given in annexes to this report, published separately as volumes II and III.

FT-34 was an investigation of the demonstration of the destruction of nuclear weapons by visual observation, use of radiation detection equipment, inspection of X-ray plates of weapons, and laboratory analyses of the resulting fissionable material. The test was conducted from 21 June to 20 October 1967 at the following U.S. Atomic Energy Commission plants:

2. Rocky Flats Plant, Golden Colorado - recovery and processing of plutonium.

3. Paducah Plant, Paducah, Kentucky - processing and disposition of nonnuclear components.

The test objectives were:

1. To determine the extent to which the proposed method of demonstrating destruction reveals classified weapon information.

2. To evaluate the effectiveness of the tested procedures in terms of convincing the Test Inspection Force that nuclear weapons are being destroyed.

3. To evaluate the practicability and effectiveness of the proposed methods and to suggest and implement possible improvements during the test.

4. To identify operational, technical, classification, safety and security problems which arise.

D. <u>RESOURCES</u>

1. Funding for the field test was provided equally by the ACDA and the DOD.

2. The DOD provided 80 personnel on a TDY basis for planning and conducting the test, and three members of Field Operations directed and supervised the test. Analytic and technical support was provided by the Sandia Corporation as arranged for by a reimbursable agreement with the AEC. This agreement also provided for AEC plant support. The AEC also provided classification specialists to observe all inspection operations and determine the amount of classified information revealed. The real nuclear weapons used during the test were provided by the AEC from

[redacted]

among those scheduled for normal retirement. The DOD provided some training weapons and conventional munitions which were modified and used as fake nuclear weapons.

3. Approximately 43 man-years of direct effort were expended for planning, conducting, and analyzing the test.

E. INSPECTION

Three general exercises were tested during the field test: (1) a test of the overall demonstration of the destruction of nuclear weapons, (2) a more thorough test of the analysis of uranium by selected main-force inspectors, and (3) a test of the analysis of uranium by scientists employed by the Oak Ridge Plant contractor. Inspectors for the first two exercises were provided by the Department of Defense on a TDY basis. All but one, who was a retired Air Force officer, were military officers on active duty and all had some training or experience in nuclear weapons or chemistry or both.

1. The test of the overall operations consisted of inspecting all phases of the demonstrated destruction from the initial inspection of a batch of weapons to be destroyed to inspections of the resulting fissionable material and non-nuclear components. Two similar groups of inspectors, operating on a staggered schedule, inspected four batches of weapons and the resultant components. Each batch contained bona fide nuclear weapons scheduled for normal retirement and fake weapons. The fake weapons were included to test the effects of evasion on inspection. To test the effects of team size and access, the two groups of inspectors were subdivided into two-man and four-man teams, and teams were permitted various degrees of access to the destruction operations. The operational facilities, the weapons, and the components resulting from weapon destruction were examined to determine the amount of classified information revealed and to determine the credibility of the demonstration. During the assay of the plutonium and uranium derived from the weapon shapes destroyed, evasions were tested by concealed substitutions of materials by laboratory technicians and by modifications of laboratory equipment.

[redacted]

2. At the conclusion of the overall test by each inspection group, selected inspectors were rearranged into new two-man teams, one-half of which were composed of men skilled in chemical analysis procedures and the other one-half composed of relatively unskilled men. This allowed team composition to be tested. Using these new teams, special assay analyses were conducted to study the problems of uranium assay more thoroughly under evasion conditions in a host's laboratory. Specially prepared uranium samples were used for this test.

3. Finally, a new team made up of three experienced laboratory scientists repeated the special assay analyses using the same samples and subject to the same evasion.

F. RESULTS

1. Four access levels were investigated during the field test, from low (observing weapons and resulting material) to high (including studying X-ray plates of weapons). Many classified items were revealed at each access level. A total of 112 items of classified information were revealed at the highest level of access, 60 items at the next lower access, 41 items at the next level, and 34 items were revealed at the lowest level tested. Classified information was revealed during all operations inspected except during a tour of the foundry and empty warehouse by inspectors at Paducah.

One team of inspectors collected a very small sample of radioactive material in a previously "cleaned" work area which revealed classified information when analyzed.

2. During the field operations inspectors were required to state whether they believed the facilities used were credible, whether weapons introduced were real or fake, and whether evasion had been practiced during analyses of fissionable material. Facilities, of course, were real and inspectors were convinced of their credibility.

At the lowest access level, an average of 49 percent of the calls were correct; at the highest access level, an average of 81 percent of the calls were correct. The proportion of correct calls did not vary much with team size but increased significantly with access level.

For all assay phases of the field test, a total of 504 sample operations were performed by inspection teams. Of these, 187 sample operations were evaded. Inspectors made only seven correct evasion calls. The effectiveness of detection, then, was 7/187 or four percent, which represents a substantial risk for the evader. Most detections, however, were a result of equipment malfunction or mistakes by laboratory personnel. The effectiveness of evasion improved as the test progressed, and the final team, the professional scientists, detected no evasion. There probably would always be some risk, however, that even the best prepared evasion schemes would fail and be detected.

3. For the most part, the methods for demonstrating the destruction of weapons were found to be practicable, and no significant improvements were required.

Inspectors, not being classification specialists, detected on the average only 56 percent of the classified information exposed during the test. The AEC provided classification specialists to observe all operations, however, so that all classified information exposed could be determined.

Analysis of the major data-gathering phase of the test indicates that inspectors collected an average of 79 percent of weapons information available, including identifications of classified information where required by data forms.

With the limited training available for the field test, inspectors were able to perform mass spectroscopic operations in a satisfactory manner, but the accuracy of their chemical analysis operations was below laboratory standards. They used well-defined standard procedures, of course, and laboratory specialists were always available for assistance.

4. Although no major problems arose during the field test, some of the more significant problems are summarized in the following subparagraphs.

Inspectors were unable to maintain an accurate balance between weights of weapons introduced for inspections and the weight of the resulting components and materials. The maximum weight imbalance for a batch of weapons was 3 percent. Many factors contributed to this problem-such as, inaccurate scales, different record-keeping systems by different plants, and inspectors' errors.

The test was planned and conducted with strict adherence to requirements for safety, security, and noninterference with normal plant operations. Accordingly, it was necessary that inspection procedures and schedules be adjusted and contingency time provided in order to conform to these requirements.

Some equipment malfunction and limitations of equipment affected inspection operations slightly.

5. Test control, support, personnel qualifications, and training were satisfactory, and the test was conducted as planned. The requirement to operate in four widely separated facilities, operated by three different contractors, and with each employing different administrative, security, and safety practices introduced some confusion to inspectors and required extensive logistic preparation and support.

G. CONCLUSIONS

1. If the United States were to demonstrate the destruction of nuclear weapons in existing AEC facilities following the concept which was tested, many items of classified weapon design information would be revealed even at the lowest level of intrusion. Much of the classified information could be protected by redesign of facilities and equipment.

[redacted]

It will be possible to protect most classified information during a demonstration in a specially prepared facility if inspector access is limited to visual inspections of weapons and facilities, if some features of weapons are effectively masked, and if some fissionable materials are blended. It is unlikely, however, that all information of use to a foreign government could be protected unless the inspection were quite limited. This was indicated by a post-test analysis of the value of information revealed during the field test, some of which was unclassified and available from superficial visual inspections of weapons.

Minute samples of weapons material can be gathered by inspectors during inspections of facilities. These microsamples can be analyzed for element and isotopic content which may reveal classified information.

2. Inspectors' abilities to discriminate between bona fide and fake nuclear weapons is poor at the low level of intrusion envisioned in the basic concept for the demonstrated destruction of nuclear weapons. Although the ability to detect fake weapons increases with access to weapons being destroyed, inspectors would require complete access to the destruction process to be reasonably certain that real weapons were being destroyed.

Inspectors can be evaded as to the purity or isotopic content of fissionable materials when performing analyses in host-controlled laboratories. Evasion schemes can be devised which cause the U-235 content of a sample to appear to be as much as 5 percent greater than actual. Any greater amount of attempted evasion probably could be detected by skilled analysts.

3. The amount of classified information and other descriptive data collected by inspectors seemed to be limited by the capabilities of the inspectors and not by the inspection methods as such.

[redacted]

4. None of the problems which arose during the field test affected test results significantly. Conclusions concerning these problems, however, may assist in planning further tests or treaty inspections.

In a multi-site operation wherein different scales and weight-recording systems are employed and where a great number of assemblies and components are weighed at different stages of processing, some weight errors are probable. Such errors could be reduced by minimizing and standardizing weighing operations, using accurate scales, and exercising care in calculations and in recording weights. Fissionable material set aside for peaceful uses should be weighed separately to minimize errors and should be weighed on sensitive and accurately calibrated scales.

Inspectors' calls of fake when weapon shapes were in fact bona fide nuclear weapons indicated guesswork on the part of some inspectors.

The procedures and scheduling of inspection activities in a future test or an actual adversary demonstration of destruction would have to conform strictly to security requirements in order to control the exposure of classified information and also to safety requirements for the benefit of both inspectors and facility personnel. Therefore, plans for such activities must take into account these considerations.

Some malfunctioning of electrical and mechanical equipment for inspectors or plant operators is inevitable and can delay or preclude the completion of some operations.

5. Planning for the test was satisfactory and resources were adequate, however, the requirement to operate in four different facility environments caused some inconvenience, confusion, duplication of effort, and added expense. There probably could be some consolidation of operations for a future test in existing AEC facilities or

[redacted]

complete consolidation of operations in a specially prepared single facility. For a future test, all operations could be performed or simulated at Pantex and Oak Ridge except the assay of plutonium. The assay of plutonium is restrictive, and data needed for a field test could be gathered by one study group or inspection team.

It should be pointed out that, even though the field test was conducted in four facilities and under security, safety, and operational restrictions, adequate test data were generated to relate the demonstration to one facility.

H. RECOMMENDATIONS

1. If classified information is to be protected during a demonstration of the destruction of nuclear weapons a special facility should be prepared and the level of intrusion must be low. Universal tooling, handling equipment, and measuring equipment must be provided. The enrichment of uranium derived from weapons probably will have to be altered as well as the phase of the recovered plutonium. Weapon access must be limited to superficial observations without the use of radiation measuring equipment. In addition, inspectors should not be permitted to observe nonnuclear components removed from the weapons unless the components have been processed to conceal all classified information. Facilities to be inspected must be thoroughly cleaned to preclude the gathering of micro-samples which might reveal classified information.

2. If one desires to be reasonably certain that real nuclear weapons are being destroyed, inspectors must be allowed complete access to the entire destruction process. If a lesser degree of conviction of the credibility of a demonstration of the destruction of nuclear weapons would be satisfactory and can be identified, it is recommended that the trade-off of information which would be revealed (in a specially prepared facility) versus conviction be considered from the discussion provided in paragraph 3 of chapter VIII of this report.

[redacted]

Samples of fissionable material to be transferred to peaceful uses must be analyzed in a laboratory over which inspectors have complete control.

3. Methods of demonstrating the destruction of nuclear weapons as envisioned in the basic concept (but in a specially prepared facility and with other measures to protect classified information) are recommended for future field tests or for a treaty inspection.

It is also recommended that inspection methods similar to those tested be used for any future test or inspection (depending on access desired) and that the inspection force be thoroughly trained by practice inspection operations.

4. Several recommendations can be made based on problems which arose during the field test.

Special emphasis should be placed on providing adequate and accurate scales and recording systems for maintaining weight balances.

If a field test such as FT-34 is conducted again, safety and security requirements should be standardized as much as possible, and the inspection operations should be given priority over other operations if it can be arranged.

Standby equipment for inspections and weapons-dismantling operations should be available if tight inspection schedules must be met.

5. Prior to agreement for the inspection by foreign personnel of a demonstration of the destruction of U.S. weapons another thorough field test inspection should be conducted by U.S. personnel in the facilities to be used, using procedures planned for the treaty inspection, and using the specific types of weapons to be destroyed. FT-34 showed that all problems cannot be anticipated.

I. FUTURE STUDIES

Prior to any destruction of weapons under the inspection of foreign personnel, a study should be made of the specific weapons to be destroyed to determine the types and numbers of weapons to be presented in order to conceal the amount and type of nuclear material in each weapon. Also a study should be made on how fissionable materials should be mixed to conceal enrichments or impurities which may reveal classified information.

Table of Contents

[redacted]

Table of Contents (cont'd)

[redacted]

[redacted]

Table of Contents (cont'd)

[redacted]

Contents of Volume II
(Confidential, Restricted Data)

Contents of Volume III
(Secret, Restricted Data)

List of Figures

[redacted]

List of Figures (cont'd)

[redacted]

[redacted]

I. INTRODUCTION

A. BACKGROUND

1. History. A proposal to transfer fissionable material to an International Atomic Energy Agency to be allocated to serve the peaceful pursuits of mankind was made by President Eisenhowever in his "Atoms for Peace" address to the United Nations in December 1953. Reductions of nuclear armaments and control of fissionable material were discussed in world forums many times thereafter. On 16 August 1960, the U.S. Representative to the United Nations, Mr. Lodge, in a speech to the Disarmament Commission stated that the U.S. was ready to set aside 30,000 kilograms of weapons grade U-235 for transfer to peaceful uses if the Soviet Union would reciprocate. The following day Mr. Lodge explained that transfer would result in the dismantling of sizeable numbers of presently existing weapons. The U.S. subsequently proposed at a meeting of the Eighteen Nation Disarmament Committee (ENDC) in March 1962 that the U.S. and the U.S.S.R. each agree to transfer 50,000 kilograms of weapons grade U-235 to nonweapons purposes. The U.S.S.R. continually rejected U.S. proposals for a variety of reasons.

The U.S. formally proposed at the ENDC in April of 1962, in an outline of the basic provisions of a general disarmament treaty, that the U.S. and the U.S.S.R. each transfer to purposes other than use in nuclear weapons an agreed quantity of weapons grade U-235.

The U.S. Delegation at Geneva, in April 1963, suggested to the Soviet Delegation that the U.S. would transfer 60,000 kilograms of weapons grade U-235 to peaceful uses if the Soviets would transfer 40,000 kilograms. In order to counter Soviet arguments that U.S. proposals were "not disarmament," Ambassador Goldberg on 23 September 1965 in his opening address to the United Nations General Assembly, proposed a demonstrated destruction by the U.S. and the U.S.S.R. of a substantial number of nuclear weapons. He repeated that the U.S. would be willing to transfer 60,000 kilograms of weapons grade U-235 to nonweapons uses if the Soviet Union

[redacted]

[redacted]

would transfer 40,000 kilograms. Each nation would destroy nuclear weapons so as to make available for peaceful purposes such amounts of fissionable material. Ambassador Goldberg further stated that the U.S. would add to this transfer associated plutonium obtained from the destroyed weapons, in an agreed quantity or ratio if the U.S.S.R. would do likewise. All fissionable material thus transferred would be placed under the safeguards of the International Atomic Energy Agency or some equivalent agency.

Because of these and associated considerations the U.S. Arms Control and Disarmament Agency and the Department of Defense decided to study problems associated with the demonstrated destruction of nuclear weapons. Accordingly, in 1965 Field Operations (at that time Project CLOUD GAP) was given the task of testing a concept for the demonstrated destruction of nuclear weapons. ACDA also requested the AEC to conduct two studies: one on the extent to which Restricted Data might be revealed during demonstrated destruction and the second on the design of a facility in which the demonstrated destruction would be carried out. The results of these studies were transmitted to ACDA during January and March of 1966 and are reproduced in annex G of this report.

2. Field Test. The Test Concept[1] was published in March of 1966 and the Test Plan[2] was approved by the ACDA and the DOD on 25 August 1966. Detailed planning commenced in November 1966. Visits by planning personnel were made to prospective test sites in November and December 1966, and a pilot test of the draft operations and technical plans was conducted in April 1967. Detailed plans were completed in early June 1967, and test personnel were deployed. Actual test operations took place from 21 June to 20 October 1967.

B. BASIC CONCEPT OF DEMONSTRATION

Any method of demonstrating the destruction of nuclear weapons must attempt to meet conflicting requirements of

---

[1]Test Concept, CG-X34, Demonstrated Destruction of Nuclear Weapons (U), 15 March 1966.

[2]Test Plan, CG-34, Demonstrated Destruction of Nuclear Weapons (U), 22 August 1966.

[redacted]

being convincing, of safeguarding sensitive design information, and of practicability. The following subparagraphs describe a possible approach to demonstrating the destruction of weapons to an adversary for his inspection. Three general stages of the process can be treated more or less separately: (1) weapon introduction, (2) weapon disassembly, and (3) disposition. The inspection and destruction operations would be conducted at a single facility established for the purpose in each of the participating countries. A possible functional arrangement of such a facility is shown in figure 1.

1. Introduction. In the first stage, a number of weapons would be brought together in a fenced or enclosed compound for cursory inspection by adversary inspectors. At this point, the weapons would be within the ballistic cases in which they are normally delivered to the target.[1] That is, warheads would be enclosed within bomb cases or in the nose sections or re-entry vehicles, and adaption kits would be in place. Delivery vehicles would not be included.

The inspection might be limited to visual observation, counting, and perhaps weighing weapons. No internal access would be permitted to any covered portion. It would not be permissible to allow inspectors to employ radiation measuring instruments to determine the gross gamma ray activity at the surface of the weapons under inspection. Access to external configuration may present problems. While many of the external configurations and weights of nuclear weapons are unclassified, some are not.

Safety considerations may well determine the maximum number of bombs and warheads that can be brought together in the area at any one time.

Before any of these weapons were moved into the disassembly facility, the adversary inspectors would be permitted to make a complete walkthrough tour and inspection of the

---

[1]Gaseous tritium in bottles would be removed from the weapons before delivery to the compound.

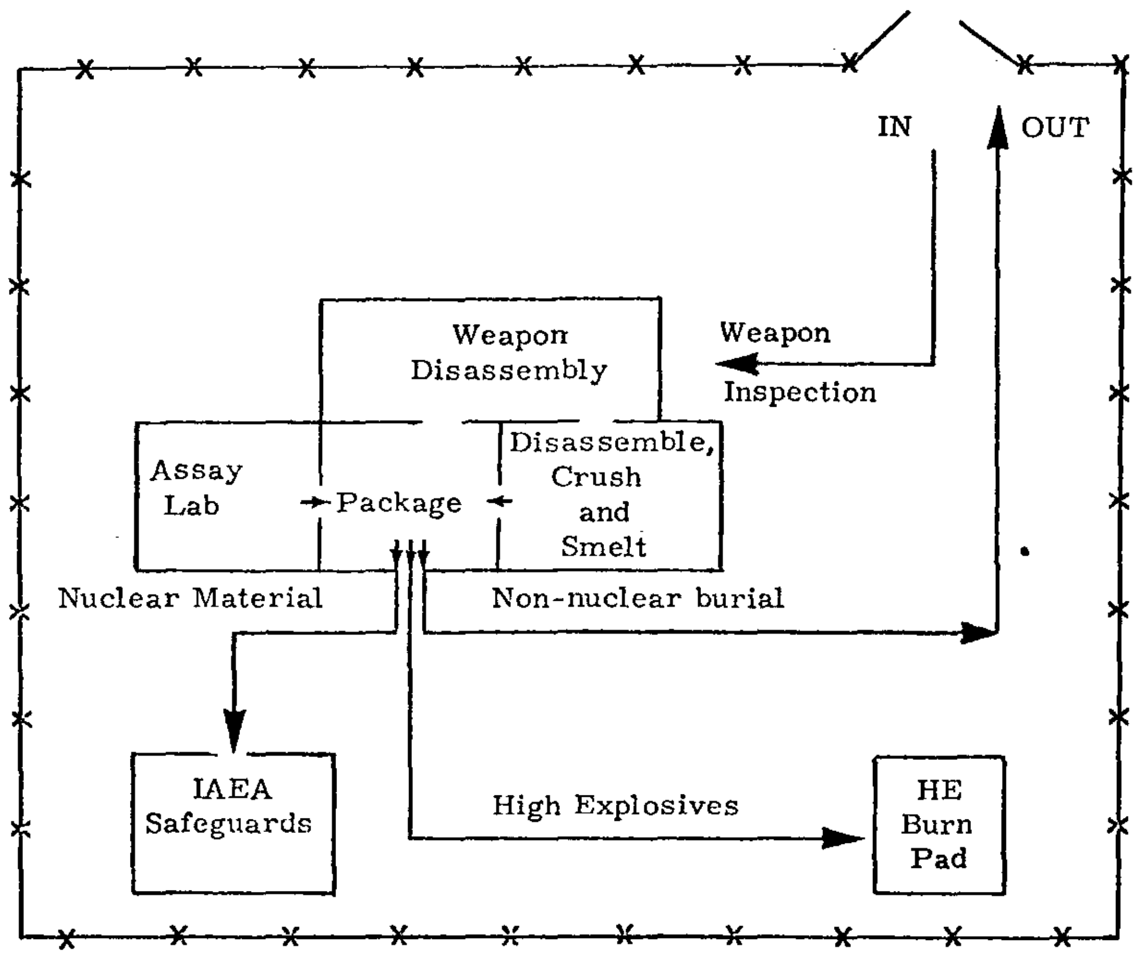


FIGURE 1. Single Destruction Facility.

[redacted]

facility, being permitted visual access to all compartments and areas. The intent of such a tour would be to provide an opportunity to observe that nuclear weapon components and materials were not present in the facility prior to the introduction of the weapons to be destroyed and for providing a basis for inspection after disassembly to show that no materials were left behind.

2. Weapon Disassembly. The facility for weapon disassembly would be enclosed by a security fence, and adversary inspectors would be required to remain outside the fence during the entire process from introduction of the weapons to removal of the fissionable material and rubble remaining from other components. Entry into the area could be permitted after a complete batch of weapons had been processed. Inspectors would probably be allowed to inspect the non-weapon materials (other than documents) moving in and out of the facility in order to observe that nuclear materials and explosives were not introduced extraneously, and that salvage of nuclear and other weapon materials was not occurring. They would also be able to observe the activities as best they could from outside the fence.

The facility itself would require a building or buildings equipped for removal and handling of high explosives. Also, a building equipped to handle plutonium components in a radiologically safe manner would be required. It should include equipment capable of reducing the plutonium to "buttons" or ingots. This same or another building would be required for handling considerably larger amounts of uranium than the plutonium, however, the handling of uranium does not require "hot-box" facilities as plutonium does.

3. Disposition. The disposition of the materials that result from the disassembly of weapons would present a number of potential difficulties because this stage offers prime opportunities to provide assurance that weapons are indeed destroyed but at the same time subtle possibilities for the disclosure of sensitive information.

[redacted]

a. For the purposes of demonstrating destruction of weapons the disposition stage requires the following facilities as a part of or convenient to the main facility for disassembly:

(1) An explosives pad for burning or perhaps detonating high explosives.

(2) Facilities capable of reducing all components other than fissionable material and high explosives to a form for disposal.

(3) An assay laboratory containing facilities capable of performing mass spectrometry and chemical assays of the plutonium and uranium yielded by the destruction process. This building should be accessible to the inspectors, but need not be physically close to the main facility.

b. From time to time during the destruction of the weapons, fissionable material would be delivered to the assay laboratory and rubble would be removed for disposition. Inspectors at the assay laboratory would determine the amounts of fissionable material presented and these amounts would subsequently be placed under International Atomic Energy Agency or similar international safeguards.

c. If the rubble can indeed be reduced to unclassified form, its disposition should not present significant problems. In any event, it would appear that a deep ocean burial of the rubble, perhaps sealed in drums, could circumvent the difficulties. An adversary inspector could be permitted to accompany a shipment of rubble to verify its disposition if that were necessary.

d. It is in the disposition stage that the actual amounts of U-235 and plutonium in the batch of weapons become known. Whether or not these numbers constitute a compromise of classified information must be considered in connection with batch selection. Other questions regarding the delivery of fissionable material from the destruction process have to do with the makeup of the materials themselves.

[redacted]

The presence of stabilizing impurities in plutonium is unclassified but the phase used in weapons is classified. However, the isotopic composition of both U-235 and plutonium as delivered should be carefully considered with regard to disclosure of sensitive information. In this connection, the uranium might be delivered at enrichments lower than the ___ used in weapons to provide a method of turning in material of intermediate enrichment. By blending different enrichments, it should be possible to meet a nominal enrichment without disclosing the actual enrichments used.

C. TEST OBJECTIVES

The field test developed to test and evaluate inspection procedures based on the concept described above was designated as Field Test FT-34, "Demonstrated Destruction of Nuclear Weapons." Of primary concern was a determination of the amount of classified information which might be revealed if the U.S.S.R. were to monitor a U.S. demonstration of the destruction of nuclear weapons. It appeared that to convince inspectors that bona fide nuclear weapons were being destroyed some classified information would be revealed. The objectives of the test were established to evaluate this problem and to investigate practical problems of the demonstration. The specific objectives were:

1. To determine the extent to which the proposed method of demonstrating destruction reveals classified weapon information.

2. To evaluate the effectiveness of the tested procedures in terms of convincing the Test Inspection Force that nuclear weapons are being destroyed.

3. To evaluate the practicability and effectiveness of the proposed methods and to suggest and implement possible improvements during the test, as necessary.

4. To identify operational, technical, classification, safety, and security problems which arise.

[redacted]

D. TEST CONDITIONS

For realism, the field test was conducted at U.S. Atomic Energy Commission facilities routinely retiring older nuclear weapons, and real nuclear weapons were used. No single facility exists in the United States where all operations associated with weapons retirement or destruction are performed. Therefore, it was necessary to utilize four different AEC plants which, together, perform all these operations. The AEC plants used and the functions performed at each during the test were:

2. Rocky Flats Plant, Golden, Colorado for the recovery and assay of plutonium.

3. Paducah Plant, Paducah, Kentucky for the disposition of nonnuclear components.

4. Y-12 Plant, Oak Ridge, Tennessee for the recovery and assay of uranium.

E. ORGANIZATION

1. Test Headquarters. Test Headquarters was located at the Paducah Plant, Paducah, Kentucky. The test was conducted under the direction of a Test Director, a Technical Director, and an Assistant Technical Director who were members of the staff of the Field Operations. Several additional personnel in the headquarters were provided by the DOD on a temporary duty basis. These personnel provided direction and control of the operations, data processing, logistic control and support, and administrative control and support. The details of test organization and of other aspects of test administration are contained in annex A, volume II of this report.

2. Field Organization. Supervision of test activities at each of the four test sites was the responsibility of a Test Site Commander. Site commanders and their test

[redacted]

control, support, and administrative personnel were provided by the DOD on temporary duty. The site commanders directed test control operations and coordinated test operations with plant personnel. Test control operations included scheduling and directing inspection activities, escorting inspectors, collecting and processing true information about inspection targets and facilities against which inspectors' data were compared, and coordinating evasion activities. Plant personnel implemented all evasion. Test control activities are described in detail in annex A of volume II.

3. Inspectors. Inspector personnel also were provided by the DOD on temporary duty. All were military officers on active duty (except one retired Air Force officer) and all had some experience in nuclear weapons or chemistry or both. Details of qualifications of inspectors are given in annex B of volume III.

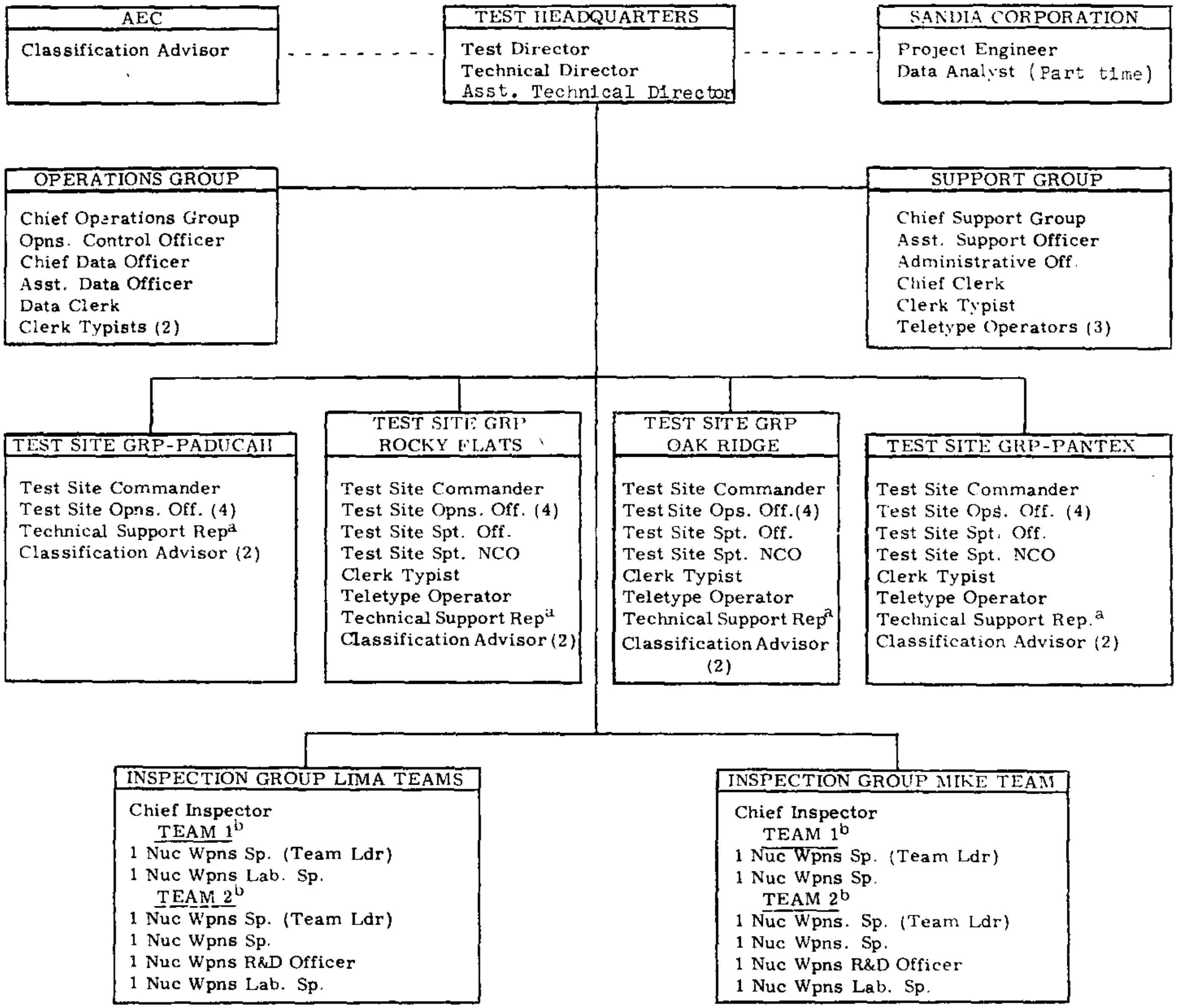
4. Contractors Support. A reimbursable working arrangement was made with the U.S. Atomic Energy Commission for support by their contractors. Primary support was provided by the Sandia Corporation in planning the test, in giving technical assistance during field operations, in analyzing the results of the test, and in preparing the report of the operation. Contractors operating the AEC plants where inspection operations took place provided operational, technical, and some logistic support.

The U.S. Army Test and Evaluation Command produced a documentary film of the field test. This was also provided for by a reimbursable agreement.

5. U.S. Atomic Energy Commission. In addition to support provided by a reimbursable agreement, the AEC also assisted in determining the amount of classified information actually revealed during inspection operations. For this purpose AEC classification specialists were present during all inspections, and a classification specialist supervisor was located at Test Headquarters.

6. Organization. An organization chart for the field test is shown in figure 2.

[redacted]



[a]Report to the Project Engineer

[b]Two such teams required.

FIGURE 2. Field Test Organization

7. Manpower. The manpower required throughout the test totaled 43 man-years. This is shown by test phase and by by personnel source in figure 3.

AGENCY	FUNCTION			TOTAL
	PLANNING	FIELD OPERATIONS	ANALYSIS & REPORTS	
ACDA[a] Field Ops Div.	2	1	2	5
DOD (TDY)	5	18		23
Sandia Corporation	4	2	3	9
AEC Plants		4		4
AEC Classification		2		2
TOTAL	11	27	5	43

[a] Project CLOUD GAP prior to 13 September 1967

FIGURE 3. Man-Years of Effort Expended for FT-34

[redacted]

II. TEST CONDUCT

A. GENERAL

1. Test Exercises. The field operations were conducted as three basic exercises. The first was conducted in sequence at all test sites and included all phases of the overall destruction demonstration. The second was conducted by selected military inspectors at the Oak Ridge site and concerned only the analysis and assay of samples of uranium. The final exercise was similar to the second but was conducted by a team of scientists from the Oak Ridge plant contractor.

2. Evasion. Evasion was included in all test exercises. The U.S. proposal concerning the demonstrated destruction of nuclear weapons provides for a specific amount of fissionable material to be set aside for peaceful uses and for obtaining this material from nuclear weapons. Two possible approaches to evasion, then, would be to set aside less active material for peaceful uses than advertised or to obtain the material from sources other than nuclear weapons. Evasion attempts tested were based on these two general considerations. No intentional harassment was tested during FT-34.

3. Inspection Techniques. Several inspection methods were tested for monitoring facilities, weapons, and weapons components during the overall destruction exercise. During all inspection operations inspectors recorded observations on prepared data forms. When monitoring facilities some inspectors also made sketches, took photographs, and searched for fissile material with Geiger counters. Weapons were measured, weighed, sketched, and photographed. Radiation detection equipment and X-ray were also used by some inspectors. Nonnuclear components and residue were weighed, sketched, and photographed.

During the analysis and assay inspections for all exercises, normal laboratory facilities, materials, and equipment were used. Analyses were conducted just as analyses are normally conducted in AEC facilities on production fissionable

[redacted]

material. Operations included mass spectrometry, chemical analysis, and emission spectrography.

B. FACILITY CONDITIONS

One of the fundamental restrictions on the field test was that inspection operations must not interfere with normal production operations taking place at each test site facility. In addition, test personnel and the processing of test material were governed by normal security and safety restrictions at each facility.

Special areas were designated at each plant for FT-34 activities. All weapons production areas and operations not associated with the field test were shielded from inspectors' views. This required the erection of barriers and curtains in some cases. In addition, specific routes to and from inspection areas were defined. In general, "destruction" of weapons was accomplished by normal weapons retirement processing.

C. TRAINING

Inspectors received 10 days training prior to inspection operations. This training included familiarization with the purpose and objectives of the test, refresher orientation on U.S. nuclear weapons design and hardware, identification of classified aspects of nuclear weapons, test procedures, operation of test equipment, analysis of fissionable materials, data forms, safety practices, security requirements, and administrative matters. In addition, training was given at each inspection site on procedures and equipment used at that site.

Test control personnel were given similar training with emphasis on test control procedures. Test controllers were also made aware of evasion to be tested.

Administrative and support personnel were briefed on the test background, public relations, security, and administrative and support requirements. In addition, on-the-job training was given at each test site prior to the start of operations.

D. OVERALL DESTRUCTION EXERCISE

1. General. The test of the overall destruction operations was designed to simulate as closely as possible the inspection of all phases of the demonstrated destruction of nuclear weapons under the inspection concept previously described. The test, however, varied inspection parameters to embrace a greater range of inspection procedures in order to assess the relative importance of possible alternatives. Weapons were dismantled in batches, and inspectors followed the processing of the resulting batches of materials and components from one site to the next until all processing had been completed. Actual inspection operations for this overall exercise lasted 13 weeks.

2. Weapons. Four identical batches of weapon shapes were processed during the field test and subjected to inspection. Some were bona fide nuclear weapons, and, to test evasion, others were fake. Five types of bona fide nuclear weapons were selected from among those scheduled for normal retirement. These included bombs and warheads and represented a broad spectrum of weapons technology. The real nuclear weapons types were:

Mk 25 Warhead, AIR-2A configuration
Mk 28 Y2, Mod 1 EX Bomb
Mk 30 Y1, Mod 2 Warhead, configuration
Mk 39 Y1, Mod 2 Bomb
Mk 56, Mod 1 Warhead, configuration

3. Material Flow. The flow of the material for the overall destruction exercise through the four AEC facilities used for the field test is shown in figure 4. The figure shows schematically the relationship of the functions of the test facilities

plutonium were sent to Rocky Flats where the plutonium was recovered and assayed. Nuclear assemblies containing uranium but no plutonium were sent from Pantex to Oak Ridge as was uranium from the assemblies processed at Rocky Flats. At

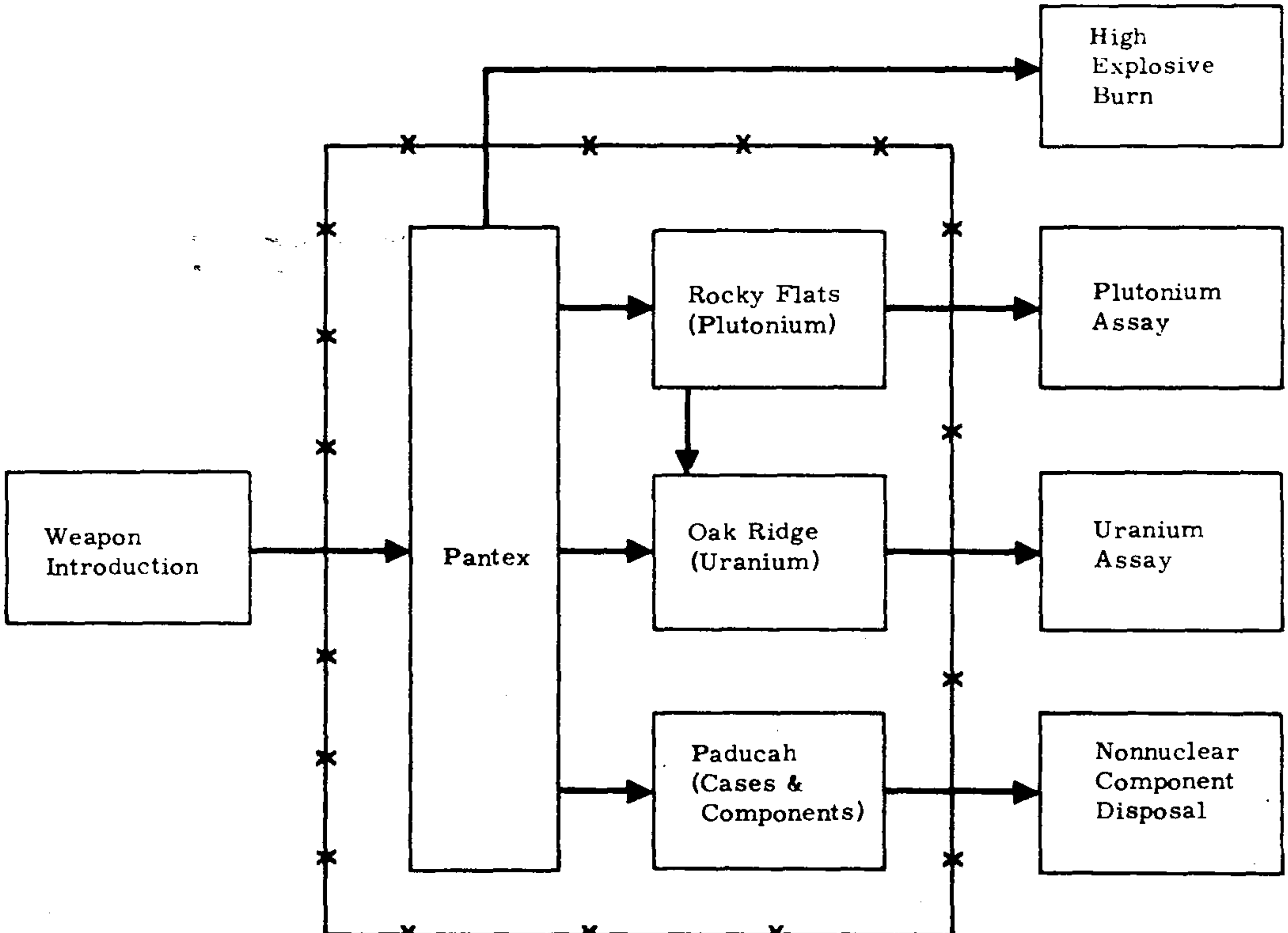


FIGURE 4. Material Flow For FT-34

Oak Ridge the uranium was recovered and assayed. The weapon cases and other nonnuclear components were sent to Paducah for disposal where some metal components were smelted, some classified components were buried, and other material was held by the plant for future disposition. Some minor nonnuclear components were also disposed of at Rocky Flats and Oak Ridge.

4. Test Phases. The inspection operations for the overall test were divided into five phases, some of which overlapped in time or location. Throughout each of these phases, inspection teams made extensive records of everything they observed including dimensions and features of tooling, weapon shapes, and destruction products. With these observations, inspectors attempted to detect classified information revealed and to determine the credibility of the demonstration.

a. The first phase consisted of walkthrough tours of each of the four facilities by the inspectors who looked for indications that the facility was equipped to process bona fide weapons, searched for indications that nuclear material had been prepositioned, and recorded any classified information that was revealed. These walkthroughs were conducted before and after the processing of each batch of weapons or material.

b. The second phase was the inspection of the weapon shapes presented for destruction. Any classified information that was revealed by this examination was recorded, and inspectors attempted to determine the credibility of the weapon shapes or material. This phase was conducted primarily at the Pantex facility, however, the credibility of the components inspected at Paducah was also considered.

c. The third phase was the burning, under the observation of inspectors, of the high explosive and other burnable components resulting from weapon disassembly. This phase was also conducted at the Pantex facility.

d. The fourth phase was the destruction of the remaining nonnuclear components by smelting and/or burial under the observation of the inspectors or by packaging and simulated disposal. This phase was conducted primarily at the Paducah facility; however, nonnuclear components associated with the nuclear assemblies were disposed of at Rocky Flats and Oak Ridge.

e. The fifth phase was the assay of the recovered fissile material and was conducted at Oak Ridge for uranium and at Rocky Flats for plutonium. At both locations the process was similar although utilizing different equipment and techniques. The purity of the samples (uranium or plutonium) was determined by chemical titration, impurities were analyzed by emission spectroscopy, and the isotopic content of the fissile material was determined by mass spectrometry.

f. Throughout these phases, except the first, inspectors maintained records of the weights of materials being processed. The incoming weight was determined at Pantex by weighing the weapons presented for destruction. At each of the four facilities the outgoing weights of burnables, nonnuclear material, and fissile material were determined. The total outgoing weight was compared against the incoming weight to determine the net weight balance for the process. Due to time limitations and safety considerations, inspectors did not perform the actual weighing but spot checked the weights as determined by plant personnel.

5. <u>Test Variables.</u> The overall destruction exercise investigated the effects of several controlled variables on the inspection process. The variables were the degree of access which inspection teams were permitted to the weapon shapes and destruction facilities, inspection team size, and the nature of evasions practiced against the inspection teams.

a. <u>Access.</u> The degree of inspector access to the weapon shapes and disassembly facilities during the overall exercise was tested at either two or four levels depending on the operations being performed. As a general rule, each higher level of access to an operation contained all the elements of the preceding lower level.

(1) During the walkthrough phase the low access inspection teams were allowed only to observe the facilities, fixtures, and tooling and to make notes and sketches. High access teams were additionally allowed to take measurements, photographs, and Geiger counter readings to check for pre-positioned fissile material and to detect particles of nuclear material resulting from destruction processing which might, when assayed, reveal classified information.

(2) During the weapon shape inspection phase, four levels of access were tested. At the first level (A1) the inspection teams examined the weapon shape exteriors and determined weights, locations of some external features, centers of gravity, and dimensions. Heavy tape covered the identification markings and access doors. At the second level (A2) the teams were additionally allowed to look in opened access doors on the weapon shapes and to use Geiger counters at the surfaces of the shapes in order to determine the locations of any radioactive material. At the third level (A3) the inspection teams were additionally allowed to take photographs, use neutron counters to detect indications of the presence of plutonium, and use gamma spectrometers to determine the types of the radioactive material located previously by the Geiger counters. At the fourth access level (A4) the teams were additionally allowed to examine X-ray plates of the weapons.

(3) During the burn phase, low access inspection teams observed the weighing of closed boxes containing the high explosives and other burnables and observed the burning from a safe distance. The high access teams were additionally allowed to look into and photograph the opened boxes containing the burnables. Both access levels allowed the teams to examine the residue after the burning.

(4) Four access levels were tested during the disposition of the nonnuclear components. At the first level (A1) the inspection teams observed metal ingots from the smelter, closed boxes containing various components, and several weapon cases (with ends sealed) which could not be smelted and which were too large for packaging. They checked the weights of some material for disposal and recorded all weights. They also observed the burial of some packaged

classified components. At the second level (A2) the teams were additionally allowed to look into the opened packing boxes and weapon cases, with ends unsealed, from a distance of about 10 feet. At the third level (A3) the teams were additionally allowed to examine, but not touch, the contents of the packing cases displayed on the floor. At the fourth level (A4) the teams were additionally allowed to handle, measure, and photograph these components. No further disassembly was permitted.

(5) During the fissile material assay phase, low access inspection teams observed laboratory technicians performing the assay and could ask no questions. High access level teams performed all operations except those not permitted by safety regulations.

b. Team Size. For the overall exercise 26 inspectors were divided into two groups, designated as LIMA and MIKE. Within each of these 13-man groups a Chief Inspector was appointed and two, two-man and two, four-man, inspection teams were formed. In each of the five phases previously described, and at each access level, two-man and four-man teams were tested.

c. Evasion. Evasions were practiced on the inspection teams during the weapon shape inspection and the fissionable material assay phases.

(1) Weapon Shape Introduction.

Since each of these take weapons contained fissionable material, fissionable material which did not come from bona fide nuclear weapons was introduced into the destruction process and included in the total amount of recovered material. By virtue of their design, three of the four fake weapon types were expected to be detected by inspection at successively higher levels of access. The fourth was expected to be undetected. Schematics of the designs of the fake weapons are shown in annex D. The four types were:

Mk 57 BDU: expected to be detected at access level A2.

[redacted]

Eight-inch Artillery Shell: expected to be detected at access level A3.

Mk 28-S (spoof): expected to be detected at access level A4.

Hawk Training Warhead: expected to pass all access levels.

Some aspects of this evasion carried over into the burning of explosives at Pantex where fake explosive material from the Hawk was burned, and into the disposal of non-nuclear components at Paducah where the cases and/or components were displayed.

(2) <u>Uranium Assay.</u> Evasion was practiced on all the teams during the uranium assay at Oak Ridge. This was done by adjusting the mass spectrometer remotely so as to indicate a higher than actual proportion of U-235 by 2 percent on one-half of the samples taken from the uranium derived from each batch of weapon shapes.[1] Thus inspectors would be led to believe that more U-235 had been produced for transfer than actually had been produced.

(3) <u>Plutonium Assay.</u> During the assay of plutonium at Rocky Flats, evasions were practiced against all inspection teams while assaying one-half of the plutonium samples from each batch of weapon shapes. Since the purity of the plutonium was very high, evasions could only be arranged which indicated a lower than true purity. The evasion techniques practiced utilized prepared laboratory analysis equipment and concealed material substitutions by the technicians who were performing the analysis. Low plutonium purity values were obtained in the chemical analysis by substituting, while the inspectors watched, a ferroin indicator of different strength than advertised. An electrode containing a different carrier was substituted during the emission spectroscopy so that this analysis of the amounts of impurities would agree with the low purity determined in the titration. The apparent ratio of plutonium isotopes was altered by substituting a pre-plated filament in the mass spectrometer.

[redacted]

6. Schedule of Operations. In order to gather an adequate quantity of test data for analysis LIMA and MIKE inspections were the same.

., then .nt to Rocky Flats for the plutonium assay, tnen travelled to Paducah to monitor the disposition of nonnuclear material, and, finally, went to Oak Ridge for the uranium assay. The LIMA group commenced operations at Pantex on 3 July 1967, and the MIKE group commenced 4 weeks later. Figure 5 shows the schedule of inspection operations. When the inspectors completed their operations at Oak Ridge for the overall exercise, some returned to Paducah for debriefing, and others remained at Oak Ridge for the special assay exercise.

E. SPECIAL ASSAY

1. General. The principal theme of the U.S. proposals concerning the demonstration of the destruction of nuclear weapons is to transfer weapons grade U-235 from use in weapons to peaceful uses. The nature of the peaceful application of the material would be the concern of the owning country, but an international control agency would insure that the material would not be used in the manufacture of weapons. The inspecting country must be assured that the material to be transferred to peaceful uses is actually in the amounts and purities advertised. For this reason, special emphasis was placed on the analysis and assay of uranium during the field test. A special assay exercise by the military inspectors was conducted to investigate the assay of uranium in the hosts' laboratory. The facilities, equipment, and analysis materials were under the control of the host; the samples of uranium to be analyzed, however, were under the custody and control of the inspectors. An additional purpose of the special assay exercise was to test the effects of team composition.

2. Inspection Force and Operations. From the 13 original inspectors within each of the LIMA and MIKE groups,

LOCATION	Week of 19 Jun	Week of 26 Jun	Week of 3 Jul	Week of 10 Jul	Week of 17 Jul	Week of 24 Jul	Week of 31 Jul	Week of 7 Aug	Week of 14 Aug
Pantex			LIMA Teams	LIMA Teams	LIMA Teams		MIKE Teams	MIKE Teams	MIKE Teams
Rocky Flats						LIMA Teams	LIMA Teams		
Paducah	LIMA Teams R O&T	LIMA Teams O&T			MIKE Teams R O&T	MIKE Teams O&T		LIMA Teams	LIMA Teams
Oak Ridge									

LOCATION	Week of 21 Aug	Week of 28 Aug	Week of 4 Sep	Week of 11 Sep	Week of 18 Sep	Week of 25 Sep	Week of 2 Oct	Week of 9 Oct	Week of 16 Oct
Pantex									
Rocky Flats	MIKE Teams	MIKE Teams							
Paducah			MIKE Teams LIMA Inspectors DB	MIKE Teams LIMA Inspectors DB			MIKE Inspectors DB	MIKE Inspectors DB	
Oak Ridge	LIMA Teams	LIMA Teams	LIMA Special Assay[a]		MIKE Teams	MIKE Teams	MIKE Special Assay[a]		Contr. Special Assay[a]

R = Teams Report for Duty.
O&T = Orientation and Training.
DB = Debriefing and Report Writing.
a = Part of Special Assay Exercises.

FIGURE 5. Schedule of FT-34 Field Operations 1967

eight were assigned to two-man teams, each group having four teams. Two teams of each group were made up of inspectors with little or no skill in chemical analysis, and the remaining two teams were made up of inspectors relatively skilled in chemical analysis. Two of these teams from each group, one unskilled and the other skilled, were allowed high access - that is, they performed all operations, and the other two teams were limited to low access, observing operations being performed by laboratory technicians. Each group devoted 1 week to the special assay exercise. The schedule of their operations is shown in figure 5.

3. Evasion. To test evasion during the special assay exercise special samples of uranium were prepared. The same set of evasion techniques was designed to make the samples appear to have more uranium than actual by about 2 percent, and to increase the apparent ratio of U-235 to other uranium isotopes. The chemical tests for purity were evaded by adding impurities to the samples (which, in a treaty inspection, would have been taken from an ingot of material to which impurities had been added) and altering the balance used for weighing the samples. The added impurities were disguised in the emission spectroscopy by covering their presence with the carrier or by altering the programmed output of the quantometer (a direct-reading spectroscope). The isotopic ratio, as determined by the mass spectrometer, was biased by heating (by remote activation) a different filament (coated with a sample of different composition) than that installed by the inspectors or by changing the potentiometer output on the readout chart.

F. CONTRACTORS ASSAY

Although highly qualified personnel were requested from the DOD to act as inspectors, it was recognized that obtaining professional scientists highly skilled in the specific analysis operations for uranium was unlikely. To test evasion against the best qualified personnel available a team of professional scientists was formed to perform the same tests as performed by the special assay military inspectors.

This team was composed of three employees of the Nuclear Division of Union Carbide, the contractor operating the Oak Ridge plant. One was a specialist in mass spectrometry; one was a specialist in chemical analysis; and the third was a specialist in emission spectroscopy.

The contractor's assay team used the same samples as used by the military inspectors, performed the same analysis operations, and were subjected to the same evasion. Their exercise was performed during the final week of the field operations, the week of 16 October 1967.

[redacted]

III. TEST ENVIRONMENT

A. GENERAL

1. The test sites were selected from the AEC weapon-production complex as most representative of the facilities and requirements that would be utilized in a single facility for the destruction of nuclear weapons. This chapter includes a summary of the description of the facilities and the site environment in which inspections were conducted. A detailed description of the facilities is given in annex C.

2. This chapter also summarizes descriptions of bona fide nuclear weapons and fake weapons processed during the field test. More complete descriptions are given in annex D.

3. Equipment used by inspectors included linear scales, radiation monitoring equipment, cameras, and laboratory analysis equipment. Full descriptions of this equipment are given in the FT-34 Technical Plan.[1] This chapter includes a listing of equipment and a brief description of the use of some items.

B. TEST FACILITIES

All operational facilities used for Field Test FT-34 are owned by the U.S. Atomic Energy Commission and operated for them by private companies under contract. All facilities are currently engaged in the production of nuclear weapons or nuclear weapons components or in processing nuclear weapons material. The facilities also perform normal nuclear weapons retirement and upgrading processing.

1. Pantex Ordnance Plant

a. The Pantex Ordnance plant, located near Amarillo, Texas, is operated by the Mason and Hanger-Silas Mason

---

[1] Technical Plan, Field Test CG-34, Annex E, 8 June 1967.

[redacted]

, the following major operations were performed or supported:

(1) Preparation of bona fide and fake weapons.

(2) Walkthrough of the facilities.

(3) Initial weapon monitoring.

(4) Disassembly of weapons (not witnessed by inspectors).

(5) Disposal (burning) of explosives and other burnable material.

(6) Shipment of nuclear and nonnuclear residue to other AEC plants for further processing and disposal.

b. Office space for administrative and test control functions was provided in one of the plant's buildings near the area in which inspection operations were performed. These offices were off-limits for inspectors. Two 10- by 55-foot mobile homes were provided nearby for inspectors' use when not actually performing inspection operations. A two-man and a four-man team were assigned to each mobile home.

c. For walkthrough and weapon monitoring operations, two disassembly buildings and the interconnecting hallway were set aside for FT-34 operations. Partitions were constructed to isolate the FT-34 area from other operational areas and activities of the plant. All tools required for disassembling weapons and scales for weighing weapons and burnable components were located within the area designated for inspection operations.

d. Explosives and other combustible material removed from weapons destroyed during the test were burned in the normal plant burning ground which is located approximately 4 miles from the building used for other inspection activities.

2. Rocky Flats Plant

a. The Rocky Flats Plant is located near Denver, Colorado and is operated by the Dow Chemical Company. The primary function of the plant is the fabrication of plutonium pits for nuclear weapons. Plutonium used is supplied by other AEC facilities or is derived from retired weapons. The Rocky Flats plant performed or supported the following operations for the field test.

(1) Receipt of material from the Pantex Plant.

(2) Walkthrough of the facilities.

(3) Disassembly of weapons pits and separation into plutonium, uranium, and other residue (not witnessed by inspectors).

(4) Melting and casting of plutonium parts into ingots (not witnessed by inspectors).

(5) Sampling and assaying of cast plutonium ingots.

(7) Disposal of other pit residue.

b. No office space was available at the Rocky Flats Plant for FT-34 administrative functions. Two 10- by 55-foot commercial office trailers were provided for test-site administrative and control personnel. These were located within the plant boundary but a considerable distance from operational areas. Adjacent to these trailers were located two 10- by 45-foot commercial trailers for use by inspector personnel when preparing for inspections or when completing data forms and reports. Bus transportation was provided between the trailers and the inspection areas.

c. Inspection operations were performed in a special receiving and disassembly area set aside for FT-34 operations, a portion of the plutonium foundry, and the laboratory. Curtains were draped within the shop and foundry buildings to screen non-field test areas and operations from inspectors' views. Analysis operations in the laboratory are normally unclassified, so no screening was necessary for FT-34 plutonium analyses. Inspectors were confined to specifically designated areas, however.

d. Inspectors' activities at Rocky Flats were severly restricted because of elaborate safety precautions necessary when handling plutonium. Plutonium is an alpha-emitting element, and an allowable accumulated body burden has been set at 0.6 microgram. A particle of plutonium the size of a single, ordinary dust particle weighs about that much. Also the maximum allowable concentration of plutonium in the atmosphere in which personnel may work is 0.00003 microgram per cubic meter of air. Accordingly, plutonium is handled at Rocky Flats in covered work areas or "glove boxes." Because of the safety hazard FT-34 inspectors were not allowed to perform any analysis operations wherein plutonium or its compounds were handled. Inspectors did, however, carry plutonium samples from the foundry to the laboratory, and high access inspectors could perform operations associated with the assay wherein plutonium was not handled.

3. <u>Paducah Plant</u>

a. The Paducah Plant, located near Paducah, Kentucky, is operated for the AEC by the Nuclear Division of the Union Carbide Company. The basic mission of the Paducah Plant is the production of enriched uranium by gaseous diffusion processes, reclamation of commercially valuable salvage material from weapon retirement programs, disposal of contaminated or classified salvage, and storage until final disposition of classified weapon components. The following major operations were performed or supported by the Paducah Plant for FT-34:

(1) Receipt of nonexplosive and nonnuclear material from Pantex.

(2) Walkthrough of the facilities.

(3) Separation of materials into salvageable categories.

(4) Reclamation of aluminum and lead (smelting not witnessed by inspectors).

(5) Disposal of classified and/or contaminated residue.

b. Office space for administrative, control, and inspector personnel was provided in the plant headquarters building at Paducah. Also provided within the same building was a large auditorium for training test personnel. Primarily because of the excellent training facilities and spacious office areas the headquarters for the field test was established at Paducah.

c. Inspection operations were conducted in a warehouse and foundry building which was located on the opposite side of the Paducah facility from the headquarters. The grounds for burying classified or contaminated components were adjacent to the foundry and warehouse building. No modifications were made to the foundry for inspection operations, but a separate area within the warehouse was established. The warehouse contained many bomb components not associated with FT-34, so the inspection area was separated from the remainder of the warehouse by ceiling-to-floor opaque plastic sheeting. Inspectors travelled to the inspection area outside the facility boundary by bus or assigned automobiles.

4. <u>Y-12 Plant</u>

a. The Y-12 Plant is part of the AEC complex at Oak Ridge, Tennessee. It is operated by the Nuclear Division of the Union Carbide Company. [illegible] parts from retired weapons, and the assay of material for product control. The plant performed or supported the following operations for the field test:

(1) Receipt of material from Pantex and Rocky Flats.

(2) Walkthrough of the facilities.

(3) Disassembly of material received into compounds of enriched uranium, depleted uranium, lithium compounds, and residue parts (not witnessed by inspectors).

(4) Decontamination of nonfissile material.

(5) Melting and casting of uranium parts into ingots (not witnessed by inspectors).

(6) Sampling and assay of uranium ingots.

(7) Disposal of residue other than enriched uranium.

(8) Test of special assay conducted on sample material from sources other than FT-34 weapon-derived material.

(9) An additional assay exercise conducted by Union Carbide employees.

b. Ample office space was provided in a building within the Y-12 facility for use by test site and inspector personnel. This was not within normal walking distance to the inspection areas, but at Y-12, unlike other sites, field test personnel were permitted to drive assigned automobiles on the site. Also, personnel were permitted to use the normal internal bus transportation for travel to the operation buildings.

c. Inspection operations were performed in the normal disassembly shop, the enriched uranium foundry, and the laboratory. Opaque plastic sheeting and canvas were used in the disassembly area and foundry to shield non-field test equipment, components, and operations from inspectors' views. No such shielding was required in the laboratory.

C. WEAPON SHAPES

Bona fide nuclear weapons and fake weapons destroyed during the field test included both bombs and warheads and represented a broad range of nuclear design and hardware technology. The following subparagraphs describe the weapons briefly.

1. Bona Fide Weapons

a. The Mk 25 Warhead is used in the U.S. as shown in figure 6. The warhead is a It weighs approximately pounds and contains The missile warhead body is It weighs approximately pounds.

b. The Mk 28 Mod 1 EX Bomb is a freefall bomb carried externally on tactical aircraft. It is shown in figure 7. The warhead is a device which contains both plutonium and uranium. The bomb is inches in diameter and inches long. It weighs approximately

c. The Mk 30 Mod 1 Warhead is used in the U.S. as shown in figure 8. The warhead is a sealed, single-stage, pressurized, nuclear device inches in diameter and inches long. It weighs approximately pounds and contains The missile warhead body is in diameter and It weighs approximately

d. The Mk 39 Mod 2 Bomb is a freefall or parachute-retarded bomb delivered by strategic aircraft. The warhead is a ntaining The bomb, which is shown in figure 9, is 140 inches long and weighs approximately

(The parachute was removed from the units destroyed during the field test leaving a weight of about 6 660 pounds.) The diameter of the main body is

The Mk 39 was the largest weapon used in the field test.

e. The Mk 56 Mod 1 Warhead used in the

2. Fake Weapons

a. The , figure 11, is a ballistic drop unit used as a practice bomb. It has the appearance and ballistic characteristics of the Mk 57 Bomb, a weapon delivered by tactical aircraft, but is merely an empty shape which can be dropped and recovered for reuse. For the FT-34 test, each unit was modified by the addition of a ½-kilogram plutonium ball, suspended in foam plastic, in the nose section and a lead ballast in the rear case section. Some external modifications were made to simulate the appearance of real weapons. The modified units were 14.75 inches in diameter, 118 inches long, and weighed approximately 500 pounds.

was intended to be exposed as a fake at access level A2 by the invalid location of radioactive material (Geiger counter survey) and because of the bare interior exposed through an opened access door.

b. Figure 12 shows the mockup fabricated for the test to resemble the 8-inch artillery shell. For this mockup, conventional inert 8-inch artillery shells were obtained and modified. Additional length was added to the rear of the shell to provide an overall length equal to that of the bona fide weapon, and other superficial modifications were made. To simulate a [redacted] a 1-inch bar was inserted in the shell. At two credible locations

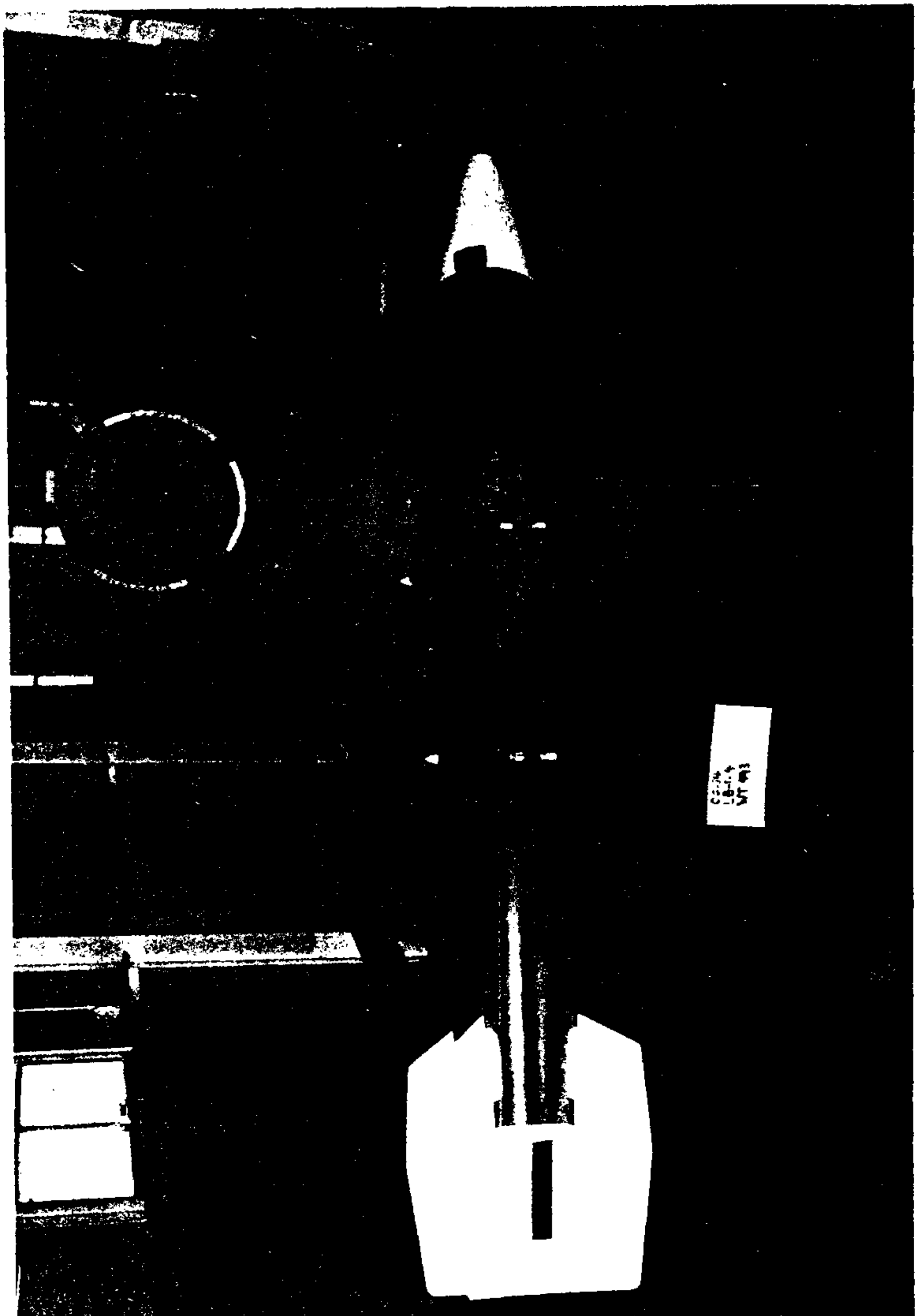


FIGURE 11. BDU 12/B

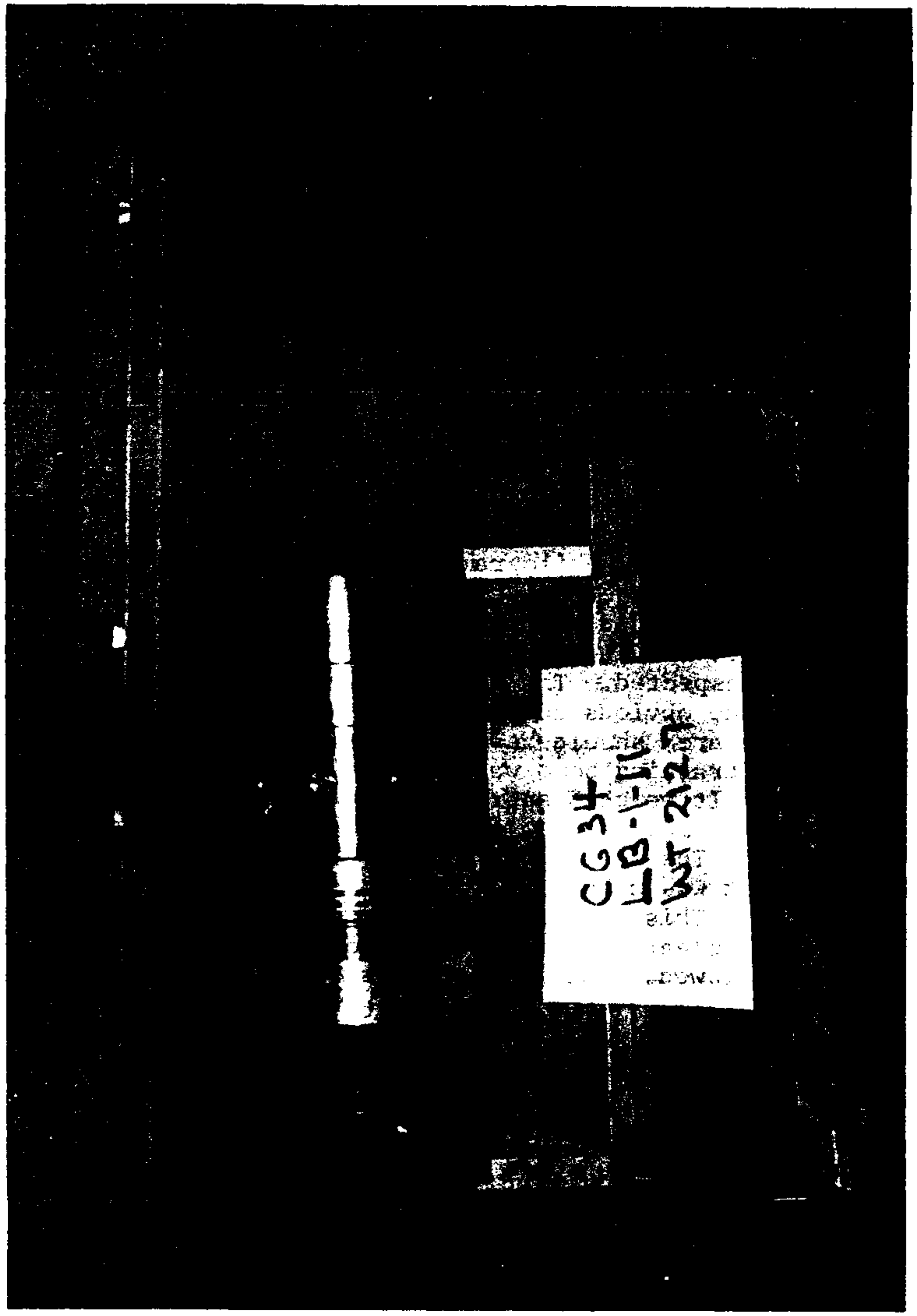


FIGURE 12. Eight-Inch Artillery Shell (Fake

the bar was made up of two 1-kilogram sections of uranium; one was U-235 and the other U-238. The fake shell was expected to be detected by inspectors at access level A3 by means of the gamma spectrometer which should have indi-

fake shell weighed 213 pounds. This was the only gun-type device tested; all others were implosion-type.

c. Figure 13 shows the Mk 28 fake weapon used in the test. This shape was derived, in part, from the Y1 yield version of the Mk 28 EX Bomb, which uses a steel ballast in place of a secondary stage. For the test, the

Then the system was reassembled. Also, a cavity was machined in the steel ballast, and a 3-kilogram cylinder of U-235 was bolted into the cavity. Nose and tail sections were the same as those found on the bona fide Mk 28 Bomb. The fake bomb was expected to be detected at access level A4, where X-ray plates were inspected. The lack of a

nd the obvious addition of the U-235 cylinder in the secondary area should have revealed the shape as a fake. The modified training bomb was 20 inches in diameter and 170 inches long. It weighed approximately 2,000 pounds.

d. The most sophisticated fake weapon used for the field test was a modified warhead from the U.S. Army Hawk missile. This warhead was expected to be accepted as a bona fide nuclear weapon by inspectors irrespective of the access allowed. The warhead used for the test is shown in figure 14.

The Hawk system used was a modified inert trainer. The inert conventional warhead was removed from the trainer and replaced with a mockup nuclear warhead. This warhead was configured to resemble an advanced fission warhead with two detonators. The unit used for the test had a diameter of 14 inches, was 94.12 inches long, and weighed approximately 250 pounds.

D. EQUIPMENT

Inspectors were issued kits of equipment which contained items used at all operational sites during the field test. In addition, some items were used by inspectors at only one location. This paragraph identifies the principal items used by inspectors and gives brief explanatory comments of some equipment. Only that equipment which inspectors used (or would use) is listed; plant tooling and processing equipment are not listed. No special equipment for inspectors was required at the Paducah plant.

1. Issued Kits

a. Attaché Case - for carrying equipment and documents.

b. Polaroid Land Camera, Model No. 100, with film-issued to high access teams only.

c. Camera Tripod - issued to high access teams only.

d. Drying Board - issued to high access teams only, for attaching Polaroid photographs while drying.

e. Carpenters Rules - 6-foot folding rules.

f. Scale - 3-foot scaled straightedge.

g. Scale - 12-inch.

h. Measuring Tape - 5-foot flexible tape.

i. Flashlight - explosion proof, two-cell.

j. Notebook.

k. Clip Board.

2. Pantex Equipment. The following equipment was used by inspectors at Pantex as appropriate for assigned access levels.

a. Plastic Covers for Shoes - to prevent sparking.

b. Geiger Counters.

c. Portable Neutron Counters.

d. Gamma-Scintillation Spectrometers.

e. Light Tables - specially constructed tables for viewing X-ray plates.

f. Draftsman's Bow Compasses - for measuring arcs and diameters of images on X-ray plates.

3. Rocky Flats Equipment. Equipment for the assay of plutonium is included even though safety restrictions precluded inspectors' actual operation of the equipment.

a. Special Shoe Covers - for protection against radiation contamination.

b. Safety Goggles.

c. Respirators - to be used in the event of radiation contamination of the atmosphere.

d. Protective Smocks.

e. Volumetric Titration Equipment - for determining amount of plutonium in samples.

f. Mass Spectrometer - for isotopic analysis.

g. Emission Spectrograph - for impurity analysis.

h. Balance - for weighing samples.

4. Oak Ridge Equipment

a. Safety Goggles.

b. Volumetric Titration Equipment - for determining amount of uranium in samples.

c. Mass Spectrometer - for isotopic analysis.

d. Emission Spectrograph - photographic spectrograph for impurity analysis.

e. Emission Spectrograph - direct-reading quantometer for impurity analysis.

f. Balance - for weighing samples.

IV. RESULTS OF OVERALL DESTRUCTION EXERCISE

A. GENERAL

This chapter discusses the results of the overall destruction exercise - that is, all phases of the demonstrated destruction of nuclear weapons. The results are discussed as they relate to each of the test objectives. Chapter V discusses the results of the special assay exercises, and chapter VI concerns other results of the field test.

B. CLASSIFICATION RESULTS

The first objective of the field test was to determine the amount of classified information revealed by the demonstration. Classification specialists from the AEC assisted during the field operations to identify all items of classified information exposed to inspectors during all operations witnessed or performed by inspectors and at all levels of access tested.

After field operations were completed a post-test analysis was made of items of classified information associated with the test.[1] The objective of this analysis was to determine the significance of the information which might be compromised during a demonstrated destruction. The approach was to use as evaluators knowledgeable individuals having a variety of backgrounds and experiences in the field of nuclear weaponry. The evaluators, who remain anonymous, provided the personal and unofficial judgements of individual experts rather than any official organizational judgement or position. Thus, organizations such as the AEC and DOD did not participate in this evaluation and analysis. A two-part document containing classified information and instructions was circulated to the evaluators. Part I consisted of a listing of 110 items of weapons information, classified and unclassified, including those derived from the field test. Part II consisted of listings of weapon monitoring information at each access level tested during field operations plus information associated with an untested access level (designated A5). This access level was defined as complete access to weapon disassembly operations with measurement and sampling privileges for nuclear system components. Access level information for part II was

[1] See Vol. III, Annex F, FT-34 Final Report (Jan. 1969).

furnished for the five bona fide weapons used plus the Hawk warhead section which also revealed classified information.

For part I of the classification review booklet, evaluators were asked to score each item of information on the basis of their opinion of the worth of that item to a foreign nation. For part II evaluators were asked to provide a relative score for each access level for each weapon, also on the basis of the worth of the information to a foreign nation. Two general types of foreign nations were considered. One type was a nation such as the U.S.S.R. The second type was a country not possessing nuclear weapons, such as Sweden.

1. Information Revealed During Test

a. A total of 112 items of classified information were revealed to inspectors throughout the overall destruction exercise. Figure 15 shows a break-down of items revealed versus operation and access level. Figure F4-1, annex F, identifies these items. Teams operating at the highest cumulative access level (A4 and "high") were exposed to the 112 items and those operating at the lowest cumulative access level (A1 and "low") were exposed to 34 items. The greatest increase in the number of items exposed from one access level to the next higher access level was at Pantex where X-ray plates were examined at the A4 access level.

b. Classified information was exposed at all access levels and during all operations except during the walkthrough inspections at Paducah. Some items of classified information were revealed by different means during different operations or at different inspection sites, therefore some duplications are represented in figure 15. Sixty unique items were revealed to high access inspectors throughout the exercise, and 33 unique items were exposed to inspectors afforded the lowest access.

Examples of classified information revealed at the lowest level of access were the fact of gas boosting (inferred from examination of pit containers during

SITE	OPS \ ACCESS	Number Items Available: Low A1	Low A2	High A3	High A4
Pantex	Walkthru	5		5	
	Weapon Inspection	2	4	6	58
	HE Burn	4		11	
Rocky Flats	Walkthru	4		4	
	Disposal	1		1	
	Assay	1		1	
Paducah	Walkthru	0		0	
	Component Inspection	2	7	16	16
Oak Ridge	Walkthru	12		13	
	Assay	3		3	
Total		34	41	60	112

FIGURE 15. Classified Items Revealed

walkthrough inspections at Pantex) and the use of alpha phase plutonium (from observation of the drilling and cutting of the metal during assay at Rocky Flats). Examples of classified information revealed at the highest level of access were the design of the [redacted] and the radar frequency of the MK 28 (from studying X-ray plates at Pantex).

c. No attempt was made to hide or conceal classified information associated with the test weapons, materials, or destruction process. The determination of the extent of the revelation of classified information was a major test objective. Many classified items were revealed because no attempt was made to protect them. The following subparagraphs summarize and discuss this revelation.

(1) Walkthrough Inspections

(a) Many items of classified information were revealed because inspectors were allowed to examine and look inside nuclear component shipping containers. No attempt was made to alter the containers or to deny access to them. Also, tooling and equipment unique to certain weapons revealed classified dimensions and characteristics of weapons components.

(b) One item of classified information was detected by the analysis of a small sample of material collected by one of the inspection teams in a work area where nuclear assemblies had been dismantled. No attempt had been made to clean the area beyond that required for normal operations.

(2) Weapon Monitoring

(a) The frequency of the fuzing radar for one weapon shape was revealed because the length of its antenna could be measured on the external surface of the shape. No attempt was made to tape over the antenna or otherwise conceal its dimensions.

(b) Detection and analysis of weapon radioactivity revealed many items of classified information. Additional shielding or additional radioactive source materials were not added to weapons to protect information or to mislead inspectors.

(3) Material Burning. Many items of classified information were revealed because some inspectors were permitted to view unaltered high explosive components and materials. Other items were revealed to inspectors when they viewed residue on the burn pads that had not been disturbed after burning.

(4) Component Monitoring. Sixteen items of classified information were revealed during monitoring of weapons components at Paducah. Most of these could have been protected by smelting or crushing all components prior to inspections.

(5) Assay. Four items of classified information were revealed during the assay of fissionable material because no attempt was made to dilute or enrich uranium to unclassified levels or to modify the characteristics of plutonium to conceal the phase used in nuclear weapons.

2. Post-Test Information Evaluation

a. For analyzing part I of the post-test review exercise, the evaluated items were reorganized into categories similar to the four access levels tested, A1 through A4, plus the fifth (higher) access level not tested, A5. Each of these reorganized access levels, however, contained only the additional information revealed beyond that included in the next lower access level. These access levels can be defined briefly as follows:

A1: External weapon configurations (dimensions, weights, centers of gravity, case features).

A2: Component observations through access doors; Geiger counter scanning.

A3: Neutron counter and gamma-spectrometer scanning.

A4: X-ray plate examination.

A5: (untested) Full access to weapon disassembly.

b. The evaluators ranked the information included in the 5 access levels as follows:

(1) For U.S.S.R. revelation, access level rankings were A5, A4, A3, A1 and A2 in descending order of importance. (Based only on the new information provided by each successively higher level.)

(2) For Nth country revelation, access level rankings were A5, A3, A4, A1, and A2 in descending order of importance. (based only on the new information provided by each successively higher access level.)

c. The U.S. proposal for the demonstrated destruction of nuclear weapons envisions the use of inspectors or observers from the U.S., the U.S.S.R., and from other countries. For this reason the values established for information divulged at each access level to both the U.S.S.R. and an Nth country were averaged. The mean value established by the post test evaluators for information revealed by access level across weapon shapes and evaluators is shown in figure 16. The mean value of information revealed at A5 is much greater than at lower levels because some evaluators assigned extremely high values to the compromise of complete weapons design information. Details of evaluators' responses are given in appendix F4 of annex F.

	ACCESS LEVEL				
	A1	A2	A3	A4	A5
MEANS	8.6	18.1	27.4	97.2	445.2

FIGURE 16. Mean Values of Classified Information Revealed

d. For part II, evaluators ranked the access levels in ascending order of importance; the A1 level was the lowest and the A5 level the highest. This was anticipated of course, since, for part II, information provided for each access level included all information contained in the lower access level(s). In comparing rankings among the six weapons included in part II of the exercise it was found that evaluators believed that revelation of thermonuclear weapon design information was more important than revelation of fission weapon design information. Generally, newer weapon designs were ranked higher than older designs.

e. The evaluators had a variety of backgrounds. As a generalization, weapon design and development evaluators tended to rate design features high, and technical intelligence evaluators favored higher ratings to features which could be subject to counter measures.

C. CONVICTION RESULTS

The second objective of the field test involved a determination of the effectiveness of the tested procedures in revealing whether or not nuclear weapons were being destroyed. Inspection teams evaluated all facilities, weapons, and the results of analyses of fissionable materials. The abilities of inspectors to distinguish between real and fake facilities and weapons and to detect evasion in the analyses of plutonium and uranium were determined. The investigation of uranium analysis was treated in greater depth during the special assay exercises. As for the first objective, data were gathered during the field operations and during a post-test exercise.

During the field operations, inspectors were required to call facilities and weapons real unless they could show reasons why they were not real. Similarly, for material analyses, inspectors were required to produce evidence if calls of evasion were made.

The post-test exercise concerned only the credibility of weapon shapes used during the field test. For this exercise, five three-man teams were made up of selected personnel from AEC laboratories. Team size, team composition (by professional discipline), and access levels afforded each team were held constant. The only variable investigated was access level. This exercise, like the post-test classification exercise, was not an actual field inspection but a "paper exercise."

An inspection booklet was distributed to post-test inspectors explaining the test and giving information available on the weapons at each of the four access levels tested plus an untested access level. The latter, access level A5, was defined as complete access to all weapon disassembly operations. Information was provided on each of the nine unique shapes used during the field test. Inspectors were instructed to make calls of real or fake on each weapon shape at each access level. Fake calls were to be supported by reasonable evidence.

Two sets of calls were required by the post-test inspection teams. One set of calls was required on the basis that the shape considered "could be real," the other set of calls was required on the basis that the shape "is real." The first set of calls dealt only with data derived from the field test (limited); the second set (unlimited) dealt with field test data plus other factors such as prior knowledge of team members, adequacy of weapon design, and other intangibles which related to individual inspectors.

1. Field Operation Conviction Results

a. Facilities. Inspectors' data sheets revealed that they were convinced that the test facilities used during the field operations were properly equipped and staffed to process nuclear weapons and materials for destruction.

b. Weapons. Altogether inspection teams made 720 calls on weapon shapes during the field operations. Of these, 478 were correct. Analyses were made on correct calls of fake weapons as a group, on bona fide weapons as a group, and on all weapon shapes considered together. Figure 17 shows the mean values of the percentages of correct calls for these three considerations.

(1) Examination of the lower two sections of figure 17 reveals that inspectors were generally more correct in calls for bona fide weapons than for fakes. The disparity was expected and was primarily a result of the requirement for inspectors to call weapon shapes real unless reasons could be given for calling them fake and a result of the deliberate design of the fake weapons to appear as real at given levels of access. For example, correct calls of fake weapons were expected to be 0 percent at access level A1, 25 percent at A2, 50 percent at A3, and 75 percent at A4. All calls were expected to be 100 percent correct at all access levels for bona fide weapons.

(2) Analysis of correct calls indicated that team size was an unimportant factor in the ability of a team to distinguish between real and fake shapes. Also, team makeup was only a minor influence on a team's ability to distinguish real from fake weapons. A most important influence, however, was access.

Inspection team detection capability increased with increasing access level of inspection. This was as expected because access level definitions were formulated to present more information about a shape at each successive access level. The A1 access level presented only external information about a shape. Information content was increased to the point that almost complete internal information was revealed at the A4 access level. No team correctly identified all 18 shapes in a batch. The lowest number of correct calls was 7 (39 percent); the highest number was 17 (95 percent).

Analysis indicated that ability to make correct calls was significantly affected by access and was significantly lower at the A1 level than at the A2, A3, and A4 levels. A significant difference appeared between the A1 and A2 levels, while little difference was evidenced between

FIGURE 17. Percentages of Correct Weapon Shape Calls During Field Operations

ALL WEAPON SHAPES					
TEAM SIZE	ACCESS				MEAN
	A1	A2	A3	A4	
2-Man	47%	61%	61%	83%	63%
4-Man	50%	75%	89%	78%	73%
MEAN	48%	68%	75%	80%	68%
	Low, 58%		High, 78%		

BONA FIDE WEAPONS					
TEAM SIZE	ACCESS				MEAN
	A1	A2	A3	A4	
2-Man	80%	80%	85%	100%	86%
4-Man	90%	100%	100%	90%	95%
MEAN	85%	90%	92%	95%	91%
	Low, 88%		High, 94%		

FAKE WEAPONS					
TEAM SIZE	ACCESS				MEAN
	A1	A2	A3	A4	
2-Man	6%	37%	31%	62%	34%
4-Man	0%	43%	75%	62%	45%
MEAN	3%	40%	53%	62%	40%
	Low, 22%		High, 58%		

the A3 and A4 levels. A significant difference was found between low acess (A1 plus A2) and high access (A3 plus A4).

c. Assay

(1) Rocky Flats. Of the 96 sample operations conducted during the assay of plutonium at Rocky Flats, evasion was attempted on 48 sample operations. LIMA teams detected three of these evasion attempts; MIKE teams detected none. Two evasions detected were attempts to substitute materials within glove boxes; the other was the correct estimate by inspectors of the amount of impurities added during the emission spectrography analysis. No evidence was gathered to indicate that team size was a factor in the few evasions detected.

(2) Oak Ridge. Evasion was introduced only during the mass spectrometry analysis of uranium at Oak Ridge during the overall destruction exercise. Evasion was practiced on 32 sample operations. No valid calls of evasion were made. In order to be credited with a valid evasion call, an inspection team must have made a correct call on an evaded sample and must have specified the correct reason for the method of evasion used.

2. Post-Test Conviction Exercise

a. All post-test inspectors made completely correct calls at the highest access level, defined as A5; therefore, only access levels A1 through A4 were used for analysis purposes. An interesting result, however, was noted concerning post-test inspectors' calls at the A5 level. These inspectors were asked to give a percent conviction score to all their calls. Although all A5 calls were correct, some inspectors were only 99 percent convinced that the weapons, to which they had essentially complete access, would give full scale nuclear yields. They noted that for some systems, dimensions may be so critical that perturbations which may not be perceived by visual inspection measurements could cause a significant decrease in yield.

b. Post-test teams made 360 calls on weapon shapes for the first four access levels. Of these, 240 were correct. Figure 18 gives the mean values of the percentages of correct calls on the shapes considered by post-test team members. By comparing figures 17 and 18 it can be seen that post-test contestants' mean correct scores were equivalent to military inspectors' mean scores at the low access level (A1 and A2) but were less than military inspectors' mean scores for the high access level (A3 and A4).

c. Analysis was performed on the real-fake calls for post-test teams (for access levels A1 through A4) in the same manner as for the field-test team calls. However, team size and access were held constant for all teams, and the only variable which affected calls was access level. Two sets of data were analyzed: one set for "limited information" calls and one set for "unlimited information" calls.

For "limited" calls, correct distinction between real and fake shapes increased with access level. A small difference in overall distinction capability was measured between the A1 and A2 levels, but a larger difference was found between the A3 and A4 levels. Another difference was found between the A1 and A2 levels combined as low access and the A3 and A4 levels combined as high access.

For "unlimited" calls, correct distinction also increased with access level. Differences in overall distinction capability were found between the A1 and the A2 levels and also between the A3 and A4 levels. Differences also were found between low (A1 plus A2) and high (A3 plus A4) access levels.

d. Analysis indicated that for "limited" scores, little difference was exhibited between access means and profession means for either real or fake shapes. Access means for fake shapes, however, were lower than for real shapes at corresponding access levels. For the "unlimited" results, access and profession means were lower than for "limited"

FIGURE 18. Percentages of Correct Weapon Shape Calls of Post-Test Teams

ALL WEAPON SHAPES					
NATURE OF INFORMATION	ACCESS				MEAN
	A1	A2	A3	A4	
Limited	56%	64%	64%	78%	66%
Unlimited	60%	64%	67%	80%	68%
MEAN	58%	64%	66%	79%	67%
	Low, 61%		High, 73%		

BONA FIDE WEAPONS					
NATURE OF INFORMATION	ACCESS				MEAN
	A1	A2	A3	A4	
Limited	100%	100%	100%	96%	99%
Unlimited	96%	96%	100%	96%	97%
MEAN	98%	98%	100%	96%	98%
	Low, 98%		High, 98%		

FAKE WEAPONS					
NATURE OF INFORMATION	ACCESS				MEAN
	A1	A2	A3	A4	
Limited	0%	20%	20%	55%	24%
Unlimited	15%	25%	25%	60%	31%
MEAN	8%	23%	23%	58%	28%
	Low, 16%		High, 41%		

results. For real shapes, electrical and mechanical engineers' mean scores were close together at the A2 and the A3 level and were significantly lower at these access levels than the physicists' mean scores. For "unlimited" results on fake shapes, a significant profession difference was detected at the A2 level where the mechanical engineers' and physicists' mean scores were close and higher than the electrical engineers' mean scores at this level.

3. Average of Correct Calls. As an overall measure of the abilities of inspectors to discriminate between bona fide and fake weapons, results of field-test and post-test inspectors' calls can be combined. Figure 19 shows the averages of all inspectors' correct calls for all weapons shapes tested.

FIGURE 19. Average Percentages of all Inspectors' Correct Calls

	ACCESS LEVEL				
	A1	A2	A3	A4	A5[a]
CORRECT CALLS	53%	67%	71%	80%	100%

[a]Post-Test Inspectors Only

D. EFFECTIVENESS RESULTS

The third objective of the test was to evaluate the practicability and effectiveness of the proposed methods and to suggest improvements. The method of demonstrating the destruction of weapons which was tested was similar to that suggested by the basic concept but modified as required by the need to use multiple facilities. Technical and operational problems associated with the demonstration are discussed in paragraph E below. For the most part, the methods of demonstrating the destruction of weapons were found to be practicable, and no significant improvements were required.

The scope of the demonstration should be determined primarily by the access allowed, however. Technical and operational problems would be reduced considerably if the demonstration were performed in a single facility specially configured for that purpose.

The analysis of this objective primarily concerned the practicability and effectiveness of inspection methods. By examining inspector performance of assigned tasks, a determination of the relative effectiveness and practicability of inspection methods can be obtained. High inspection effectiveness indicates some degree of practicability of test methods and also indicates comprehension and motivation on the part of inspection personnel. Selected areas of inspection effectiveness which were used to analyze the performance of inspection personnel were (1) the detection of classified information, (2) the acquisition of test data, (3) the performance of weapon monitoring tasks, (4) the maintenance of material weight balances throughout the test, and (5) the performance of assay tasks.

1. Classification Detection Effectiveness.

a. Although many inspectors had experience in nuclear weapons and all inspectors had received some instruction in classified aspects of nuclear weapons during the field test training periods, it was not anticipated that they were expert enough to recognize as classified all such items observed. For this reason inspectors' sketches, photographs, X-ray plates, and written descriptions were searched for items of classified information detected as well as their specific listings of items they believed classified. The analysis considered all items of classified information detected whether recognized as such by inspectors or not.

b. Figure 20 shows the overall effectiveness of inspectors' detection of classified information for four general levels of access throughout the field test. (See figure 15 for the numbers of items exposed). In figure 20 access levels 1 and 2 include those items of classified information detected respectively at access levels A1 and A2 for weapon monitoring and component disposition plus those items detected at the "low" access level for walkthrough inspections, burning operations, and assay. Likewise, access levels 3 and 4 include items detected at A3 and A4 for weapon monitoring and component disposition plus those detected at the "high" access level for other operations.

FIGURE 20. Mean Percentages of Classified Items Detected

TEAM SIZE	ACCESS LEVELS				MEAN
	1	2	3	4	
2-MAN	47%	45%	57%	56%	51%
4-MAN	56%	56%	64%	66%	61%
MEAN	52%	51%	61%	61%	56%
	Low, 51%		High, 61%		

c. The analysis of classified information detected indicated that team size did not have a significant effect on the capability to detect classified information during weapon monitoring and component disposition inspections but that a significant difference existed between low (A1 plus A2) and high (A3 plus A4) access levels. This difference appears to have been caused primarily because high access teams were permitted to record observations with Polaroid cameras. Acquisition of classified information was based upon identification by AEC classification specialists from their own independent observations, as well as from inspectors' data packages and not upon callouts or recognition of classified information by inspectors.

Neither team size nor access caused statistically significant differences for walkthrough inspections, burning operations, or assay.

2. Acquisition of Available Data

a. The greatest amount and the greatest variety of test data was collected at the Pantex facility. (Test data collected included descriptions of physical features of weapons, listings of items or components present, listings of classified items detected, etc.) Weapon monitoring data packages from the Pantex operations were selected for analysis as being a representative measure of effectiveness for inspectors' acquisition of available data. Data packages from all inspection teams were reviewed, and correct answers to all questions asked were tabulated. These tabulations were compared to test reference data for correctness and completeness. Completeness of correct inspection data was found as a percentage of the test reference data answers. The means for completeness are shown in figure 21.

FIGURE 21. Mean Percentage Completeness of Data Acquisition

TEAM SIZE	ACCESS LEVELS A1	A2	A3	A4	MEAN
2-MAN	71%	73%	80%	80%	76%
4-MAN	75%	80%	87%	81%	81%
MEAN	73%	76%	84%	80%	78%
	Low,	75%	High,	82%	

b. Overall, a completeness of 78 percent was found for weapon-monitoring data packages. Completeness percentages increased from 73 percent at access A1, to 76 percent at access A2, to 84 percent at access A3. A reduction to 80 percent was observed at access A4. This reduction resulted from the treatment by inspectors of redundant weapon shapes in a batch. Data packages for the first shape in a batch examined at the A4 (X-ray) level were completed to the best of the inspectors' abilities. The second time X-ray plates of the shape were examined, the inspectors checked for simi-liarity between the second and first shape; and if they discovered that the shapes were the same, they did not repeat the information required by the data sheets.

c. Analysis of acquisition of available information provides moderate evidence for the conclusion that there are statistically significant differences among the access means. In particular, the average of A1 and A2 (low) is different from the average of A3 and A4 (high).

3. Performance of Inspection Tasks

a. As an additional measure of the performance of inspectors, especially as related to investigating team size and access variables, the times required to perform inspection tasks were analyzed. The analysis considered times required to complete weapon inspection operations at Pantex and assay operations at Oak Ridge as representative of all tasks throughout the field test. Weapon monitoring times and times to perform analyses of uranium are summarized here. (See annex F for details.)

b. Weapon Monitoring Times. As shown in figure 22, mean times for monitoring weapons at given access levels were found to be 27 minutes per shape at access level A1, 17 minutes per shape at A2, 34 minutes per shape at A3, and 23 minutes per shape at A4. The A2 values were low because of the limited number of shapes per batch which had access doors. The A3 values were high because of the time required to use radiation monitoring equipment.

Team size had little effect on weapon monitoring times. Monitoring times were lower the second time a team inspected at any given access level than for the first time at the same access level. For example, the average inspection time per shape for LIMA teams for the first batch of weapon shapes was 26 minutes. The average time for comparable access levels for the second batch was 16 minutes per shape. This indicates that the shape familiarity obtained during first batch operations was reflected in reduced monitoring times for second-batch operations.

FIGURE 22. Mean Times in Minutes Required for Weapon Monitoring

TEAM SIZE	ACCESS LEVELS				MEAN
	A1	A2	A3	A4	
2-MAN	30	20	29	23	25
4-MAN	23	14	39	23	25
MEAN	27	17	34	23	25
	Low, 22		High, 29		

c. Assay Operation Times. Data from high access level teams (performers) at Oak Ridge were used to analyze assay operation times in terms of average time per sample. For the main exercise, the average time to prepare and run a sample through all phases of assay was 164 minutes. A further discussion of this and a comparison with the results of the special assay exercises appears in paragraph D, chapter V.

4. Maintenance of Weight Balances. The maintenance of material weight balances throughout the overall destruction exercise was not satisfactory. Operational difficulties

and the lack of complete test reference data precluded a statistical analysis of weight balance data. Some error was unavoidable because of unreliable scales and the different methods, equipment, and accuracies used in weighing material at the various sites. Some of the contributions to errors were directly attributable to inspector error, such as incorrect transcription and conversion from kilograms to pounds. Figure 23 shows the weight balances reported by inspectors per weapon batch. The negative numbers indicate teams' calculations of weight losses that were not accounted for. The variation occuring in the weight balance for a given batch of weapons was from 0.4 pounds to 800 pounds. The maximum imbalance of 800 pounds is approximately 3 percent of the average weight of a batch of weapons. However, 800 pounds represents about 93 per cent of the total amount of fissile material recovered from a batch of weapons.

FIGURE 23. Inspector-Reported Weight Balance Values (Pounds)

TEAM NO.	TEAM SIZE	LIMA GROUP		MIKE GROUP	
		Batch 1	Batch 2	Batch 3	Batch 4
1	2-MAN	- 74.2	0.4	345	450
2	2-MAN	- 67.6	3.8	253.3	477.3
3	4-MAN	591	800	324	428
4	4-MAN	- 78.4	11.7	342.5	333.7

5. Performance of Assay Tasks. Main test inspectors performed mass spectrographic analyses as well as the laboratory technicians but their chemical analyses were not generally as accurate.

E. PROBLEMS

The final objective of the test was to identify operational, technical, classification, safety, and security problems during the field operations. Many problems arose in all these areas but most were minor and to be expected in a one-time field exercise of the nature of FT-34. Only those problems of some significance or which would affect a future test or treaty inspection are discussed herein. Quantitative data were not collected on problems, therefore, no quantitative analysis was made.

1. Operational Problems

a. An uncontrolled and undetermined "stack loss" occurred during the smelting of bomb components. This loss, which would also occur in a treaty inspection if parts were smelted, contributed to unsatisfactory results in maintaining weight balances throughout the test as previously discussed.

b. The weighing of bombs during weapon inspections at Pantex presented some problems. Some bombs (Mk 39) were too large to be weighed on the scales available, and time limitation precluded weighing all other shapes in the presence of inspectors. Scales at Pantex were not reliable, and this contributed to inaccurate weight balances throughout the test.

c. Inspectors sometimes provided questionable reasons for calling weapon shapes fake. This was especially evident when bona fide weapons were called fake. Inspectors' guidelines were that a weapon must be called real unless there was plausible evidence to call it fake.

d. In order to accomplish as much work as practicable in the time allotted for inspections and reduce interference with normal plant production schedules to a minimum, inspection schedules sometimes were compressed and out of sequence. This was especially true at Oak Ridge where some teams had to perform laboratory operations out of sequence.

2. Technical Problems. Some problems, although affecting operations, were basically technical in nature and are, therefore, included in this paragraph.

a. Several cases of equipment malfunction occurred during the field test. Some delayed operations and led to inspectors' detection of evasion during the overall exercise in the assay of uranium. Also, uncontrolled temperature and humidity caused erratic readings on the gamma spectrometer early in the exercise at Pantex.

b. Shielding from normal weapons components tended to obscure or alter gamma spectrometer indications of some isotopes of fissionable material during weapon inspection at Pantex. This caused difficulty in interpreting the read-out graphs and led to some erroneous identifications (or lack of identifications) by inspectors of isotopes within weapons inspected.

c. Preparation of X-ray plates for weapon inspection at Pantex was difficult for some units. In some instances X-ray exposures tended to emphasize nuclear geometry and did not show electromechanical components clearly. Also exposures did not reveal internal nuclear designs of the secondary stages of some weapons.

3. Classification Problems. No significant classification problems arose other than that discussed previously; the inability of inspectors to detect all classified information revealed. One important finding, however, identifies potential problems for any treaty-inspection. Inspectors correctly deduced nuclear pit dimensions and the fact that some weapons were "gas boosted" by examining empty pit containers which, when not associated with nuclear weapons, are considered unclassified.

4. Safety Problems. No safety problems were encountered other than those normally associated with processing nuclear weapons. Two of those which affected test operations are identified below.

a. Safety restrictions concerning the handling of plutonium are discussed paragraph III B 2 above. Not only were inspectors restricted from performing operations wherein plutonium was handled but the necessary plutonium safety precautions precluded limiting tools and equipment within glove boxes to those required only for FT-34. Accordingly, inspectors were exposed to and perhaps confused by superfluous tools and equipment unrelated to field test operations.

b. Safety restrictions at Pantex, where high explosives are handled, prohibit the use of normal lighting equipment. Inspectors were not allowed to use flashbulbs when taking Polaroid photographs in the inspection area. Area lighting did not provide sufficient illumination for good quality photographs.

5. Security Problems. Security requirements limited inspector access to only those operations, weapons, and equipment associated with the field test. No other access was desired; however, this restriction required inspectors to follow predetermined and sometimes roundabout routes to inspection areas and in some instances required constant escort. The need for these restrictions was recognized, but they did cause some inconvenience.

V. RESULTS OF SPECIAL ASSAY EXERCISES

A. GENERAL

The two special assay exercises conducted on uranium samples at Oak Ridge differed only in the qualifications of inspectors performing analyses. The primary purpose of the exercises was to investigate the effects of evasion when using a host-controlled laboratory. An additional purpose was to investigate team composition.

Evasions were practiced during all major operations of the analyses on one-half the specially prepared samples. Each team analyzed nine samples including a standard. Samples were under the control of inspectors but laboratory equipment and materials were not.

B. SPECIAL ASSAY BY MILITARY INSPECTORS

1. Evasion Detections

a. LIMA inspectors were subjected to evasion on 47 sample-operations and detected evasion on three. All three were detected by one team, a relatively skilled team operating at the lower access level. (Evasion was planned on 48 sample-operations, but equipment modified for evasion failed to function on one operation with the mass spectrometer.) All three of the LIMA team's detections were an indirect result of malfunctioning equipment that had been modified for evasion purposes.

Excess iron, which gives the same visual indication during chemical titration as uranium, was added to three samples to make the samples appear to contain more uranium than actual. Samples normally contain some iron; sometimes in sufficient quantity to be indicated by a precipitate during chemical treatments. The amount of iron is measured with the emission spectrograph. For the samples on which evasion was detected, inspectors observed the iron precipitate. The emission spectrograph was modified to indicate an order of magnitude less iron than was actually present, yet enough to cause a visible precipitate during chemical treatments. The modified spectrograph malfunctioned, however, and indicated such a small amount of iron that its precipitate would not have been visually evident. This alerted inspectors to evasion. The malfunction was corrected, and subsequent evasions of that nature successfully deceived inspectors.

b. MIKE inspectors were subjected to evasion on 48 sample-operations and detected one. The team which detected the evasion was made up of relatively skilled inspectors operating at the lower access level. This detection resulted from comments in the presence of inspectors by a laboratory technician who was not aware of the significance of his remarks. The technician informed a supervisor that a mass spectrometer source had been changed the previous night. The source contained a preplated filament to be activated remotely after inspectors had inserted the filament prepared by them from their sample. More extensive explanations to laboratory technicians on the FT-34 operations prevented further slips of this nature.

2. Inspector performance. As in the main test, Special Assay Teams performed mass spectrographic analyses as well as the laboratory technicians but their chemical analyses were not as good.

C. SPECIAL ASSAY BY CONTRACTOR TEAM

Evasion used during the contractor assay exercise was the same as that used for the special assay exercise by military inspectors. Out of 24 sample-operations performed (in addition to those on a standard sample), 12 were evaded; the same number for each of the military teams. All evasion preparations functioned successfully, and no evasions were detected.

D. TEAM COMPOSITION

No data collected indicated any significant differences in the performance of teams during assay operations due to team composition. Evasions were deliberately designed to be detection-proof and succeeded when modified equipment functioned as planned; those evasions detected did not relate to team composition.

Operating times for assay analyses were recorded on all teams' operations. These times determined by teams (high access analysis operations) were analyzed in terms of average time per sample and can be compared with the average time of 164 minutes per sample for the main exercise (previously discussed). For the special assay exercise by military inspectors and the contractor assay exercise, average times to prepare and assay samples were 154 minutes and 177 minutes respectively. When categorized by skills, skilled special assay teams required 149 minutes and unskilled special assay teams required 158 minutes, compared with the 177 minutes required by the contractor team. The mean sample time for all skills was 161 minutes.

Main-exercise and special-exercise assay teams did not, on the average, require as much time to analyze a sample as did the contractor assay team. The longer average time required by the contractor team reflected the professional care exercised in procedures by the team members and, additionally, the time required to consider and list areas in which evasion could be practiced.

E. POST-TEST REVIEW

Upon completion of the special assay exercises at Oak Ridge a review conference was held with the contractor inspectors, the laboratory supervisory personnel from Oak Ridge and Rocky Flats, and FT-34 technical advisors. The purpose of the review was to evaluate the evasion methods tested during the field test and to discuss other possible methods of evasion. A report of this review appears in annex D.

There are many methods, in addition to the relatively simple methods investigated during the field test, that a host could employ in a laboratory under his control to prevent the correct assay of fissionable material. During the field test the amount of U-235 in a sample was made to appear to inspectors to be about 2 percent high. Specialists agreed during a post-test conference that uranium analyzed in a laboratory over which they did not have control could be made to appear to have about 5 percent more U-235 than actual.[1] This would depend on proper functioning of evasion schemes. Specialists agreed that attempts to evade in excess of 5 percent probably could be detected by skilled inspectors.

VI. OTHER RESULTS

A. GENERAL

In addition to results obtained concerning the formal objectives of the field test, information and data were available for evaluating other aspects of the operation which may relate to future field tests of the demonstration of the destruction of nuclear weapons or to possible treaty inspections. These results, which are discussed in this chapter, concern test control, support, inspectors' qualifications, training, and test site environment.

B. TEST CONTROL

Control of test operations was provided by the Test Director, Test Site Commanders, and Operations Officers who were guided by detailed operational and technical plans which were developed prior to the beginning of inspection operations. A detailed evaluation of test control and test control personnel is given in annex A. A brief evaluation follows.

1. All inspection operations were completed satisfactorily and according to plan with only minor variations.

2. Test control personnel carried out their supervisory duties satisfactorily after having been given only brief group training and after a few days on-the-job experience. Only 3 days were available, however, for test control personnel at Pantex to prepare for inspectors' arrival. Although inspection operations were controlled satisfactorily, some confusion was evident the first few days of operations.

3. After data gathering and data display systems were established the Assistant Data Officer was no longer needed and was returned to her permanent station.

4. Many operational problems arose at all sites which were resolved only by continual and close coordination with plant personnel.

C. <u>SUPPORT</u>

Funding for FT-34 was provided by the ACDA and the DOD. The DOD provided additional support in the form of munitions hardware, some transportation, and administrative services. All support was administered by the FT-34 organization.

1. All funding, supply, and administrative support required by the field test were provided.

2. Field test administrative and support personnel, who were requisitioned by specialty, carried out their functions satisfactorily.

3. After logistical support procedures were established and functioning, the Assistant Support Officer was not needed; he was returned to his permanent station.

4. The field organization called for teletype operators to prepare and process messages, however, the AEC plants provided teletype services. Some teletype operators were released; others were utilized as clerk-typists.

D. <u>INSPECTORS' QUALIFICATIONS</u>

Backgrounds and skills requested for personnel to act as inspectors are given in annex B. In general, it was desired that each team have members with nuclear weapons backgrounds and chemical analysis backgrounds.

1. In general, personnel supplied by the DOD to act as inspectors possessed the qualifications requested. The backgrounds and experience in nuclear weapons research and development possessed by some inspectors was less than desired, however. Those inspectors supplied by the contractor for the final special assay exercise fully met the backgrounds required.

2. Inspection teams performed their tasks in a satisfactory manner. A summary of the analysis of inspector performance is given in chapter IV.

E. TRAINING

Training included group training at the test headquarters and individual training at each site. All test personnel were included in some group training sessions, but inspectors and test control personnel were trained separately in other sessions.

1. Test personnel performed their tasks satisfactorily with the overall training preparation provided.

2. During some joint training sessions test control personnel inquired about some matters which could not be discussed in the presence of inspectors - such as, the make-up of weapons batches or evasion. Separate training sessions for inspectors and test control personnel were subsequently held as planned, but discussions in joint training sessions could not always be free.

3. Training for inspectors was planned on the basis that inspectors would meet fully the qualifications requested. Although inspectors were adequately qualified to perform their duties satisfactorily, their knowledge in some areas was less than anticipated. Some changes were made in the second training session to overcome this situation. It was especially found necessary to place more emphasis on individual inspector skills, such as assay, and to provide more realistic "dry runs" of inspection operations.

F. TEST SITE ENVIRONMENT

The field test was conducted at four widely separated facilities, and inspectors were subjected to different operational environments, different security and administrative procedures, different safety precautions, and different problems at each site. Because of this situation inspectors were faced with some confusion, some doubt about the inter-relationship of different operations, and some loss of continuity of operations. For example, inspectors did not seem to relate the walkthrough inspections as being performed at a single facility. In addition to such operational problems, the multisite environment required duplication of test control personnel and extensive logistical preparation and support.

VII. CONCLUSIONS

A. OVERALL DESTRUCTION EXERCISE

Conclusions are presented for each objective of the field test. Further conclusions on some objectives as well as on other results of the test are discussed in subsequent paragraphs.

1. Classification

a. For the concept of the demonstrated destruction of nuclear weapons which was tested, classified weapon design information would be revealed even at the lowest level of intrusion. The classification of some of the information exposed even at the lowest level of access tested was Secret Restricted Data and concerned sensitive weapon design features.

b. Much of the classified information exposed could be protected by redesign of facilities and equipment. This redesign would consist of a specially constructed facility wherein universal tooling and fixtures would be used for weapons and material disassembly. Nonnuclear materials would be disposed of by rendering the material unrecognizable (complete smelting or effective crushing), and access to unprocessed components (as tested at Paducah) would not be permitted. Further, weapon surfaces would be masked to conceal features (such as radar antennas) that would reveal classified information. After burning of high explosive components, and prior to viewing by inspectors, debris would be thoroughly mixed to conceal such information as the number of detonators in one segment of high explosives. Different enrichments of U-235 would be smelted together to give an unspecified enrichment of less than 90 percent. Alpha phase plutonium would be treated in such a manner as to change its phase.

Figure 24 summarizes the number of items which would be revealed. Compare this with figure 15. Figure 24 shows that while there would be a great amount of information exposed in the highest level of access, there would in fact be very little exposed at the lowest level. Figure

F-4 annex F, identifies the specific items of information which would be revealed. At the lowest level of access there would be one item revealed during assay of the fissionable materials, the use of unspecified enrichments of uranium below 90 percent U-235.

FIGURE 24. Items of Classified Information Exposed in Special Facility

	ACCESS			
	Low		High	
OPERATION	A1	A2	A3	A4
Walkthrough	0		0	
Weapon Inspection	0	2	4	58
Burning	0		0	
Assay	1		1	
TOTAL	1	3	5	59

c. The following subparagraphs define an access level for inspecting a demonstration of the destruction of weapons in a facility designed to protect classified information, and with precautions discussed above, during which only one item of classified information should be revealed. The conviction that bona fide nuclear weapons were being destroyed, however, would be very low. Further, paragraph d(4) below indicates that external weapon information, while perhaps unclassified, might be of significant importance to foreign observers.

(1) Facility walkthrough tours with the use of Geiger counters. Work areas where fissionable materials are processed must be thoroughly cleaned so that microsamples which might reveal classified information cannot possibly be collected by inspectors.

(2) Weapon monitoring at the A1 access level-no Geiger counters, no radiation monitoring equipment, no X-ray plates, and no access to weapon access doors. Features on weapons surfaces revealing classified information must be masked.

(3) Observation of burning of high explosives and inspection of debris. Inspectors must not be allowed to view components prior to burning, and debris must be thoroughly mixed after burning.

(4) Assay of fissionable material samples. Alpha phase plutonium must be treated in such a manner as to change its phase or not included in the demonstration. Uranium must be blended to conceal the fact that individual

(5) Balance of incoming versus outgoing weights-depending on whether significant weight changes would occur by blending U-235 with extraneous U-238.

d. Some general conclusions can be made from the results of the post-test evaluation of classified information which was exposed during the test or which would be exposed at a higher level of intrusion than that tested. Following is a summary of these conclusions:

(1) The disclosure of thermonuclear system and fission system weapon design information would be more harmful to the U.S. during an inspection operation than the loss of information regarding nuclear materials, external weapon configurations, and nonnuclear weapon components.

(2) The details of weapon design would be more useful to the U.S.S.R. than the identification of fissile material isotopes used. This is probably true because such information might confirm intelligence estimates, reveal features for counter measures, and serve to define design differences between U.S. and Soviet weapons.

(3) While X-ray information might reveal weapon design information to an Nth country, such information would be less useful than the identification and relationship of fissile material isotopes in weapons.

(4) The importance to the U.S.S.R. or an Nth country of determining the location of radioactive materials in weapons is lower than that of examining external weapon features. Evaluators' rankings implied that they believed that both U.S.S.R. and Nth country observers would be aware of material locations and staging, and, therefore, would find close-up examination of a variety of nuclear weapons more rewarding than the detection of internal material locations.

(5) As indicated by post-test evaluators' relative scores for information revealed, information which would be compromised at the untested access level A5 would be several times more valuable than information revealed by weapons X-ray plates or lesser access levels.

2. Conviction

a. Inspectors' abilities to discriminate between bona fide and fake nuclear weapons is poor at the level of intrusion envisioned in the basic concept for the demonstrated destruction of nuclear weapons.[1] Results indicated that many calls at this level were mostly guesses. Although the ability to detect fake weapons increases with the access allowed to weapons being destroyed (along with a corresponding increase in the exposure of weapon design information), no teams, military or post-test, were able to identify all weapons correctly even at the highest level of access tested during field operations (X-ray). Even at the higher A5 level (complete visual access to weapons components) post-test

[1]See p.26 Supra.

inspectors were not 100 percent assured that real nuclear weapons would produce design yield. For some nuclear weapon systems, computer calculations would be necessary to verify that such systems would produce design yield if detonated.

b. Seven evasions out of 187 sample evasion operations were detected by inspectors. While the risk of inspectors detecting seven out of 187 evasion attempts probably would tend to deter a host from trying to evade, evasion operations tested were relatively unsophisticated when compared to some techniques which could be employed. (See annex D.) It is concluded that inspectors can be easily evaded when performing analyses of fissionable materials under conditions tested using a host-controlled laboratory. This matter is treated in more detail in paragraph B below.

c. Although team size and individual inspectors' backgrounds affected weapon conviction calls to some extent, the most significant variable was access. Team composition is discussed in paragraph D below.

3. Test Methods

a. The general method of demonstrating the destruction of nuclear weapons as discussed in the concept (introduction, weapon disassembly, and disposition) is practicable, but the scope would be determined by the access allowed. Many of the technical and operational problems experienced in the multisite field test would not exist during an inspection in a single facility.

b. The inspection system tested detected on the average 56 percent of the classified items exposed. This is measured against the assumed 100 percent collection and identification by classification specialists. Since classification specialists had access to the same material available to inspectors, it can be concluded that the inspection methods are effective, but that the inspectors were not adequately skilled to detect all classified information to which they were exposed. Four-man teams were more effective than two-man teams, and more information was detected as teams inspected at higher access levels after having inspected at lower access levels. This indicates that greater exposure and learning on the job have considerable effect on detecting classified information.

c. On the average 79 percent of the data describing inspection targets was collected by inspectors. As a rule, inspectors had all the time desired to collect data. Also, all reference data against which inspectors' findings were measured could have been determined by equipment used by inspectors. It appears, therefore, that the amount of information gathered was limited primarily by the skill of inspectors in data gathering techniques.

d. Inspectors were able to complete similar operations in shorter lengths of times as these operations were repeated. This can be attributed to learning on the job. Team size didn't appear to affect significantly the time required to complete operations. Time required to perform inspection operations such as radiation measurements was often determined by equipment characterisitcs.

e. Multi-site operations, use of different scales, use of different standards, and personnel errors contributed to accurate weight balances. The keeping of weight balances would probably be much improved in an inspection of operations in a single standardized facility and as inspectors' skills improved with experience. Since the destruction of weapons does not require the care and accuracy of producing weapons, however, it is unlikely that exact weight record balances would be practicable.

If some error in the overall weight balance is to be assumed, it should be noted that weight of fissionable material removed from weapons is relatively small. Accordingly, measuring the amount of fissionable material derived from a batch of weapons should not be related to the overall weight balance.

f. FT-34 experience indicates that inspectors with good scientific backgrounds can be trained in a short time to perform routine mass spectrographic analyses of fissionable materials but that more extensive training is required for chemical analyses.

4. Problems

a. Weight balances of weapons versus residue were not accurate because of several factors. Accurate weights were not determined prior to and after all processing operations to identify and account for weights lost during processing. Scales were inadequate for some loads, some scales were inaccurate, and some calibrations were not reliable. Units of measurement were not always standardized, and inspectors apparently made careless errors in calculations.

b. Inspectors' calls of fake when weapon shapes were in fact bona fide nuclear weapons indicated guesswork on the part of some inspectors. Their reasons may have been sufficient to suspect evasion but not for proof of evasion.

c. The need not to interrupt normal AEC production operations is recognized and was respected during the field operations. More flexibility in scheduling inspections would have resulted in a more efficient field test, however.

d. It appears that some malfunctioning of electrical and mechanical equipment is inevitable. Lack of standby or duplicate equipment can cause delays or preclude the completion of some operations which are time-limited.

e. Some inspectors were not adequately skilled in interpreting gamma spectrometer readings. Inspectors were adequately trained to read normal spectrographic displays, but some were not adequately trained to interpret anomalies.

f. X-ray plates of weapons show a great amount of internal information of weapons. Information is not revealed, however, when heavy shielding is present and is confusing when the images of numerous components are superimposed.

g. Some equipment, though treated as unclassified, may reveal classified information when associated with nuclear weapons or components.

h. Safety and security restrictions are absolutely necessary in handling weapons materials and in protecting classified information. Planning and executing any test or inspection of demonstrating the destruction of nuclear weapons will be controlled to a great extent by these restrictions.

B. SPECIAL ASSAY EXERCISES

Special exercises for the assay of uranium at Oak Ridge related primarily to the second objective of the test, which concerned inspectors' conviction of the credibility of the demonstrated destruction. The exercises also related to the third objective, evaluation of test methods.

1. Evasion

a. Inspectors can be deceived as to the true amount of uranium or the percentage of U-235 in a sample of weapons grade uranium when the sample is analyzed in a laboratory over which inspectors have no control. Evasion schemes may be devised by a determined host which cause the U-235 content of a sample to appear to be as much as 5 percent greater than actual.

b. Evasion methods employed may vary from crude to sophisticated. Evasions may be detected by alert inspectors, however, if evasion operations or systems do not have a high degree of reliability or if personnel effecting evasions become careless in their operations. Accordingly, a potential evader would run some risk of being detected.

2. Team Performance

a. The performance of inspectors during the special assay exercises reinforces the conclusion indicated by assay operations performed during the overall exercise - that is, inspectors with general scientific backgrounds can perform mass spectroscopic analyses of fissionable material satisfactorily with several days of training and practice, but require more training for chemical analyses. Inspectors, of course, would be following standard guidelines and procedures.

b. Team composition (considering the skills of the inspectors in the test) or whether teams observe or perform analysis operations in a host-controlled laboratory appear to have little effect on the analytical results of assay operations performed by routine, standard procedures.

C. OTHER CONCLUSIONS

1. Test Control

a. Test control plans were adequate for completing the field test satisfactorily.

b. Test control personnel were sufficiently qualified and adequately trained to carry out their supervisory functions satisfactorily. Not enough time was allowed, however, for onsite preparation for the initial inspection operations of the field test.

c. The organization for test control was adequate; there was an excess of one officer.

d. Unforeseen technical problems in an operation such as FT-34 arise which require prompt resolution. A technical supervisor must be present during all operations to provide immediate guidance.

e. Frequent operational problems are inevitable in a field test such as FT-34. A close working relationship between test control personnel and plant personnel is mandatory in order to complete operations without detrimental interruptions.

2. Support.

a. Support for the field test was adequate.

b. Administrative and support personnel were properly qualified and adequately indoctrinated to perform their functions satisfactorily.

c. The organization of administrative and support personnel was adequate with minor modifications. One officer and the teletype operators were in excess, but additional clerk typists were required.

3. Inspectors' Qualifications

a. Inspectors' qualifications for the field test, although not entirely as desired, were adequate for the tasks they were required to perform.

b. Only two-man and four-man teams were tested for the overall destruction exercise. Analyses indicated that the sizes of teams tested did not affect data gathering results significantly, although two-man teams were hard-pressed to complete some of their operations in the time available. Judgements of teams however, indicated appreciable differences in abilities of inspectors to interpret their observations.

4. Training

a. The training program was adequate although some improvements could be made.

b. Inspectors and test control personnel perform different roles and have different perspectives. Joint training inhibits free discussions of individual tasks and responsibilities - especially if evasion is to be tested.

c. A training program, to be effective, must be tailored to individual inspector's duties and qualifications. Realistic simulated exercises are especially beneficial in preparing inspectors for their individual inspection operations.

5. Test Site Environment

a. Operational problems associated with the multi-site character of the field test had no significant effect on the results of the test which related to the formal test objectives because continuity in gathering test data was enforced by the design and use of data forms. The inconvenience and confusion to inspectors and the extensive logistical and administrative requirements of the test could have been reduced, however, if the test were conducted in fewer facilities.

b. None of the operations performed during the test could be omitted without loss of test data. There probably could be some consolidation of operations for a future test in existing AEC facilities, however, or complete consolidation of operations in a specially prepared single facility. For example, the Pantex facility has the capability to perform or simulate all the operations performed at Paducah. On the other hand, operations performed at Oak Ridge and Rocky Flats could not be consolidated without extensive modifications to one of the facilities. The laboratories are specifically equipped to handle and assay uranium or plutonium respectively but not both. Because of the severe safety restrictions at Rocky Flats, however, inspectors could not perform sufficient operations to generate much data. The data gathered there could have been gathered by a single study group or test team without the trouble and expense of exercising eight inspection teams.

VIII. RECOMMENDATIONS

A. OVERALL DESTRUCTION EXERCISE

1. Protection of Classified Information. If classified information is to be protected during a demonstrated destruction of nuclear weapons to foreign inspectors special facilities and equipment must be prepared and access to the demonstration must be low.

a. A single processing facility should be prepared with universal tooling, handling equipment, and measuring equipment. A more thorough discussion of the design of such a facility appears in the FT-34 Procedures Manual. Processing of fissionable material must also be carefully controlled.

uranium from the weapons in the batch cannot be divulged, then some further enrichment or dilution will be necessary

(2) Alpha phase plutonium should be treated in such a manner as to change its phase. The mere fact that alpha phase plutonium is presently used in weapons is classified. (Whether plutonium is alpha phase or delta phase would be obvious to a knowledgeable inspector performing or observing the analysis of plutonium.)

(3) Prior to any access by inspectors to areas where fissionable material is processed great care must be taken in cleaning those areas so that small samples of material which may reveal classified information cannot be collected. The gathering of microsamples by inspectors could be inconspicuous to host escorts. For example, dust containing a sample might adhere to shoes or clothing.

b. Once a single facility is prepared, access by inspectors should be limited to:

(1) Facility walkthrough tours, with the use of Geiger counters.

(2) Weapon monitoring of mixed batches of weapons with visual access only to external features of weapons and with weapons features, which may reveal classified information, masked.

(3) Assay of fissionable materials with necessary blending or addition of impurities to protect classified information.

(4) Monitoring of burning of high explosives with no visual access to components prior to burning and with mixing of residue on the burn pad after burning.

(5) Maintaining incoming versus outgoing records of weapons and bulk, nonnuclear components to be disposed of with thorough smelting or crushing of all components.

This restrictive access is required not only to protect information that is classified because of its own nature but to preclude inferences of classified information by inspectors. For example, some ancillary equipment associated with nuclear weapons may be unclassified when considered alone but may reveal classified aspects of nuclear designs when associated directly with weapons.

2. Controlled Exposure of Classified Information. If the United States is willing to compromise a limited amount of classified information during a demonstration of the destruction of nuclear weapons, priorities of revelation of the information should be considered and access to the demonstration should be modified accordingly. A limited analysis of the classified information exposed during the field test indicated the following categories of information would be of ascending importance to the U.S.S.R. or to an Nth country.

a. U.S.S.R.

(1) Location of nuclear materials.

(2) External features of weapons.

(3) Identification and locations of fissionable material isotopes.

(4) Details of fission system design.

(5) Details of thermonuclear system design.

b. Nth Country

(1) Locations of nuclear materials.

(2) External features of weapons.

(3) Details of fission system design.

(4) Identification and locations of fissionable material isotopes.

(5) Details of thermonuclear system design.

3. Conviction

a. If one desires to be absolutely certain that bona fide nuclear weapons are being destroyed, access levels greater than those considered during the field test must be allowed for some sophisticated weapons. In effect, inspectors must have complete access to the weapons and elaborate laboratory facilities for detailed and minute measurements and analyses.

b. If a high degree of conviction that nuclear weapons are being destroyed is not necessary, then the level of access discussed in paragraph A.1 above is recommended.

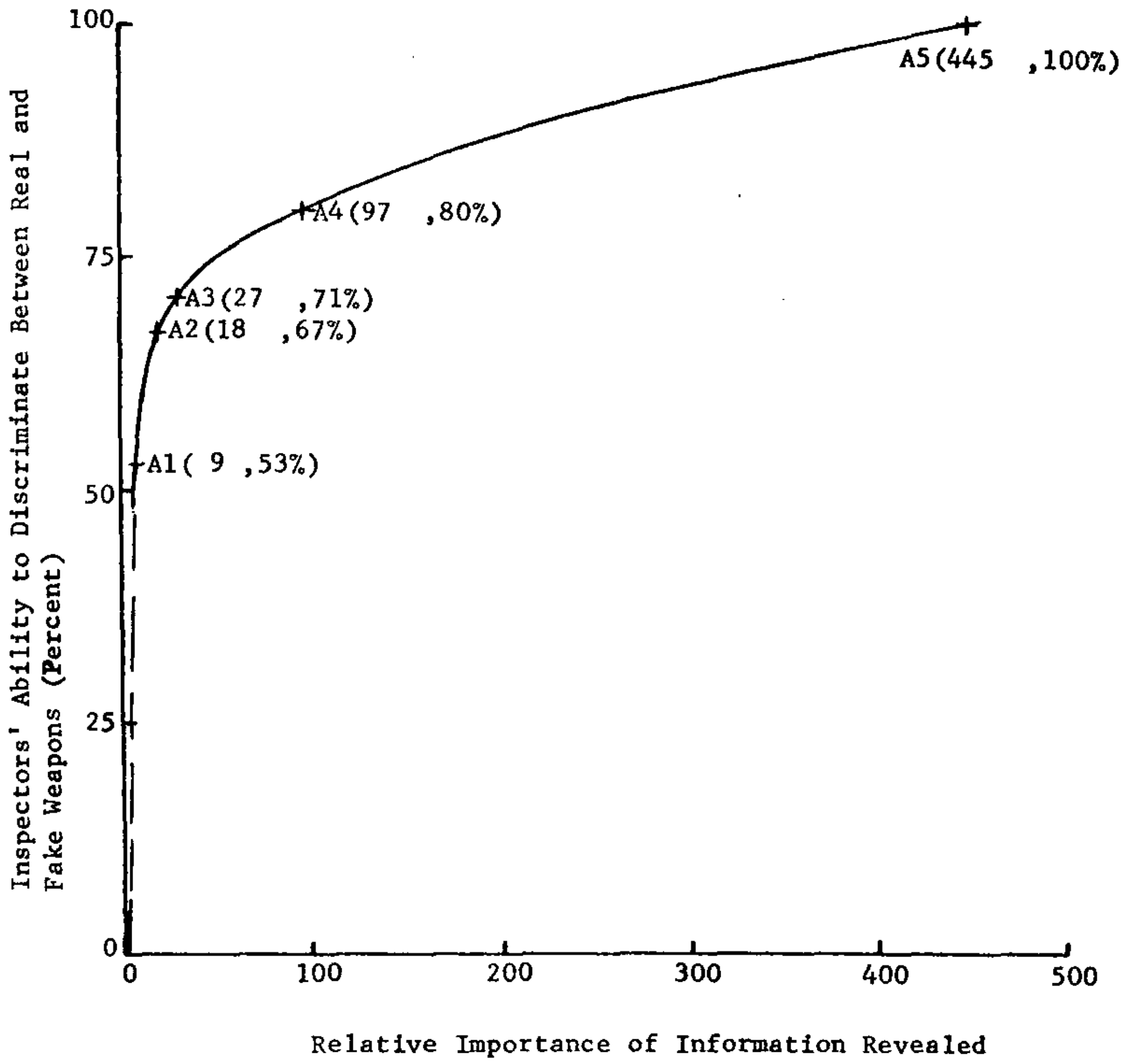
c. Some comparison of the ability of inspectors to discriminate between bona fide and fake weapons and the value of the classified information lost can be made from test results. Figure 25 gives this comparison. Points for access levels plotted in figure 25 are taken from figures 16 and 19. The ordinate is an average of field-test and post-test inspectors' abilities to discriminate at the access levels tested and the A5 level considered only by post-test inspectors. The abscissa is the average of post-test evaluators' relative values of information revealed at the different access levels.

4. Test Methods

a. Methods of demonstrating the destruction of nuclear weapons as described in the basic concept and with safeguards discussed herein are recommended for future field tests or for a treaty inspection. Limitations on access of inspectors should be carefully controlled, however, depending on the degree of protection of classified information desired versus the degree of credibility of the demonstration desired.

b. For a field test such as FT-34, inspection methods tested are adequate except for those minor deficiencies discussed elsewhere in this report. Improvement by inspectors as they gained experience, however, emphasizes the desirability of practice inspections. It is recommended that, once the inspection force has been selected, enough practice inspections be conducted to train inspectors thoroughly in the techniques of inspection and the collection and recording of data. Critiques of operations should be held and improvements implemented. Sufficient time should be allotted for practice sessions so that (1) all test reference data can be obtained; (2) inspection and destruction procedures can be checked thoroughly; (3) equipment can be checked for proper operation in the test environment; (4) data acquisition, handling, transmission, and analysis can be practiced; (5) administrative functions can be checked; and (6) safety, security, and classification problems can be recognized and corrected.

FIGURE 25. Weapon Discrimination Versus Value of Information Revealed



c. It is recommended that weight balances of weapons presented for destruction versus materials resulting from the disassembled weapons be accurately maintained. The purpose of maintaining a weight balance would be a check on other inspection activities (e.g., facility surveillance) to assure that no material or components of weapons were being withheld for possible future use in the fabrication of other weapons. Accurate and tested balances, capable of weighing even the heaviest items handled, should be made available to inspectors. Weight standards for calibration should also be provided.

The weighing of fissionable materials, while included in the weight balance, should also be treated as a separate matter. Sensitive laboratory scales should be used to determine the amount of fissionable material transferred to peaceful uses.

5. Problems

a. If a field test such as FT-34 is planned in the future, arrangements should be made if at all possible to give inspection operations priority. The requirement to tailor inspection operations not to interfere with higher priority operations inevitably leads to scheduling problems and concessions which affect the efficiency of the test.

b. Standby equipment should always be made available for inspection or destruction operations if a tight schedule must be followed. Capabilities and limitations of equipment and information provided by equipment (such as X-rays) should be thoroughly determined and understood.

c. During any test inspection or treaty inspection of the demonstrated destruction of nuclear weapons, time and resources must be provided to cope with inherent safety and security requirements. A great amount of confusion can be caused by differing security and safety systems. For efficient test or inspection operations these systems should be streamlined and standardized. Unnecessary restrictions to properly cleared and qualified personnel should be avoided.

B. SPECIAL ASSAY EXERCISES

1. Inspectors must be permitted to have complete control over equipment and materials used for the assay of fissionable materials. It is recommended that inspection teams have their own laboratories or that samples to be analyzed be returned to U.S. government-controlled laboratories for analysis. For an inspection in a foreign country, the former would be preferred to prevent delays to inspectors in determining the quality of materials being held for transfer to peaceful uses.

2. Although the test showed that inspectors with general scientific and technical backgrounds can be trained to perform standard analyses, it is recommended that highly qualified personnel be used for this purpose. The uncertainties of the composition of fissionable material compounds and alloys of a foreign country, unforeseen problems with laboratory equipment, discussions with expert representatives of the foreign country, etc., may present problems to a nonprofessional inspector and jeopardize an inspection.

C. OTHER RECOMMENDATIONS

1. Test Control

a. For a test such as FT-34, test control personnel should arrive 1 to 2 weeks in advance of inspection operations. This will allow time for local organization, detailed preparation for operations, and time for simulated control exercises.

b. A test control organization similar to that used during the field test should be used for any future field test of similar nature. Annex A gives detailed outlines for field tests in single or multiple facilities.

c. Sufficient technical supervisors should be provided to allow their continued presence during all test inspection operations.

d. Every effort should be made to secure AEC and site contractor operational support and cooperation in every phase of an operation similar to that of FT-34 to resolve operational problems which inevitably occur.

2. Support

a. Thorough planning for supporting FT-34 field operations resulted in an effective and efficient supply of equipment, logistics, and administrative services. It is recommended that the same thorough effort be afforded any similar operation.

b. Arrangements should be made to secure adequate and prompt support from the host facility in a field test such as FT-34, where no time could be allowed for lack of equipment or services.

3. Inspectors' Qualifications

a. For another field test such as FT-34 inspectors' qualifications should be defined in detail and obtained from whatever source available. It may be that the military services alone are not able to provide inspectors with all qualifications desired. A treaty inspection should not be attempted without inspectors fully qualified in every respect.

b. Inspection teams for an inspection of the scope of FT-34 should contain inspectors with a combined expertise in the following fields:

(1) Nuclear physics with experience in designing and developing nuclear and thermonuclear components including high explosives.

(2) Nuclear physics with experience in radiation monitoring and interpretation of X-ray film (if X-ray will be allowed).

(3) Aerodynamics with experience in designing and developing nuclear weapons ballistic shapes.

(4) Electrical or mechanical engineering with experience in designing and developing electromechanical components used in safing, arming, fuzing, and firing nuclear weapons systems.

(5) Chemistry, metallurgy, or physics with experience in chemical, isotopic, and spectrographic analysis of uranium and plutonium.

(6) Security classification with experience in determining the importance of nuclear weapon design information to a foreign country.

4. Training

a. Inspectors and test control personnel should be trained separately. Although joint training sessions in subjects of common interest may appear to be an efficient use of training resources, roles and perspectives of these two groups of test personnel differ and may even conflict.

b. Inspectors' qualifications should be determined in as much detail as possible prior to planning training programs. Once qualifications are determined, realistic exercises should be planned to prepare inspectors fully for their tasks prior to the commencement of inspection operations. If inspectors, time, and resources are available, full "dress rehearsals" and critiques of inspection operations should be conducted using the same inspectors that will participate in the test.

5. Test Site Environment. If resources are available a single facility should be prepared for a field test such as FT-34 or for a treaty inspection. In any event, the inspection operations could be limited to two sites: Pantex, or some other similar AEC facility, and the Y-12 Plant at Oak Ridge. Along with test inspection operations a study should made at the Rocky Flats Plant on all pertinent matters concerning the recovery and assay of plutonium.

D. FUTURE STUDIES

1. If it appears that a treaty for the demonstration of the destruction of nuclear weapon will be agreed upon, weapons which the U.S. will destroy must be identified. A study should be made of these specific weapons to determine weapon batch size and batch content so that the amounts of materials contained in a given type weapon cannot be determined by inspectors. Also a study should be made of how fissionable materials contained in the weapons can be mixed to conceal actual enrichments used in the weapons.

2. Prior to an agreement allowing inspection in a U.S. facility (or facilities) by inspectors of a foreign government, it is recommended that a thorough field test inspection by U.S. inspectors be conducted. The primary purpose of such a test would be to assure as much as possible that classified information would be protected by the procedures to be agreed upon.

IX. DISTRIBUTION

Agency	No. Copies
ACDA	
Economics Bureau	1
International Relations Bureau	1
Weapons Evaluation and Control Bureau	5
Science and Technology Bureau	4
Public Affairs	1
Executive Director	1
Reference Information Center	4
General Counsel	1
Col Donald H. Humphries, USAF OSD/ISA Room 4E-840, The Pentagon Washington, D.C. 20301	2
Hon. John S. Foster, Jr. DDR&E/OSD Room 3E-1006, The Pentagon Washington, D.C. 20301	2
Maj Gen B. F. Evans, USA JCS/OSD Room 1E-969, The Pentagon Washington, D.C. 20301	5
Dept of Army (DA-ODCSOPS) Attn: LTC William A. Hudson, USA Room 3E-548 The Pentagon Washington, D.C. 20301	5
Dept of Navy (OPNAV) Attn: Capt Richard A. Amme, USN Room 4D-558, The Pentagon Washington, D.C. 20350	5

Agency	No. Copies
Headquarters Marine Corps Attn: LTC R. L. Cunningham, USMC Room 2108, Navy Annex Arlington, Virginia 22214	2
Dept of Air Force (AFXPDPA) Attn: LTC J. Schindler, USAF Room 4E-1085, The Pentagon Washington, D.C. 20330	5
U.S. Atomic Energy Commission Attn: Mr. Allen M. Labowitz Mail Station B-312 Washington, D.C. 20545	2
Central Intelligence Agency Attn: Mr. Graham R. Evans Room 3F-43-HQ Bldg. McLean, Virginia 22101	2
Central Intelligence Agency Attn: Mr. A. C. Lundahl Washington, D.C. 20505	1
Assistant Chief of Staff Plans and Programs Defense Intelligence Agency The Pentagon 20301	2
Defense Intelligence School Defense Intelligence Agency Building 5 Anacostia Annex Washington, D.C. 20390	1
Director, DASA (Defense Atomic Support Agency) Washington, D.C. 20305	1

Agency	No. Copies
Director, Weapons System Evaluation Group 400 Army Navy Drive Arlington, Virginia 22202	1
Special Assistant to the President National Security Affairs The White House, West Wing Offices Washington, D.C. 20306	1
Dr. Lee DuBridge Special Assistant to the President Science and Technology Executive Office Building Room 200 Washington, D.C. 20506	1
Mr. Eugene V. McAuliffe EUR/RPM Room 6227, Department of State Washington, D.C. 20520	1
Mr. Vladimir Toumanoff EUR/SOV Room 4225, Department of State Washington, D.C. 20520	1
Mr. Philip J. Farley G/PM Room 7313, Department of State Washington, D.C. 20520	1
Mr. Hush Wolff - INR/RSB/BP Room 7422, Department of State Washington, D.C. 20520	1
Mr. John Shaw - G/PM Room 7320, Department of State Washington, D.C. 20520	1