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U.S. Department of Energy
Office of Inspector General

November 1987

Report on

**Use of Functional Analysis to
Reduce the Cost of Weapons
Production Facilities**

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United States Government

Department of Energy

memorandum

DOE/IG--0245

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DATE: NOV 2 1987

REPLY TO

ATTN OF: IG-1

SUBJECT: INFORMATION: Report on "Use of Functional Analysis to Reduce the Cost of Weapons Production Facilities"

TO: The Secretary

BACKGROUND:

The attached report is submitted to inform you of the results of an inspection of the Department's nuclear weapons production activities. The purpose of our inspection was to identify cost reduction opportunities within the Department's Weapons Production complex.

DISCUSSION:

An initiative by the Albuquerque Operations Office (AL00) demonstrated that functional analysis reviews, a form of value engineering, could generate substantial cost avoidance opportunities for weapons production construction projects. Through use of this technique, alternative design approaches are identified that are less costly than the designs originally proposed. We examined functional analysis reviews for three proposed weapons production facilities. The reviews had identified alternative designs that could reduce the costs of the proposed facilities by 19 to 45 percent. We concluded that expanded use of functional analysis reviews should be made in Defense Programs and that the Department should consider using this technique for construction projects in other program areas.

In our report we recommend that the Assistant Secretary for Management and Administration (ASMA) evaluate the results of the AL00 initiative to determine if functional analysis could be effectively utilized Departmentwide and, if so, that a policy be developed regarding its use. We also recommend that the Assistant Secretary for Defense Programs (ASDP) develop guidelines concerning the application of functional analysis techniques to its construction projects.

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Our draft report was provided to the ASMA, ASDP and Manager, AL00. In general, they were in agreement with the recommendations in our report.

John C. Layton
Inspector General

Attachment

cc: Assistant Secretary, Defense Programs
Assistant Secretary, Management & Administration
Manager, Albuquerque Operations Office

U.S. DEPARTMENT OF ENERGY
OFFICE OF THE INSPECTOR GENERAL

USE OF FUNCTIONAL ANALYSIS TO REDUCE THE COST OF
WEAPONS PRODUCTION FACILITIES

Report No.: DOE/IG-0245
Date of Issue: November 2, 1987

Office of Inspector General
Washington, D.C.

USE OF FUNCTIONAL ANALYSIS TO REDUCE THE COST OF
WEAPONS PRODUCTION FACILITIES

TABLE OF CONTENTS

	<u>Page</u>
PART I - PURPOSE AND SCOPE OF INSPECTION	1
PART II - BACKGROUND	1
PART III - RESULTS OF INSPECTION	2
PART IV - RECOMMENDATIONS	5
PART V - MANAGEMENT REACTION	5

PURPOSE AND SCOPE

The purpose of this inspection was to identify cost reduction opportunities within the Department's Weapons Production complex. Our review included visits to the major weapons production facilities within the complex, interviews with program officials and contractor representatives, and examination of relevant files, reports, studies and other documents. Additional information was obtained through interviews with Defense Programs officials at Headquarters and senior program officials at the Albuquerque Operations Office (ALOO), as well as examination of documents obtained from these officials.

BACKGROUND

During our review of weapons production activities at ALOO, we observed that the ALOO Division of Facilities and Construction Management (FCMD/ALOO) had conducted functional analysis¹ reviews of several, relatively small-scale construction projects. The ALOO initiative, which had been underway for little more than a year, demonstrated that functional analysis reviews, a form of value engineering, could generate substantial cost avoidance opportunities through identification of alternative design approaches that were less costly than the designs that had been originally proposed by their contractors.

Functional analysis seeks to identify elements of planned facilities that are not needed to satisfy programmatic requirements and also seeks to identify an alternate design or approach that contains only those elements necessary to accomplish the required functions. The proposed design, which is usually represented by a Conceptual Design Report (CDR), is compared with a design developed from critical and secondary

¹This concept, developed by the General Electric Company during World War II, is commonly known as value engineering, but has been called value analysis, value control, value improvement or value management. Although a form of value engineering, functional analysis reviews focus more on the early design phases of construction projects.

functions identified by functional analysis techniques.¹ The difference in the cost of the two designs represents the cost of the elements in the original design that were not necessary to fulfill programmatic needs. The objective is to eliminate as many unnecessary or secondary functions as possible.

Few, if any, functional analysis reviews were performed by FCMD/AL00 prior to 1984. In 1984, an Interagency Agreement with the U.S. Army Corps of Engineers (Corps) provided AL00 the capability to conduct its own in-house reviews by using Corps consultants. The first review of a proposed Departmental facility was completed by Corps consultants in January 1985.

RESULTS OF INSPECTION

To date, functional analysis reviews by FCMD/AL00 have demonstrated that substantial cost avoidance is possible through application of this technique. For example, since 1984, AL00 has reviewed CDRs for about 182 proposed projects, many of them weapons-related. Of these, approximately 50 projects were subjected to some degree of review using functional analysis. The reviews included 25 major studies performed by consultants or Departmental personnel and 25 lesser efforts conducted by study groups in various Departmental workshops sponsored by FCMD/AL00. The cost of the 50 reviews, including the salaries of workshop participants, was about \$873,000. About \$32.6 million² in cost avoidance may actually be realized from these reviews.

We selected three studies performed by the Corps contractor to evaluate the methodology and its potential for application to other projects within Defense Programs and the Department. The contractor's review developed alternative designs that would satisfy programmatic needs, but at costs of 19 to 45 percent less than the designs proposed by Defense Programs contractors. The total cost of the three reviews was about \$75,000.

¹The CDR and design review process is a systematic process for evaluating and improving designs in which alternatives are considered, although development of specific, low-cost alternatives is not common.

²The first actual cost avoidance from a functional analysis review was realized for the planned security center at the Pinellas Plant in Florida. The original Total Estimated Cost of the facility was reduced by more than 12 percent, a cost avoidance of about \$650,000.

For example, a study of the conceptual design for the Protective Clothing Decontamination Facility planned for construction at the Rocky Flats Plant, Golden, Colorado, was prepared by the Corps contractor in July 1985. The estimated cost of the facility proposed by the Defense Programs contractor was \$4.1 million. However, the functional analysis review identified an alternative design that could reduce the cost of the facility by about \$1.9 million, primarily through changes in the building design.¹ The alternative design included construction of a facility based on a more efficient workflow, deleted the proposed solar water heating system, and used a pad mounted electrical transformer in lieu of a substation. The functional analysis review, which cost \$19,000 to perform,² identified an alternative design that would satisfy programmatic needs, but for 45 percent less cost than the design originally proposed.

In December 1985 the Corps contractor reported the results of the review of the Strategic Defense Facility Complex to be built at the Sandia National Laboratory for \$24 million. The functional analysis review of the proposed design led to alternatives that could lower the construction cost of the facility by almost \$4.7 million, a 19 percent reduction over the initial construction cost, while still meeting programmatic requirements.³ The alternatives included a more efficient design for the Light Laboratory facility and use of lower-cost, but adequate building materials in lieu of the proposed materials. They also included deletion of utility tunnels in the site/tank farm area and deletion of the boiler room from the Heavy Laboratory facility. The cost of the review was \$30,000.⁴

In May 1985, the Corps contractor reported on the functional analysis review of the Tritium Emissions Reduction Facility

¹Value Engineering Study, Subject: Protective Clothing Decontamination Facility, Value Associates, Inc., July 10, 1985.

²Interagency Agreement with the Corps of Engineers, DOE IA No. DE-AI04-85AL30211, MOD 004, May 1, 1985.

³Value Engineering Study, Subject: Strategic Defense Facility, Value Associates, Inc., December 11, 1985.

⁴Interagency Agreement with the Corps of Engineers, DOE IA No. DE-AI04-85AL30211, MOD 007, August 16, 1985.

(TERF) planned for construction at the Mound Plant in Ohio for an estimated \$5.7 million. The review recommended alternatives that could reduce the project cost by over \$1.2 million, a 21 percent cost reduction from the design proposed by Defense Programs contractors.¹ The alternatives included construction of a new facility in lieu of costly renovations to existing buildings and use of the Pumparound heat reclamation concept to reduce annual operating costs. The alternatives also involved consideration of a new emission reduction process technology. The cost of the review was \$26,000.²

Although the effort by AL00 has been the principal application of functional analysis within the Department, there have been other, minor efforts directed to the same objective. For example, the Acting Director, Engineering and Construction Management Division, Idaho Operations Office, said that a small-scale value engineering effort had been established by their operating contractor. However, he indicated that the contractor's staff lacked experience and the process needed improvement. The Director, Project Engineering Division, Savannah River Operations Office (SRO), said that similar studies may have been conducted by some Architect/ Engineer firms that had worked at SRO, but neither the DOE/SRO staff nor the operating contractor staff had conducted value engineering/functional analysis-type reviews of planned projects. However, the operating contractor, with the assistance of the Corps, recently completed a value engineering study of the Tritium Loading₃ Facility planned for construction at the Savannah River Plant.

Although we have discussed the application of functional analysis to Defense Programs activities, the techniques have also been effectively applied to nonweapons-related projects, albeit on a limited scale. For example, the success of a workshop sponsored by FCMD/AL00 for the staff of the Uranium Mill Tailings Remedial Action (UMTRA) Project led to a decision by the UMTRA project manager to conduct functional analysis

¹Value Engineering Study, Subject: Tritium Emission Reduction Facility, Value Engineering, Inc., May 1986.

²Interagency Agreement with the Corps of Engineers, DOE IA No. DE-AI04-85AL30211, MOD 010, September 30, 1985, and MOD 013, January 7, 1986.

³Value Engineering Study, Tritium Loading Facility Replacement Project, 86-D-130, Savannah River Operations Office, March 5, 1987.

reviews for all planned subprojects; first at the conceptual design stage and again at the preliminary design stage. The first five reviews were completed, resulting in recommendations that could lower the original \$129 million cost of the projects by \$22.5 million, a reduction of almost 18 percent over the cost of the designs initially proposed.

We were unable to find any Departmental orders, policies or regulations concerning functional analysis reviews, even though functional analysis techniques could be applied to facility construction and renovation projects Departmentwide.¹ Although Departmental construction contracts can contain an optional clause that allows contractors to submit cost reduction proposals/value engineering change proposals to the Department for consideration, these proposals are typically generated after construction and/or operations have begun. This approach differs from the use of functional analysis, which should be applied early in the project, i.e., primarily in the design phase.

RECOMMENDATIONS

A. For the Assistant Secretary for Management and Administration:

1. Evaluate the results of the AL00 initiative to determine if functional analysis could be effectively utilized Departmentwide.
2. If functional analysis is determined to be an effective tool for use by the Department, establish a policy regarding its use.

B. For the Assistant Secretary for Defense Programs:

Develop guidelines within Defense Programs to encourage maximum benefit from use of functional analysis.

MANAGEMENT REACTION

In commenting on our draft report, ASMA stated that due to the wide variety of programmatic activities carried out by the Department, they were philosophically opposed to imposing a specific methodology used at one location to all other organizational elements. However, ASMA would continue to evaluate the functional analysis approach used at AL00 to

¹FCMD/AL00 is developing an order for use by AL00.

determine its applicability to other field offices. Based on that review, ASMA would examine existing policy documents to determine the need for further guidance in this area.

Defense Programs agreed that value engineering, or functional analysis, is a valuable management tool for construction project managers better to define and reduce costs of facilities. Defense Programs concurred that functional analysis techniques should be evaluated for application throughout Defense Programs. They also concurred in the recommendation that ASMA should evaluate the results of AL00's initiative to determine if functional analysis could be used Departmentwide. Finally, Defense Programs concurred that ASMA should establish a policy regarding the use of functional analysis.

Office of Inspector General