

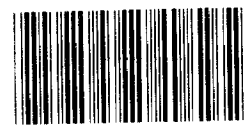
GAO

Briefing Report to the Chairman,  
Committee on Governmental Affairs,  
United States Senate

September 1986

# PROCUREMENT

## Selected Civilian Agencies' Cost Estimating Processes for Large Projects



131360

RESTRICTED—Not to be released outside the General  
Accounting Office except on the basis of specific  
approval by the Office of Congressional Relations.

RELEASED

---

---



United States  
General Accounting Office  
Washington, D.C. 20548

General Government Division

B-223234

September 17, 1986

The Honorable William V. Roth, Jr.  
Chairman, Committee on Governmental  
Affairs  
United States Senate

Dear Mr. Chairman:

By letter dated June 4, 1984, you requested that we study civilian agencies' cost estimating processes applicable to large, complex procurement projects. Specifically, you asked that we provide information on the following issues:

- the types of regulations that guide the various civilian agencies' cost estimating processes for large projects;
- how civilian agencies develop their cost estimates for large, complex projects, including how cost data submitted to the agencies by contractors is used in estimating costs; and
- how agencies decide which of the many cost estimates developed either internally or externally by independent cost estimators, or by contractors, they will select as their official cost estimates to be submitted to the Congress to obtain large project authorization and funding.

As agreed with your Committee representative, to develop the above information we studied the preparation of cost estimates for nine projects being procured by six different civilian agencies--the U.S. Coast Guard, Veterans Administration (VA), Corps of Engineers (Civil Works), Bureau of Reclamation, National Oceanic and Atmospheric Administration (NOAA), and Federal Aviation Administration (FAA). The projects were selected jointly after we discussed alternative projects with your representative. The estimated cost of the selected projects ranged from \$10.6 million to \$846 million and the projects had been in process from 6 years to 35 years.

In performing our study, we interviewed the selected agencies' headquarters and field office staffs responsible for cost estimating; reviewed applicable written policies and procedures for preparing cost estimates; reviewed memoranda, studies, and reports the agencies used in preparing cost estimates for the nine selected projects; reviewed cost estimate submittals to the Congress for authorization and/or funding approvals; and compared the submitted estimates to the latest available estimates at the times of submission. We did not attempt to evaluate the

selected agencies' analyses of variances between cost estimates and actual costs later experienced. Further, our study was directed to developing information on the cost estimating processes for the nine large, complex projects and the information we developed cannot be projected as representative of the six selected agencies' cost estimating processes for all their procurements.

On May 1, 1986, we briefed your Committee's representative on the results of our study. This report summarizes the information presented during that briefing. Specific information on each of the nine projects and on each of the points you requested we cover are contained in the appendix and are summarized below.

#### AGENCY REGULATIONS

We found no overall standard instructions or guidance to civilian agencies on either how to prepare cost estimates or on the specific elements to include in estimates.

The Office of Management and Budget (OMB) issues instructions on procurements of major acquisitions in Circular A-109. This circular specifies the management processes an agency should follow in these acquisitions--key decision memorandums and approvals at key decision points. OMB instructions to all government agencies on preparation and submission of budget estimates (Circular A-11) state that estimates should reflect the judgment of the agency head with respect to the scope, content, and quality of programs and activities that are being proposed to meet the agency's goals and objectives. Neither of these instructions provide specific guidance on the preparation or make-up of cost estimates.

Four of the six selected agencies--VA, the Corps of Engineers (Civil Works), the Bureau of Reclamation, and FAA--had prepared their own formal instructions to provide guidance to their cost estimators for the preparation of cost estimates. The two remaining agencies--the U.S. Coast Guard and NOAA--did not have such instructions. Formal instructions in the four agencies were generally set forth in agency orders or engineering manuals which addressed the various elements to be considered in the preparation of cost estimates whether by in-house personnel or by outside architect-engineer firms.

#### HOW AGENCIES DEVELOPED ESTIMATES

We found that the four agencies having formal instructions generally followed their published guidance in preparing cost estimates on the projects we studied. The provisions of these instructions for such items as project definition, inflation, contingency, documentation, and estimate revisions were generally comparable among the four agencies. We found also that, even though the U.S. Coast Guard and NOAA did not have formal written instructions for use in preparing estimates for the projects we studied, they generally included in their estimates the major items we considered desirable for good cost estimating.

On all nine projects studied, we found that the internal agency organizations coordinated and communicated on the projects' cost estimates. Individual offices were allowed to review and comment on the estimates before final decisions were reached. For such factors as inflation the agencies used either annual percentages provided by OMB or recognized industry inflation indexes in use at the time the estimates were being prepared. For example, VA used the Boeckh Index which showed indexes for various types of buildings in 186 U.S. cities and 19 cities in Canada.

The amount included by the agencies to provide for contingencies was governed by the type of construction as well as the stage of construction. Initial estimates generally contained higher contingency allowances than later estimates prepared as the construction progressed and unknowns were better defined. Because of the various types of projects, various percentages and factors were specified in the contingency allowances. However, in some estimates, we could not identify a definite dollar amount as the contingency allowance.

We found that, for the most part, the selected civilian agencies prepared in-house cost estimates for their proposed projects instead of going to outside contractors to have them develop cost estimates. However, in most agencies, cost data submitted by the contractors after contract award were used to review and update projects' cost estimates to reflect current progress. In all cases the agencies reviewed contractors' cost data for validity and reasonableness before revising the estimates.

Agencies periodically updated project cost estimates. For most projects, each revision to the project's estimates, whether they were increases or decreases due to additions, deletions, changes, or inflation, was explained and documented.

Over the years all the selected projects experienced significant cost growth from the initial cost estimates to the current estimated costs. Cost growth ranged from a low of 91 percent for the Lock and Dam #26 replacement project in the Corps of Engineers to 686 percent for the oldest project, the Upper Stillwater Dam in the Bureau of Reclamation. (See app. I for details.)

In all the projects we studied, the major portion of the increase in costs was attributable to inflation. For example, 87 percent of the cost growth for the Lock and Dam #26 project and 57 percent of the cost growth for the Upper Stillwater Dam was attributable to inflation. Other cost increases on the nine projects were due to changes in the scopes of the projects, inclusion of additional quantities, and changes in equipment and requirements.

#### COST ESTIMATES SUBMITTED TO THE CONGRESS

There is no formal system used by the selected civilian agencies to periodically report the costs and status of procurement projects to the

Congress. The Department of Defense reports its estimates of major projects' costs to the Congress periodically through mechanisms, such as the Selected Acquisition Reports, which are quarterly reports of the cost, schedule, and performance of major projects.

The selected civilian agencies generally submit information on the estimated costs of their major project acquisitions to the Congress through the budget process. For example, the Bureau of Reclamation annually presents a detailed estimate, status of construction, and a comparison of the current cost estimate with the authorized funding ceiling for each major project. Its budget presentations are supplemented with congressional hearings on the projects which sometimes generate the need for further information on the project's cost estimates to be presented at the hearings or provided for the hearing record. Also, answers to specific questions on the projects are provided by the agency's congressional liaison staff throughout the year upon request of applicable congressional committees.

Cost estimates submitted to the Congress on the nine projects were basically initial budget estimates which were revised periodically. As the projects progressed, agency staffs prepared revised estimates to account for project changes (increases/decreases) using information provided either by the contractors, by architect-engineers, or by agency projects staffs. As far as we could ascertain, the project cost estimates submitted to the Congress were the latest estimates available.

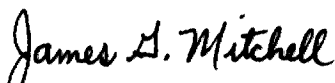
In view of the information already provided to the Congress on major acquisition projects, there is no apparent need for any additional formal periodic reporting system. Such a system would appear to duplicate information already submitted through the annual budget process.

As you requested, we did not obtain official comments on the report from the six agencies involved; however, we discussed the results of our study with the agencies and incorporated their comments where appropriate.

As arranged with your office, unless you publicly announce its contents or authorize its release earlier, no further distribution of this report will be made until 30 days from its issue date. At that time, we will send copies to the Director, OMB, the six agencies involved, and other interested parties. We will make copies available to others upon request.

If there are any questions regarding the content of this document, please call me on 275-8676.

Sincerely yours,



James G. Mitchell  
Senior Associate Director

## CONTENTS

	<u>Page</u>
APPENDIX	
I CIVILIAN AGENCY COST ESTIMATING	
Objectives, scope, and methodology	6
Project summaries	
Bureau of Reclamation	8
Upper Stillwater Dam	
Mirdan Canal, Sections 2 and 3	
U.S. Corps of Engineers	13
Blue Springs Dam	
Second Stage Lock and Dam #26	
Replacement	
Veterans Administration	17
Richmond Medical Center	
Martinsburg Medical Center	
Federal Aviation Administration	20
Airport Surveillance Radar (ASR-9)	
U.S. Coast Guard	25
Short Range Recovery Helicopter	
National Oceanic and Atmospheric	
Administration	28
Next Generation Weather	
Radar (NEXRAD)	

### ABBREVIATIONS

ASARC	Aviation System Acquisition Review Committee
A/E	Architect Engineer
ASR	Airport Surveillance Radar
DOD	Department of Defense
DOT	Department of Transportation
FAA	Federal Aviation Administration
JSPO	Joint System Program Office
KDM	Key Decision Memorandum
NAS	National Airspace System
NEXRAD	Next Generation Weather Radar
NOAA	National Oceanic and Atmospheric Administration
OMB	Office of Management and Budget
RMM	Remote Maintenance Monitoring
SRR	Short Range Recovery Helicopter
TSARC	Transportation System Acquisition Review Council
VA	Veterans Administration

CIVILIAN AGENCY COST ESTIMATINGOBJECTIVES, SCOPE, AND METHODOLOGY

The purpose of this briefing report is to furnish information on the guidance and methodology followed by federal civilian agencies when they prepare cost estimates on agency procurements. We also looked at how agencies revise and update estimates for changes and how information on individual projects is reported to the Congress.

We believe the agencies and projects selected are a cross-section of projects associated with agencies responsible for performing a variety of governmental programs. Because our study covered only a small number of the total ongoing projects, the results should not be considered representative of all federal civilian agencies who do cost estimating but rather should be considered indicative of cost estimating only for the major projects and the agencies reviewed.

For each agency we determined what formal or informal guidance existed covering the preparation of cost estimates at the departmental and the agency operating level. We determined whether the existing guidance was followed in preparing estimates on the selected projects. Our work focused on cost estimates prepared at four stages in the life of each project. Determining which estimate to consider as the initial estimate for the individual projects was guided by the degree to which the selected project was identified at that time. We did not try to determine the validity of the specific cost estimates or the reasonableness of a project's cost growth.

We followed the cost estimating criteria set forth in our previous report on Theory and Practice of Cost Estimating for Major Acquisitions (B-163058, July 24, 1972.) We held discussions with responsible agency officials and project managers and reviewed available documentation supporting the cost estimates. We discussed our summary information on the individual projects with responsible agency officials and incorporated their comments in our summaries where appropriate.

The following table shows the year each project was started and the total estimated project cost at the time we completed work at the agency.



<u>Agency</u>	<u>Year started</u>	<u>Project</u>	<u>Current Cost</u> (000 omitted)
Bureau of Reclamation	1951	Upper Stillwater Dam	\$120,174
	1972	Mirdan Canal, Sections 2 and 3	27,050
U.S. Corps of Engineers	1968	Blue Springs Dam	10,600
	1976	Second Stage Lock and Dam #26 Replacement	283,000
Veterans Administration	1971	Richmond Medical Center	122,087
	1971	Martinsburg Medical Center	75,717
Federal Aviation Administration	1978	Airport Surveillance Radar (ASR-9) <sup>a</sup>	560,700
U.S. Coast Guard	1975	Short Range Recovery Helicopter <sup>a</sup>	436,933
National Oceanic and Atmospheric Administration	1980	Next Generation Weather Radar (NEXRAD)	846,000

<sup>a</sup>These two projects were among those recently reviewed for another GAO report, Budget Issues: Cost Escalation on Three Major Department of Transportation Projects (GAO/AFMD-86-31, July 17, 1986). This report was required by Section 2905(b) of the Deficit Reduction Act of 1984. This section specifies, among other things, that GAO look at all phases of budget preparation and program evaluation in the agencies selected and examine historical patterns of funding to determine the effect of cost estimation biases.

BUREAU OF RECLAMATIONUpper Stillwater Dam  
Mirdan Canal, Sections 2 and 3BACKGROUND

The Bureau of Reclamation budget estimate for fiscal year 1986 included about \$532 million for construction. At the Bureau we obtained current cost estimating instructions and reviewed the cost estimates of portions of two separate construction projects.

At the Upper Colorado Region we looked at the estimates for the construction of the Upper Stillwater Dam. This project had been considered by various groups and governmental agencies since about 1900. Investigations by the Bureau were conducted since 1945 and a feasibility report was issued in 1951. The project was authorized as part of the Colorado River Storage Project in 1956. Construction funding for the Upper Stillwater Dam structure was requested in fiscal year 1983 and the construction contract was awarded for the dam embankment, outlet works and spillway, some roads, and other features in December 1983. The dam construction is expected to be completed in fiscal year 1987.

At the Lower Missouri Region we reviewed cost estimates for the Mirdan Canal, sections 2 and 3, a segment of the North Loup Division Project. The project was first proposed to the Congress in 1962 but was not authorized by the Congress until 1972. First construction funds for Canal sections 2 and 3 were requested for fiscal year 1984. The construction contract was awarded in early 1984 for the construction of about 27 miles of canal and about 7 miles of lateral distribution facilities.

We reviewed progressive estimates for each of the selected construction projects beginning with the estimates used to request authorization of the projects from the Congress. Other estimates reviewed were those at the time first construction money was requested, those used for evaluation of bids for the construction work, and the most current estimates available at the time of our review. These estimates covered the period from 1951 for the Upper Stillwater Dam and from 1972 for the Mirdan Canal, sections 2 and 3.

CURRENT GUIDANCE AGENCY USES  
TO DEVELOP COST ESTIMATES

Basic guidance for the Bureau's preparation of cost estimates is contained in Reclamation Instructions. These instructions are segmented into parts which cover planning, estimating, budgeting, and other functions. Specific guidance

concerning inflation factors to be used to project future costs is given through indexes issued semiannually by the Engineering and Research Center. All of this guidance is standard, that is, applicable to all Bureau regions.

The cost estimating process called for by these instructions primarily determines the units of labor, materials, equipment, and other input to be used in the construction of a project and the price of each unit. This process is accomplished by preparing a description of each major item of work in enough detail so that units needed can be determined. Minor contract items are estimated by using a percentage allowance based on engineering judgment. Other factors in establishing the total estimate include adding an amount to cover unknown changes which, based on experience, will occur, and adding the cost of plans, designs, administration, and supervision of the construction. Because projects are relatively long-term, estimates are adjusted annually to reflect the change in price levels.

Once the Bureau receives authorization from the Congress to investigate the feasibility of a project, the responsible region initiates studies to determine, based on the needs to be fulfilled, the cost of the project and the value of the benefits of the completed project. The cost includes obtaining the land; building the project to conform to all requirements including safety, environmental, and natural resource protection; planning; design; and contract administration. This study defines the major requirements sufficiently to support cost estimates.

After the Congress authorizes construction, the region begins refining and further detailing the requirements towards preparing plans and specifications for contract bid and award. As requirements or needs change, and as pricing levels change, the region incorporates the cost effect of such changes into its estimates and eventually prepares a Definite Plan Report. The purpose of revising the estimates is to maintain a current cost estimate for planning and budget purposes.

Bureau instructions require regional directors to ensure that changes in project plans are recorded promptly in the project cost estimates. Revisions to approved plans that involve major restructuring of the project must be reported to the Commissioner. The requirement for revision continues throughout the construction stage. Cost estimates are updated at least annually to reflect scope changes and price level changes. These changes support annual appropriation requests.

The guidance calls for price level changes to be included in annual estimates to show the effect of cost trends. Prior to fiscal year 1982, costs were revised to include estimated price

levels at a point 1 year before the beginning of the budget year. Price level indexes are prepared by an Engineering and Research Center organization. Beginning with the fiscal year 1982 budget estimate, guidance was added to also adjust for anticipated price level changes up to the beginning of the fiscal year being budgeted. This projection is based on data disseminated by OMB in their annual budget call directions. Although the Washington headquarters of the Bureau also makes a projection of the impact of price changes for future years, this projected impact is not included in the budget estimates sent to the Congress in support of appropriation requests. It is, however, made available to OMB examiners for their use in reviewing the Bureau budget figures.

Bureau procedures cover the use of architect-engineers and others to perform design work and cost estimating. There are no provisions made for how this work is to be reviewed before incorporating the data in official Bureau budget estimates.

HOW COST ESTIMATES WERE  
DEVELOPED FOR THE PROJECTS

Upper Stillwater Dam

This project is part of the Bonneville Unit Central Utah Project. The Bonneville Unit includes diversion of westward water from the Uinta Basin to the Bonneville Basin and related development of local water sources. Documentation at the Bureau's Upper Colorado Region showed the following estimates for construction of the Upper Stillwater Dam from time of authorization until the current estimate:

<u>Procurement cost milestones</u>		<u>Costs</u> (000 omitted)
Feasibility	(January 1951)	\$ 15,280
Funding request	(October 1982)	19,770
Bid estimate	(October 1983)	75,892
Current estimate	(October 1985)	120,174
Increase		\$104,894

The funding request and bid estimate do not include the same items as the feasibility estimate and current estimate. The funding request was only for the dam structure. The bid estimate is only for the items included in the major construction contract which includes the dam structure, spillway, outlet works, some roads, and other features, and does not include the indirect costs associated with the work.

The total estimate for this work increased by \$104.9 million. Most of this increase, \$59 million (57 percent), was due to inflation. Part of the increase was due to various design changes. A major decrease in the estimate was made when the bids for construction came in at substantially less than the engineer's estimate. We were told the lower bids resulted from strong competition at the time of the bidding.

Sufficient documentation existed to show that the agencywide procedures for cost estimating were generally followed. Specifically, cost estimates were internally developed from plans and designs prepared or reviewed by the Upper Colorado Region. Design changes were made between the initial estimate and the Definite Plan Report, dated in 1964. From 1964 until 1970, there were no changes to the estimate, although the Bureau's index for earthen dams showed about a 28-percent increase in dam construction costs. We could not determine why increases were not made to the estimates because the persons involved at that time were no longer available for us to interview. However, since the 1970 estimate, changes to reflect price trends and design changes or refinements were made annually. Contingencies for unexpected costs were included in each estimate where required. It appears reporting to the Congress was done annually through the budget process based on the most current estimates available.

#### Mirdan Canal, Sections 2 and 3

The Mirdan Canal is one feature of the North Loup Division, a central Nebraska irrigation project with recreation and fish and wildlife benefits. Documentation at the Lower Missouri Region and the North Loup Project Office showed the following estimates for construction of sections 2 and 3 of the Mirdan Canal from time of authorization until the current estimate:

<u>Procurement</u> <u>cost milestones</u>	<u>Costs</u> (000 omitted)
Feasibility (January 1972)	\$ 6,260
Funding request (February 1982)	28,490
Bid estimate (January 1984)	17,500
Current estimate (December 1984)	27,050
Increase	\$20,790

The estimate for this work increased \$20.8 million from 1972 to the most current estimate. An analysis of the cost estimates shows that about \$14.5 million or 70 percent of this increase was due to price-level increases, and the remaining \$6.3 million increase was due primarily to design changes and

revisions, including the addition of some lateral construction, as the project became more defined.

The cost estimates for the canal remained unchanged except for price level changes from 1976 until the fiscal year 1984 estimate. At that time a redesign was incorporated. These estimates appear to have been prepared in accordance with the Bureau guidelines, including the use of price level indexes and the inclusion of a provision for contingencies. Reporting was done to the Congress annually through the budget process using the most recent estimates.

PROCEDURES AGENCY USES TO REPORT  
COST ESTIMATES TO THE CONGRESS

Cost estimates for projects are reported formally to the Congress each year as part of the budget process. Bureau procedures call for a detailed presentation of each project authorized, including the current estimate, status of construction, and a comparison of the current cost estimate with the authorized ceiling for the project. Most Bureau projects are authorized for a certain amount, which may be increased by the amount of price level increases according to engineering indexes of such costs. When it appears that costs might exceed this ceiling, the Bureau informs the appropriate committees of the Congress and/or proposes legislation to cover the deficit.

In the case of the North Loup project, the budget request for fiscal year 1985 stated that it appeared costs for the overall project would exceed the authorization and noted that legislation to provide a higher appropriation ceiling would be submitted to the Congress. This same statement was included in the 1986 budget request documents. The budget requests also noted that notice of this situation had been given to the appropriate congressional committees.

U.S. CORPS OF ENGINEERSBlue Springs Dam  
Second Stage Lock and Dam #26 ReplacementBACKGROUND

At the Corps we obtained the current cost estimating instructions and reviewed the cost estimating of portions of two separate construction projects. At the Kansas City District we reviewed cost estimates for the Blue Springs Dam, a portion of the Little Blue River Lakes Project, and at the St. Louis District we looked at the estimates for the second stage of construction of Lock and Dam #26 Replacement Project.

We reviewed progressive estimates for projects beginning with the estimate used to request authorization of the project from the Congress, the estimate at the time first construction money for the feature was requested, the estimate used for evaluation of bids for the construction work, and the most current estimate available at the time of our review. These estimates covered the period from 1968 for the Blue Springs Dam and from 1976 for the Lock and Dam #26 project. Both projects are now under construction.

CURRENT GUIDANCE AGENCY USES TO  
DEVELOP COST ESTIMATES

Basic guidance for the Corps' preparation of cost estimates is contained in two primary Engineering Manuals of the Corps. Specific guidance concerning programming and budgeting is contained in an Engineering Regulation. Certain other general guidance relating to cost estimating is found in OMB Circulars, the Federal Acquisition Regulation, and other engineering manuals and instructions of the Corps. Also, specific guidance concerning inflation factors to be used to estimate future costs is given through annual budget call guidance letters. All of this guidance is standard, that is, applicable to all Corps Divisions and Districts.

The guidance calls for progressively refined estimates of the work to be done, including purchase of land, relocations, construction costs, environment and resource protection, safety, planning and design costs, and costs of contract administration. These instructions require that estimates be prepared based on visualization of the work to be done and a detailed determination of the units of work required and estimates of the costs for these units of work. For estimates developed in the early stages of the project, this visualization of work is based on less information than is known for use in later estimates. More detailed investigations of ground conditions and more knowledgeable designs are prepared as

planning progresses toward the construction stage. These estimating stages are covered by instructions calling for preliminary and advanced project planning phases. At each stage a design document is produced which includes a cost estimate.

Instructions also call for each successive design stage and estimate to include an amount to cover the uncertainties existing in each stage, with the earlier estimates providing for a greater contingency than the succeeding stages. When a design is finally prepared for the item to be constructed, specifications and bid documents are drawn up to use for obtaining construction bids, and estimates are prepared from these documents to obtain a "should cost" estimate for comparison with bids received.

Programming and budgeting requirements call for the Districts to keep estimates current. That is, as design refinements or changes are made and approved by higher levels, or as annual budget estimates are required, reestimates are prepared and indexing to current dollars is done. The new cost estimates are then used in the budget estimates submitted to the Congress.

Although the Corps Districts are responsible for the planning and estimating work, the guidance provides that assistance can and should be obtained from others when necessary, including other Corps offices, consultants, and architect-engineer contractors. The guidance also calls for review and approval of plans and estimates by the Division and Headquarters levels.

#### HOW COST ESTIMATES WERE DEVELOPED FOR THE PROJECTS

##### Blue Springs Dam

The purpose of this project, a multiple-purpose reservoir located in the vicinity of Kansas City, Missouri, is primarily to lessen flood damage to the area. Documentation at the Kansas City District showed the following estimates for construction of the Blue Springs Dam from time of authorization until the most current estimate:



<u>Procurement cost milestones</u>		<u>Costs</u> (000 omitted)
Feasibility	(August 1968)	\$ 3,361
Funding	(October 1979)	15,524
Bid estimate	(June 1982)	16,551
Current estimate	(October 1984)	10,600
Increase		\$ 7,239

The estimate for this work increased \$7.2 million. Most of the increase was due to increases in construction costs as reflected by various construction indexes used by the Corps to measure such increases. Part of the increase was also due to design changes, including one which increased the height of the dam.

The documentation for these estimates showed that the agencywide procedures for cost estimating were followed. Involvement by the various technical divisions of the District, as well as by state, local, and other federal agencies was documented. Throughout the period involved, estimates were based on then-current pricing information and designs. Changes to estimates were based on any design changes or other changes made by architect-engineer contractors. District personnel informed us that the work was reviewed by them and changes made where they believed such changes to be necessary. None of the contractors were responsible for preparing cost estimates.

Second Stage Lock and  
Dam #26 Replacement

This project includes replacement of a lock and dam at Alton, Illinois, about two miles downstream from the existing structure. The existing structures are in need of extensive rehabilitation and cannot expeditiously handle the barge traffic. Documentation at the St. Louis District showed the following estimates for construction of the second-stage lock and dam replacement from time of authorization until the current estimate.

<u>Procurement cost milestones</u>		<u>Costs</u> (000 omitted)
Feasibility	(October 1976)	\$147,900
Funding	(October 1982)	399,940
Bid estimate	(August 1984)	288,101
Current estimate	(October 1984)	283,000
Increase		\$135,100

The estimate for this work increased \$135.1 million from 1976 to 1984. According to the District's records, \$118 million, or about 87 percent, of this increase was due to inflation, including an estimate for future inflation through the construction period. The remaining \$17.1 million increase consists of increases due to design changes made as the project became more defined, other additions for work previously planned for inclusion in other than the second-stage contract, and decreases due to estimating adjustments.

Our review of the estimating done by the St. Louis District on this work disclosed essentially the same procedures and methods as were used by the Kansas City District summarized above. The work was done essentially in accordance with the Corps' current guidelines.

The replacement project was originally planned as a two-lock project under the Rivers and Harbors Act of 1909 but subsequently was approved by the Congress as a one-lock project. The initial estimate for the one-lock project was not the detailed estimate generally prescribed, but was derived from a detailed estimate that had been prepared for the project based on a different definition of the work to be done. However, subsequently, and before the request for construction funding of the work, a detailed estimate was prepared based on the one-lock configuration.

#### PROCEDURES AGENCY USES TO REPORT COST ESTIMATES TO THE CONGRESS

Cost estimates for projects are reported formally to the Congress each year as part of the budget estimate. Corps procedures call for a detailed presentation of each project authorized, including the current estimate, status of construction of the features within a project, discussions of changes in estimates or schedules and many other aspects of the project. In addition, districts are to prepare a paper for use in testimony to the Congress. These documents are for the use of testifying officers who each testify on the status of projects within their respective divisions. These budget presentation documents, the testimony, and responses to questions during hearings constitute the formal reporting to the Congress.

Officials told us they might get requests from individual members of Congress about projects to which they also respond. However, such queries and responses normally concern limited aspects of projects and would not involve new cost estimating information.

VETERANS ADMINISTRATION

Richmond, Virginia, Medical Center  
Martinsburg, West Virginia, Medical Center

BACKGROUND

Although two projects were selected, GAO only reviewed the details for the Richmond, Virginia, facility because cost estimating was done similarly for both the Richmond and Martinsburg projects. In 1971, VA prepared initial cost estimates for the Richmond and Martinsburg projects of \$48.2 and \$28.7 million, respectively.

The initial project definition of the Richmond hospital was for a 700-bed hospital including a parking lot. By the time the project was submitted as a budget request, a 120-bed nursing home with 57,600 gross square feet had been added. Estimates were changed accordingly. The hospital, located in Richmond, Virginia, provides primary, secondary, and tertiary diagnostic and therapeutic health services. The hospital is also a tertiary care referral for subspecialty treatment in open heart surgery, kidney transplantation, oncology, and vascular diseases.

The Martinsburg Medical Center located in the eastern panhandle of West Virginia has an authorized capacity of 414 hospital, 120 nursing home, and 540 domiciliary beds.

CURRENT GUIDANCE AGENCY USES  
TO DEVELOP COST ESTIMATES

The current cost estimating guidance at VA differs slightly from the procedures in effect at the time the Richmond and Martinsburg projects were started. VA has specific written cost estimating policies and procedures for both itself and for architect engineering (A/E) firms and cost consultants. VA guidance is set forth in a construction handbook and in manuals with A/E requirements for design and estimates. VA's estimating service also has internal written guidance for conceptual requirements, methodology, and procedures for A/E reviews.

VA now uses an advance planning fund, part of the construction budget, to provide for advance planning and selection of major projects. In very large projects, they usually hire a cost consultant to develop construction estimates as a check on the A/E. After internal review of estimates, a total project cost is developed including contingency, reserve, technical services, site acquisition and clearance costs, utility and other agreements. Costs are adjusted for inflation

and escalated to the dates of obligation. This estimate is the basis for budget submissions and establishes the cost target.<sup>1</sup>

HOW COST ESTIMATES WERE DEVELOPED FOR THE PROJECTS

The advance planning fund discussed above did not exist when the Richmond and Martinsburg projects were being planned. Initial estimates were developed prior to any A/E drawings and were based on limited scope and knowledge. These rough estimates were based on bed-level and historical data.

We documented the following estimated costs at the various stages of procurement.

<u>Procurement cost milestones</u>	<u>Costs</u>	
	<u>Richmond</u>	<u>Martinsburg</u>
	- - - - (000s omitted) - - - -	
Initial estimate	(1971) \$ 48,218	(1971) \$28,685
OMB approved	(1976) 116,000	(1976) 76,000
Bid evaluation	(1979) 125,180	(1978) 79,656
Current estimate	(1985) 122,087	(1985) 75,717
Increase	\$ 73,869	\$47,032

About 71 percent of the \$73.9 million increase in costs at the Richmond hospital was due to inflation. Likewise, 70 percent of the \$47 million increase in cost of the Martinsburg facility is due to inflation. The additional increases in cost for both projects were due to program and scope changes such as additions of nursing homes, changes in space planning criteria, and changes in number of beds.

---

<sup>1</sup>In June 1986 GAO issued a report assessing VA's major financial management processes (GAO/AFMD-86-7, June 27, 1986). The report pointed to a lack of effective integration between medical care planning and construction planning. This resulted largely from the lack of a national medical care strategy with clearly defined medical priorities for use in construction planning and prioritization. The report also agreed with earlier findings in an April 1985 report by Booze, Allen & Hamilton, Comprehensive Study of the VA's Organization and Procedures for Constructing Health Care Facilities. Their report stated that although general standards provide sufficient guidance for developing cost estimates, the accuracy of estimates had been reduced by VA's use of certain assumptions about project scope and design, inflation, and construction costs.

Although most of the estimating practices for the Richmond project could be explained, certain specific details were not available because program personnel who could answer questions were no longer with VA. The initial estimates were developed quickly in 1971 in response to a request for inclusion in the President's budget. A clear definition does not appear until 1977 when the master plan was approved and an A/E was hired. The current procedures provide a better definition of proposed projects for the initial and budget estimates.

VA has established an agencywide cost estimating structure. Through the Office of Construction, responsible agency offices participate and provide their input to the estimating process. We found that contractor-developed costs for the Richmond hospital were reviewed by the estimating service. Generally, we found that documentation supported the various estimates. However, on some aspects of the early estimates we did not find documents showing the source of the cost per square foot, the inflation rate, or the technical services rates. At the time cost estimates were being developed for the hospitals, VA used inflation rates developed within VA. The current practice is to use rates provided by OMB for federal construction. In the earlier cost estimates, VA included 5 percent of the construction for contingencies. Currently from 2 to 4 percent of construction costs are added for contingencies.

#### PROCEDURES AGENCY USES TO REPORT COST ESTIMATES TO THE CONGRESS

VA formally communicates with the Congress through submission of the VA budget, congressional hearings, and notification letters. The budget includes a total estimate for each major construction project, and testimony may include comments on cost estimates. VA also notifies congressional appropriations committees when the scope of a project increases 10 percent or more, or any increase of \$250,000 or more is planned. VA notifies congressional veterans affairs committees when construction contract awards are made and the appropriations committees when changes in project scope are made. VA officials meet with interested congressional staffs and provide oral or written responses to specific questions.

FEDERAL AVIATION ADMINISTRATION

## Airport Surveillance Radar - ASR-9

BACKGROUND

FAA's update and replacement of the National Airspace System (NAS) is expected to cost about \$11.4 billion. The overall program consists of some 150 individual projects, many of which are interrelated. The Airport Surveillance Radar (ASR) is one of 11 systems which are designated as Major System Acquisitions under Department of Transportation (DOT) Order 4200.14B. These systems should be subjected to intensive management review by FAA and DOT under OMB's Circular A-109 guidance for major systems acquisitions.

The ASR, or terminal radar, is a short range radar used extensively for terminal aircraft flight monitoring. FAA's inventory of surveillance radar systems includes the ASR-4/5/6 and ASR-7/8 systems. These radars provide data to the air traffic control facility where the data is utilized by controllers to direct aircraft movements within the terminal environment. The performance of the existing ASR-4/5/6 systems is limited to the same level attainable in 1958 when the equipment was designed. These systems are over 20 years old and provide only marginal detection of aircraft over strong ground clutter, in weather, or on a tangential course. Also, the quality of data provided by the ASR-4/5/6 system will not effectively support the automated systems scheduled for future implementation.

Procurement of new ASRs will replace 56 ASR-7/8 and 40 ASR-4/5/6 systems with a new state-of-the-art ASR-9 system. The 56 ASR-7/8s will be relocated to replace 56 ASR-4/5/6s at other airports. Replacement of the existing ASR-7/8s at high density airports with the ASR-9 and their subsequent relocation is referred to as the "leapfrog program" and was added by DOT in order to obtain the most current technology at all high density locations.

The contract entered into in September 1983 with Westinghouse Electric Corporation provides for delivery of the 96 replacement systems, 5 additional congressionally approved systems, and options for additional future system procurements.

CURRENT GUIDANCE AGENCY USES TO  
DEVELOP COST ESTIMATES

FAA Order 6011.4, Facilities and Equipment Estimating Procedures and Summaries Handbook, issued in September 1976, sets forth basic procedures for estimating facilities and equipment projects. The order was meant to provide standardized

cost estimating instructions and recommendations for use by all cost estimators. The order specified well developed project definitions and provides standardized cost estimating worksheets. It covered other cost estimating items such as provisions for inflation and contingencies.

Specific cost estimating guidance at FAA for major acquisitions is relatively new, beginning around 1983. The initial estimates in the ASR-9 program were not subject to the current guidance. Cost estimating guidance at the DOT level does not specify how cost estimates for major acquisitions should be prepared. Major acquisitions are subject to procurement guidance in OMB Circular A-109, Systems Acquisition and Approval, and DOT Order 4200.14B, Major Systems Acquisition, Review, and Approval.

FAA Order 1810.3, Cost Estimation Policy and Procedures, May 1984, established FAA's current cost estimating policy and includes a provision for independent review of program cost estimates. The order provides that (1) all program cost estimates and revisions shall be expressed in terms of life cycle costs and (2) as a minimum, program cost estimates must be developed or updated for the Aviation System Acquisition Review Committee (ASARC)<sup>2</sup> review prior to each key decision point.

Cost estimates prepared at FAA recognize the NAS plan as justification for the project's mission need. Each year the Deputy Secretary of Transportation selects those proposed projects to be designated major systems acquisitions which require Key Decision Memorandums (KDMs).

The program manager in the program office develops cost estimates utilizing existing cost estimating guidelines and drafts the KDM. After the KDM is reviewed by the Associate Administrator for Administration with comments from the Office of Budget and General Counsel, it is finalized, reviewed by ASARC, and submitted to the FAA Administrator for approval. Once approved by FAA, the KDM is submitted to the Transportation System Acquisition Review Council (TSARC) Executive Secretary, and ultimately to the Deputy Secretary of Transportation who issues the formal memorandum. The KDM is to be updated at each key decision point.

---

<sup>2</sup>FAA Order 1810.1D, July 1985, deleted the Aviation System Acquisition Review Committee and established a new position of NAS Program Director.

HOW COST ESTIMATES WERE  
DEVELOPED FOR THE PROJECT

The first system requirements statement on the acquisition for replacement of Airport Surveillance Radar 4/5/6 systems was prepared in November 1978 and issued as FAA Order 1811.3. The order provided for replacement of all ASR-4/5/6 systems (96 systems) with replacement equipment designed to meet current operational requirements including Remote Maintenance Monitoring (RMM) and diagnostic features to the extent they were cost effective. The system requirements statement noted that technical developments and evaluation of the moving target detector indicated that correction of most, if not all, the performance deficiencies of the ASR-4/5/6 systems were within the state-of-the-art.

The new system had to meet FAA's operational requirements and support the agency's objective of maintenance growth rate management. The original cost analysis and comparison of alternatives showed that the least costly method was to replace the existing systems with newly designed radar and beacon interrogators at an estimated cost of \$154.3 million in 1977 dollars.

A subsequent acquisition support document in September 1979 showed a replacement program expected to replace the 96 existing systems over a 5-year period. However, we were informed that the \$154 million estimate shown in this paper was based on preliminary design data and did not include costs for RMM and six-level weather channel receivers.

During early 1980, the FAA acquisition support document for the ASR-4/5/6 replacement program was reviewed by the TSARC, who opposed FAA's bypassing of the first three key decision points to move directly into production. FAA insisted that the program would use already developed and tested subsystem components and that integrating these into a complete system was considered to be a technical risk of minor nature. In July 1980, in response to TSARC, FAA decided a major restructuring of the program was necessary.

In a revised acquisition paper, dated August 1981, FAA estimated that the ASR replacement program, in 1981 base year dollars, would cost \$339 million for replacement of 96 radar units. This estimate did not include leapfrog costs attributable to redeploying the ASR-7/8s as replacements. The cost of the leapfrog program was estimated to be \$65 million in 1981 constant dollars. The \$339 million cost estimate is the baseline estimate still referred to by FAA. According to the program manager, the basic elements have not changed.



Documentation supporting estimates prior to 1982 was discarded during a 1982 program management transition. We were informed, however, that the \$339 million estimate was developed through a life-cycle-cost analysis. The model program included an allowance for inflation ranging from 5 to 12 percent. The analysis also included a factor for risk because installation of the system was considered a highly complex task.

On September 30, 1983, the Secretary of Transportation entered into a contract with Westinghouse Electric Corporation for \$480.5 million. The multiyear fixed price contract provides for 101 ASR-9 radars, technical data, support equipment, and training, with options for procurement of additional units. FAA requirements are for 96 original replacement units, 5 congressionally mandated units, options for 12 additional units, and 24 units for the Department of Defense (DOD). Costs for the five congressionally mandated units were included under another program element.

Our review showed the following cost estimates during the procurement:

<u>Procurement cost milestones</u>	<u>Costs</u> (000 omitted)
Initial Estimate (November 1978)	\$154,300
OMB Approved (September 1981)	339,000
Bid Evaluation (July 1982)	383,400
Current Estimate (August 1985)	560,700
Increase	\$406,400

The current estimate for the ASR-4/5/6 replacement program is about \$406 million more than the original estimate for the program. The \$185 million increase in the project between the initial estimate and the OMB approved 1981 proposal is attributable to expanding the scope of replacement of the ASR-4/5/6s from an enhanced ASR-8 with weather capability to a new ASR-9 system, and inflation over the 1978 to 1981 period. The \$221 million increase between the 1981 estimate of \$339 million and the current estimate of \$560 million includes \$87.9 million to relocate the ASR-7/8 radars displaced by the new ASR-9 radars, costs omitted from the initial estimates for additional features, requirements and technical changes, and inflation.

PROCEDURES AGENCY USES TO REPORT  
COST ESTIMATES TO THE CONGRESS

Cost information on major FAA acquisitions is reported to the Congress primarily through the annual budget process. In

addition to the President's budget, FAA headquarters prepares a separate congressional submission which provides much more detailed data and justification. Detail on individual projects is also provided during hearings and subcommittee deliberations which result in a report by the Appropriations Committees. Briefings are provided upon request and specific questions are answered through the agency's congressional liaison process.

U.S. COAST GUARD

## Short Range Recovery Helicopter

BACKGROUND

Replacement of the U.S. Coast Guard's HH-52A helicopter was first studied in 1974. A preliminary economic service life study estimated the cost of 86 Short Range Recovery Helicopters (SRRs) at approximately \$144 million. The final acquisition support document for 90 SRRs was approved in 1977 and estimated costs were \$175.9 million. The four additional aircraft were added in the second phase of the process to meet defined requirements. A contract for 90 SRRs was awarded in June 1979 for \$214.8 million to the Aerospatiale Helicopter Corporation with options for additional units. The Congress added six helicopters in 1983 for a total of 96.

Initial delivery of aircraft was to start in November 1981 with all 90 helicopters delivered, at the latest, by February 1986. However, early in production, Aerospatiale experienced engine problems and could not adhere to the original delivery schedule. Aerospatiale and the U.S. Coast Guard agreed on a new delivery schedule with initial delivery of helicopters starting in November 1984. As of March 30, 1986, the U.S. Coast Guard had accepted (received and tested) 26 SRR helicopters. According to the U.S. Coast Guard officials, Aerospatiale is meeting the new delivery schedule.

CURRENT GUIDANCE AGENCY USES TO  
DEVELOP COST ESTIMATES

Written guidance from DOT and the U.S. Coast Guard does not specify how cost estimates should be prepared for major acquisitions. Major acquisitions follow the procurement guidance in OMB Circular A-109, Systems Acquisition and Approval; DOT Order 4200.14B, Major Systems Acquisition, Review, and Approval; and the most recent U.S. Coast Guard Planning and Programming Manual, issued in December 1983. According to the U.S. Coast Guard, the procedures followed in procuring aircraft are different from those followed in other procurements. The agency does not procure aircraft often, and as a consequence, methods used to procure and prepare cost estimates vary with each acquisition.<sup>3</sup>

---

<sup>3</sup>We recently reviewed and reported on U.S. Coast Guard's acquisition reform actions resulting from two studies that the U.S. Coast Guard initiated to identify where and how management of the acquisition process could be improved. Coast Guard Acquisitions: Status of Reform Actions (GAO/RCED-86-161BR, June 11, 1986).

HOW COST ESTIMATES WERE  
DEVELOPED FOR THE PROJECT

The SRR performance objectives were to provide basic resource capabilities for search and rescue, polar ice breaking, law enforcement, and environmental protection to mission areas. U.S. Coast Guard develops cost estimates in conjunction with the planning, programming, and budgeting process. We were informed that estimates in the very early stages of this procurement were "ball park" or "rough order of magnitude" where emphasis was on justifying the new aircraft. Early cost estimates for the SRR were based on manufacturers' rough quotations and figures cited in aircraft trade journals. Versions of these early estimates were used to document support for the 1978 funding request. Once the contract was awarded, costs were refined using the contract price and economic price adjustments.

Our review of available cost documentation showed the following cost estimates at various stages of procurement:

<u>Procurement cost milestones</u>		<u>Costs</u> (000s omitted)
Initial estimate	(May 1975)	\$144,356
OMB approved	(September 1975)	153,560
Bid evaluation	(May 1977)	175,900
Current estimate	(February 1985)	436,933
Increase		\$292,577

About 58 percent of the increase was attributable to inflation. Other increases were due to adjustments for items such as the airframe, avionics, initial spares, training, systems integration, publications, and program management. Other definitional changes included additional aircraft, flight tests, variable cockpit training system simulation, ferry costs, and cockpit voice recorder.

The U.S. Coast Guard developed a performance and procurement definition for the SRR. However, the performance definition and related assumptions changed as the SRR characteristics were refined. A project officer was assigned pursuant to OMB Circular A-109 and copies of cost estimates were sent to the internal offices for review. We could not determine the extent to which these reviews were performed since the staff involved were no longer with the U.S. Coast Guard. As there is no agencywide standard structure, the estimates varied in format and data presentation. The DOT Order for acquisition approval documents requires disclosure of whether estimates include inflation and what rates were used. Our review of documentation showed that only in the current estimate was inflation

identified in specific dollar amounts. Rates used were based on Bureau of Labor Statistics and U.S. Coast Guard's own experience.

DOT Orders require identification of program contingencies but there is no guidance at U.S. Coast Guard. In general, estimates we looked at did not include a percentage calculation for contingencies or risks as part of the process.

Cost estimating for the project was performed in-house and no outside contractors were used for estimating. Generally, we found documentation to support the earlier estimates but not for later estimates. Therefore, we could not obtain a full explanation for all changes at the project milestones.

PROCEDURES AGENCY USED TO REPORT  
COST ESTIMATES TO THE CONGRESS

Cost information on major acquisitions is reported to the Congress primarily through the annual budget process. Details on cost estimates are communicated in the Acquisition, Construction, and Improvement detailed budget sheets which are a part of the budget documentation. Additional information is provided through briefings to congressional committee or subcommittee staffs and through testimony in hearings before these committees.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

## Next Generation Weather Radar (NEXRAD)

BACKGROUND

Acquisition of the Next Generation Weather Radar (NEXRAD) is a tri-agency effort involving the Departments of Commerce, Defense, and Transportation. The Joint System Program Office (JSPO), with members from each agency, is governed by the NEXRAD program council. NEXRAD is the proposed national weather radar system to replace current weather radar and air traffic control radar in the United States and overseas. It will upgrade existing capabilities using the Doppler principle, solid state technology, and improved communication display and data processing. The new radar will provide weather information to support field operations of NOAA's National Weather Service, the Air Force's Air Weather Service, the Federal Aviation Administration, and the Naval Oceanography Command.

This project started in 1976 with the Joint Doppler Operational Project which tested the use of radar for improving weather forecasts. To date NEXRAD funding has been for system definition and validation. A total cost estimate for the overall procurement has not yet been forwarded for inclusion in the budget. Fixed, final proposals for production were solicited in February 1986.

CURRENT GUIDANCE AGENCY USES  
TO DEVELOP COST ESTIMATES

NOAA does not have specific written guidance for cost estimating. Some aspects of cost estimating are touched upon in Department of Commerce Administrative Order 208-3 which establishes policies, procedures, and responsibilities implementing OMB Circular A-109. These instructions define the elements to include in a major system. They may include items such as hardware, equipment, services, software, construction, and real property. A program manager is assigned to manage the acquisition and prepare the program development plan, which includes the cost objectives.

The NEXRAD project is a four phase acquisition--system definition, validation, limited production, and full production. Alternative designs were evaluated with three competing contractors--Sperry, Raytheon, and Ford/Westinghouse. Sperry and Raytheon were selected to test and demonstrate their system designs and produce preproduction models. Production proposals were received in June 1986.

HOW COST ESTIMATES WERE  
DEVELOPED FOR THE PROJECT

The initial cost estimate for the program was prepared by the MITRE Corporation and included in the joint program development plan and mission needs statement. Current estimates are based on internal plans, actual contracts, and contractor-developed cost data. Facilities costs are based on the contract for site surveys, site preparation, and land acquisition. System definition and validation are based on actual contracts. The JSPO estimated the cost of limited and full production using data from Sperry and Raytheon who also provided major component cost data for the radar, processor, display, and communications. The total estimate for production cost is based on the unit cost data and the current requirements of the participating agencies. The following table shows the estimates for NEXRAD:

<u>Procurement cost milestones</u>	<u>Costs</u> (000s omitted)
Initial estimate (May 1980)	\$336,900
Current estimate (May 1985)	846,000
Increase	\$509,100

About 71 percent of the increase in cost from 1980 to 1985 is attributable to inflation. The remaining increase was due to definitional changes and increase in the number of radars. The joint program office also decreased the project by \$6.5 million by refining the estimates for program management, system development, production, and facilities.

The initial cost estimate, prepared by MITRE Corporation in 1980, used some assumptions in the information used for the initial estimate. The system includes the procurement of 160 radars, 95 Doppler and 65 nonDoppler, providing coverage to most of the United States and overseas DOD locations. No land costs were included since it was unknown whether any land would be needed. The current definition is specific and reflects changes in the programs from the initial estimate.

The initial NEXRAD estimate was stated in constant 1980 dollars with no allowance for inflation. Estimates in the 1982-84 time period were inflated 7.5 percent, the average of OMB rates. The current estimate was stated in 1985 dollars and inflated to then-year dollars using an Air Force index.

The estimates for research, development and the Doppler radar subsystem contained a 10 percent contingency factor. The

joint program office reviewed, revised, approved, and monitored contractor estimates on a regular basis. The NEXRAD program estimates exclude the cost of DOD and FAA personnel who are assigned to the joint program office.

PROCEDURES AGENCY USES TO REPORT  
COST ESTIMATES TO THE CONGRESS

The total NEXRAD program cost is not routinely provided to the Congress as a single budget item. Each of the three participating agencies requests its share of the project's cost separately in its individual budgets. NOAA provides information on cost estimates to the Congress primarily through the budget submission, related hearings, and briefings to congressional staff.

(014403)



---

Requests for copies of GAO reports should be sent to:

U.S. General Accounting Office  
Post Office Box 6015  
Gaithersburg, Maryland 20877

Telephone 202-275-6241

The first five copies of each report are free. Additional copies are \$2.00 each.

There is a 25% discount on orders for 100 or more copies mailed to a single address.

Orders must be prepaid by cash or by check or money order made out to the Superintendent of Documents.

---

United States  
General Accounting Office  
Washington, D.C. 20548

Official Business  
Penalty for Private Use \$300

Address Correction Requested

---

First-Class Mail  
Postage & Fees Paid  
GAO  
Permit No. G100