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United States Government Accountability Office  
Washington, DC 20548

February 10, 2006

The Honorable Wayne Allard  
Chairman  
Subcommittee on the Legislative Branch  
Committee on Appropriations  
United States Senate

The Honorable Jerry Lewis  
Chairman  
Committee on Appropriations  
House of Representatives

Subject: *Architect of the Capitol: Addressing Staffing and Training Issues Is Important for Efficient and Safe West Refrigeration Plant Operations*

The West Refrigeration Plant Expansion (WRPE) project is the centerpiece of an effort to expand the capacity of the Capitol Power Plant (CPP) to meet the U.S. Capitol's growing heating and cooling needs and to update plant equipment, some of which dates to the 1950s. CPP generates steam and chilled water to provide heating and cooling for the Capitol and 23 surrounding facilities that, together, encompass about 16 million square feet of space. CPP will also serve the 580,000-square-foot Capitol Visitor Center (CVC), which is under construction. When completed, the WRPE project will increase CPP's chilled water production capacity by about 23 percent and enable central operation of CPP's chillers.<sup>1</sup> The WRPE construction contract was awarded in March 2003, work is ongoing, and the project is now scheduled for completion in March 2006. Future contract changes may, however, extend this date to June 2006. The budget for the WRPE project and associated administrative expenses is \$81.7 million. Several modifications have been made to the WRPE contract to incorporate other capital improvements at CPP. The budget for these modifications is \$19.2 million, bringing the total budget for the base WRPE project and related projects to \$100.9 million. For clarity, we refer in this report to the base WRPE project and related projects collectively as the WRPE project.

The Architect of the Capitol (AOC), who manages CPP, is responsible for commissioning the new West Refrigeration Plant equipment. According to the General Services Administration (GSA), which provides guidance to federal agencies

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<sup>1</sup>The base WRPE contract provides for a distributed controls system that uses a computer program, rather than human operators, to monitor and control CPP's chillers. A contract modification is funding a similar system for CPP's boilers.

on managing their facilities, commissioning is a systematic process to ensure, by verification and documentation, that all of a facility's systems perform interactively as designed and intended to meet the owner's operational needs. AOC and its contractors are carrying out the commissioning process, including a three-stage plan prepared by the construction contractor for testing the performance of the new WRPE equipment. AOC is also responsible for ensuring that CPP is staffed efficiently and that CPP personnel have the knowledge and skills to operate the plant safely.

Over the years, we have reported on AOC's management of CPP several times and made recommendations for improvement. Our most recent report, issued in April 2005, included recommendations on CPP's staffing.<sup>2</sup> As requested, this report updates our prior work and evaluates AOC's (1) commissioning activities to date and plans for commissioning the new equipment without disrupting current operations and (2) plans for staffing the modernized power plant efficiently and ensuring that CPP personnel are trained to operate it safely. In addition, the report estimates the costs to complete the WRPE project, taking into account the possible effects of anticipated contract changes, operational issues, and other challenges to a timely and successful startup.

To evaluate AOC's commissioning activities to date and plans for commissioning the new equipment, we reviewed GSA's guidance on commissioning,<sup>3</sup> visited CPP, and interviewed CPP managers and a construction management consultant retained by AOC. We also reviewed the equipment-testing plan prepared by the construction contractor. To support our evaluation of the commissioning activities and plans, we retained an engineering consultant who specializes in heating and cooling plant operations. To evaluate AOC's plans for staffing the modernized plant efficiently and ensuring that CPP personnel are trained to operate it safely, we reviewed our guidance on strategic training and development,<sup>4</sup> interviewed CPP managers, and reviewed AOC's response to the staffing and training recommendations we made in our April 2005 report. Additionally, we randomly selected and interviewed five CPP operators to learn about the deployment and content of the training from their perspective. To estimate the costs to complete the WRPE project, we reviewed AOC's cost and schedule information related to the construction contract and identified contract changes, operational issues, and other challenges that could affect the project's costs and schedule. The same engineering consultant who helped us evaluate AOC's commissioning plan assisted us in developing our cost analysis, which includes, for each cost component, a range of costs to account for variations in circumstances, from best to worst case. We conducted our review from June 2005 through December 2005 in accordance with generally accepted government auditing standards.

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<sup>2</sup>GAO, *Capitol Power Plant: Actions Needed to Improve Operating Efficiency* (Washington, D.C.: Apr. 8, 2005), issued as unnumbered correspondence. This work was mandated in the Consolidated Appropriations Act for Fiscal Year 2005 (Section 1101 of Division G, Title I of Pub. L. No. 108-447 118 Stat. 2809, at 3185 and 3186 (2004)).

<sup>3</sup>GSA, Public Buildings Service, Office of the Chief Architect, *The Building Commissioning Guide* (Washington, D.C., April 2005).

<sup>4</sup>GAO, *Human Capital: A Guide for Strategic Training and Development Efforts in the Federal Government*, [GAO-04-546G](#) (Washington, D.C.: March 2004).

## Results in Brief

The WRPE commissioning process has been effective thus far, although the bulk of the equipment testing remains to be done. According to our analysis, AOC's commissioning activities to date and commissioning plans are consistent with GSA's commissioning guidance and are designed to allow the new plant equipment to start up without disrupting CPP's current operations. GSA's guidance calls for document reviews, checklists, functional performance tests, and training in the use of the equipment. This process is intended to ensure that the equipment meets specifications and performs as intended. AOC and its contractors have been performing the activities GSA recommends. Since March 2003, when construction began, CPP project managers and AOC's construction management consultant have been reviewing documents and monitoring WRPE construction and equipment installation activities. In addition, starting in November 2005, a commissioning agent retained by AOC, as we recommended, has been overseeing the construction contractor's execution of the contractor's three-stage plan for testing the functional performance of the equipment—the heart of the commissioning process.<sup>5</sup> Under this plan, which consists of a series of checklists, the contractor is testing the functioning of individual components, the manual operation of system components, and the automatic operation of system components. According to AOC, the functional testing has proceeded without incident, and overall plant operations have continued without disruption. However, most of the functional testing lies ahead, and the training for operators in the use of the equipment, which the equipment manufacturers will provide, has not started yet. Ultimately, the effectiveness of the commissioning process will be determined by how well the new systems function when CPP assumes full responsibility for their operation.

By contrast, AOC has made less progress in planning to staff the modernized power plant efficiently and ensure that CPP personnel are trained to operate it safely. Specifically, AOC has just begun to address long-standing CPP staffing recommendations and has not developed a plan for evaluating the training provided to CPP operators. As far back as 1996, an AOC engineering consultant found that CPP was overstaffed and recommended staffing reductions. Most recently, in November 2004, a different AOC engineering consultant recommended a reduction in CPP staffing from 88 to 46 positions. In October 2005, AOC contracted with the same consultant it retained in 2004 for an updated workload-based staffing study, a draft of which was recently delivered to AOC for review. According to AOC, the new study includes a proposed organizational chart and an implementation plan for achieving the recommended organizational structure. While this draft study is a step toward staffing CPP more efficiently, it will not be completed in time to guide AOC's investments in training required for the new equipment's operation. As a result, AOC is providing training for all plant operators, even though fewer operators may be

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<sup>5</sup>The commissioning agent retained by AOC had been involved with the project as a subcontractor to AOC's construction management consultant. We recommended that, given the importance of the commissioning process, AOC have a direct relationship with an independent commissioning agent. In November 2005, AOC entered into a new contract for commissioning services with the same firm that was formerly a subcontractor to AOC's construction management consultant.

needed after a new staffing plan is in place. To help ensure that CPP personnel are trained to operate the modernized plant safely, AOC has planned, developed, and begun to implement training for CPP operators that addresses safe plant operations, but AOC has not developed a plan for evaluating the training and using the evaluation results to guide future training investments or to help implement a new staffing plan. Without an evaluation plan, AOC cannot ensure that CPP personnel have acquired the skills needed to operate the modernized plant safely or that the best prepared operators are included in CPP's restructured workforce. Feedback from AOC's construction management consultant and our interviews with CPP operators have raised concerns about how well the initial training has prepared CPP staff to operate the new equipment. To address these concerns, AOC plans to hire a startup contractor to provide technical assistance for up to 8 weeks after WRPE's completion. AOC believes this technical assistance will help CPP staff operate the new equipment safely, without damaging it, and will help AOC identify and address any gaps in operators' training. We are recommending that AOC develop and implement an updated workload-based staffing plan based on the results of its most recent consultant's study, evaluate the training provided to CPP operators, and use the evaluation results in implementing the updated staffing plan.

We estimate that the cost to complete the WRPE project could differ from the \$101 million budgeted for it, potentially ranging from about \$98 million to nearly \$106 million, depending on the outcomes of negotiations over future contract changes and the level of training and contractor technical support that CPP operators need. Currently, the WRPE construction contract is scheduled for completion in March 2006, but because of these contract changes, CPP project managers expect that it will be delayed until June 2006. Among the contract changes that are likely to have the greatest impact on WRPE's cost and schedule are those that affect the design and construction of the fire sprinkler system, the configuration of chilled water pipes, and the design and construction of the distributed controls system for the chillers. As commissioning progresses, funds are also likely to be needed for troubleshooting and repairs, as well as for startup support if operators require additional technical assistance.

We provided a draft copy of this report to AOC for review and comment. AOC officials provided oral comments in which they generally concurred with our recommendations and offered technical clarifications and updated information concerning staffing and training efforts.

## **Background**

The director of CPP, who reports to the AOC Chief Operating Officer, is responsible for managing 95 full-time-equivalent staff and an operating budget that, in fiscal year 2005, totaled approximately \$33 million.<sup>6</sup> The director's position has been vacant since May 2005, but AOC is now working to fill the vacancy and expects to hire a new director in January 2006.

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<sup>6</sup>The \$33 million operating budget primarily consists of payroll, maintenance, and utility costs. The utility costs largely consist of fuel and electricity to operate the boilers and chillers.

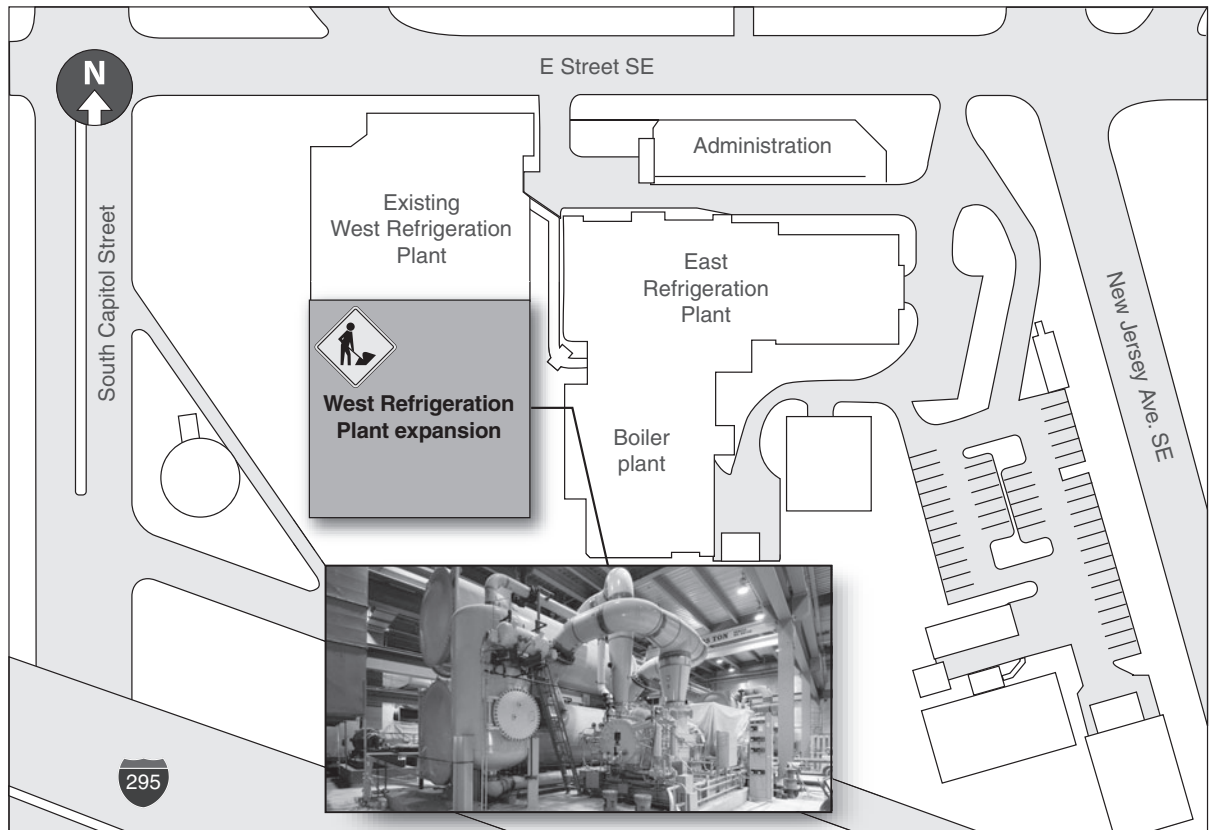
Located at New Jersey and E Streets, Southeast, in Washington, D.C., CPP consists of four main facilities:<sup>7</sup> a steam plant constructed in 1908; the East Refrigeration Plant, constructed in 1938; and the West Refrigeration Plant and administration building, constructed in 1978. WRPE, whose construction AOC is managing under an ongoing contract, will add approximately 25,000 square feet to the West Refrigeration Plant. This additional space will house new machines for generating chilled water (see fig. 1). The contract also provides for installing a centrally operated distributed controls system for CPP's chillers. AOC has budgeted \$81.7 million for this contract and associated administrative expenses. AOC is also completing other projects related to CPP operations under the same contract, including installing a centrally operated distributed controls system for CPP's boilers, a fuel oil tank, and an emergency generator, and modernizing the plant's electrical system. AOC is using multiple funding sources—primarily specific appropriations but also some CPP operating funds—to pay for these other projects, the combined budgeted cost of which is \$19.2 million. In total, the budgeted cost of the WRPE project—including both the base project and the related projects—is \$100.9 million. According to CPP project managers, the new WRPE chillers were manually tested before December 1, 2005, meeting a contract milestone. The WRPE project is now scheduled for completion by March 16, 2006; however, CPP project managers told us that pending contract changes are likely to delay its completion until June 2006.<sup>8</sup>

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<sup>7</sup>CPP does not currently produce electric power. According to AOC officials, CPP stopped producing power in 1952.

<sup>8</sup>Other work under the contract, such as the installation of the distributed controls system in the boiler plant, is likely to continue beyond this date.

**Figure 1: CPP West Refrigeration Plant Expansion Project Site and New Chiller (photo)**



Sources: GAO (map); AOC (photo).

The East and West Refrigeration Plants are used to generate chilled water for comfort cooling and equipment cooling. Together, these facilities currently have a nominal chilled water production capacity of 37,700 tons.<sup>9</sup> The base WRPE project will provide three new 5,400-ton chillers, which will replace obsolete chillers in the East Refrigeration Plant. The obsolete chillers in the East Refrigeration Plant will be removed, and two new 3,000-ton chillers,<sup>10</sup> temporarily located in the East Refrigeration Plant, are proposed to be moved to WRPE after it is completed. The expanded West Refrigeration Plant (WRP), including both the existing WRP and the WRP expansion, will then produce all of CPP's chilled water and will have a total production capacity of 46,200 tons, an increase of nearly 23 percent over CPP's current capacity. The East Refrigeration Plant will be available for alternative uses, such as housing a cogeneration system<sup>11</sup> that AOC is currently considering.

<sup>9</sup>The rate at which a chiller produces cooling is generally expressed in tons per hour. One ton of cooling is equal to the amount of cooling provided by 1 ton (2,000 pounds) of ice melting in 1 day (12,000 British thermal units per hour). The West Refrigeration Plant houses four 6,000-ton chillers, and the East Refrigeration Plant contains two new 3,000-ton chillers and four obsolete chillers (three 2,200-ton chillers—two of which were taken out of service in July 2005—and one 1,100-ton chiller).

<sup>10</sup>AOC purchased these chillers in September 2004 to supplement chilled water production in case of disruptions during construction.

<sup>11</sup>A cogeneration system is a combustion turbine generator that produces electricity and uses the heat from the combustion to produce steam.

As part of our work for Congress, we have reported on AOC's management for several years. Recently, we have testified several times on AOC's management of the Capitol Visitor Center, which is under construction.<sup>12</sup> In a September 2005 testimony, we identified incidents at CPP that we said could affect CPP's ability to provide chilled water and steam. For example, in July 2005, two chillers in CPP's East Refrigeration Plant were taken out of service because of a significant refrigerant gas leak that went undetected by CPP staff. AOC does not plan to repair the chillers because they are scheduled for demolition. In addition, in June 2005, one of CPP's two coal-burning boilers was damaged by a fire that, according to a CPP incident report, was caused by operator error. CPP has since repaired the damaged boiler. We further testified that management issues at CPP, including the absence of a staffing plan for WRPE, could affect WRPE's and CPP's operational readiness, and we stated that it was essential to fill the CPP director's position with an experienced manager who is also an expert in the production of chilled water and steam.

### **Commissioning Activities to Date and Commissioning Plans Are Consistent with Federal Guidance on Achieving Intended Performance**

AOC's commissioning activities to date and plans for commissioning the new WRPE equipment are consistent with GSA's guidance and are designed to allow the new plant equipment to start up without disrupting current operations. GSA's guidance calls for several activities during construction to help ensure that a facility's systems perform interactively as designed and intended. These activities include reviewing submittals for performance parameters, developing and using construction checklists, conducting functional performance tests, and providing training. See table 1 for details.

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<sup>12</sup>See GAO, *Capitol Visitor Center: Schedule Delays Continue; Reassessment Underway*, [GAO-05-1037T](#) (Washington, D.C.: Sept. 15, 2005); *Capitol Visitor Center: Status of Schedule, Fire Protection, Cost and Related Issues*, [GAO-06-180T](#) (Washington, D.C.: Oct. 18, 2005); and *Capitol Visitor Center, Update on Schedule and Cost*, [GAO-05-251T](#) (Washington, D.C.: Nov. 16, 2005).

**Table 1: Facility Construction Commissioning Activities**

Commissioning activity	GSA's description
Review submittals	<ul style="list-style-type: none"> <li>• Evaluate product documentation provided by contractor for items intended to be used or installed during construction</li> <li>• Documents include engineering drawings, product data sheets, and operating and training manuals</li> </ul>
Develop and use construction checklists	<ul style="list-style-type: none"> <li>• Checklists are tools for ensuring that product type and performance information specified in the contract documents is transferred to workers</li> <li>• In completing checklists, all parties are assured that the contract requirements are satisfied</li> <li>• Checklists cover activities from delivery and storage of products and materials to installation and startup steps</li> <li>• Completion of checklists is reviewed during periodic site visits</li> </ul>
Conduct functional performance tests	<ul style="list-style-type: none"> <li>• Functional performance tests are the focal point of the commissioning process and are intended to evaluate the ability of the components of a system to work together to meet performance criteria</li> <li>• Functional performance tests are performed after construction checklists are complete</li> <li>• Outcomes of tests are recorded using photographs, forms, or other means</li> <li>• Retesting is done as necessary</li> </ul>
Provide training	<ul style="list-style-type: none"> <li>• Training is conducted to teach operating personnel about required care, adjustment, maintenance, and operation of equipment and systems</li> </ul>

Source: GAO analysis of GSA's *The Building Commissioning Guide*.

Since March 2003, when AOC awarded the WRPE construction contract, CPP project managers and AOC's construction management consultant have been working together to monitor building construction and equipment installation activities. The project managers have overall responsibility for administering the construction contract, and the construction management consultant provides administrative support. The consultant has coordinated the reviews and approvals of all submittals prepared by the construction contractor and has conducted field inspections to ensure that construction and equipment installation work meets contract specifications. Given the importance of the commissioning process to ensuring that WRPE meets its designed intent, we suggested to AOC in June 2005 that it provide strong oversight of the process. AOC subsequently retained an independent commissioning agent, who had previously been involved with the WRPE project as a subcontractor to AOC's construction management consultant, to provide dedicated oversight of the activities outlined in the construction contractor's testing plan. This commissioning agent will also be providing training to CPP operators to familiarize them with the new plant equipment, as discussed in the next section, and coordinating the equipment-specific training provided by the equipment manufacturers as part of the commissioning process.

The operation of WRPE's chilled water generating system is being tested according to the construction contractor's three-stage plan. This plan includes functional testing of the individual components (stage one), manual operation of system components (stage two), and automatic operation of system components (stage three). Each



stage of the plan is based on sequenced checklists that detail testing procedures.<sup>13</sup> According to CPP project managers, as of December 1, 2005, system components had been installed, and the three new chillers were manually operational, as planned. The CPP project managers reported that stage one testing, which began in October 2005, was largely complete and that stage two testing, which began in mid-November 2005, was ongoing. According to AOC officials, the testing has proceeded thus far without incident, and CPP has continued to operate without disruption. However, most of the testing lies ahead. Specifically, the stage three testing is to begin in February 2006 and continue for the duration of the construction contract. AOC's commissioning agent has started to provide familiarization training to CPP operators, but the manufacturer-provided, equipment-specific training has not yet begun.

### **AOC Lacks a Staffing Plan for CPP and Has Not Determined How It Will Evaluate Operator Training**

To operate the modernized power plant efficiently and safely, AOC needs an appropriate number of staff with the knowledge and skills necessary to properly operate and maintain the new equipment and the new distributed controls systems. AOC has long recognized that CPP is overstaffed, but has not implemented staffing reductions and has only recently contracted for and received an updated draft study that it plans to use in establishing a new CPP staffing structure. AOC is providing training for all plant operators but has not yet determined how it will evaluate the training.

### **Studies Have Long Identified Overstaffing, but AOC Has Just Begun to Address Staffing Recommendations**

In 1996, in a technical and economic evaluation of CPP operations, an AOC engineering consultant reported that CPP was overstaffed compared with similar plants and estimated that a reduction in the number of staff from 86 to 61 would reduce CPP's staffing costs by about 29 percent.<sup>14</sup> In a March 2004 report on CPP, we noted that there had been little change in CPP's staffing since 1996 and recommended that AOC update the portion of its 1996 study related to staffing.<sup>15</sup> AOC then contracted with a different engineering consultant to update the 1996 study. This updated study, which was issued in November 2004 and took the ongoing WRPE project into consideration, indicated that current staffing levels were high, and recommended a reduction in CPP staffing, from 88 to 46 positions.<sup>16</sup> In our April 2005 report, we recommended that, by the end of September 2005, AOC develop an implementation plan for adopting its consultant's November 2004 recommendations, including the CPP staffing reduction. In October 2005, AOC contracted with the same

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<sup>13</sup>The WRPE construction contractor has prepared the checklists for stages one and two of the testing plan but has yet to prepare checklists for stage three. AOC project managers expect to receive the third stage of the plan in February 2006.

<sup>14</sup>See AOC, *Capitol Power Plant Technical and Economic Evaluation of Plant Operations* (Washington, D.C., April 1996).

<sup>15</sup>GAO, *Capitol Power Plant Utility Master Plan*, [GAO-04-456RNI](#) (Washington, D.C.: Mar. 1, 2004).

<sup>16</sup>See AOC, *Utility Master Plan* (Washington, D.C., 2004).

consultant it retained in 2004 to develop an updated staffing study. This new study, a draft of which was recently delivered to AOC, includes benchmarking and workload analyses that the consultant used to develop a proposed organizational chart and an implementation plan to achieve the recommended organizational structure. While this draft study is a step toward staffing CPP more efficiently, it was not completed in time to guide AOC's investments in training. As a result, AOC is providing training for all plant operators, even though fewer operators may be needed after a new staffing plan is in place.

AOC Contractors Are Providing Training That Addresses Safe Plant Operations, but AOC Has Not Developed a Plan for Evaluating the Training

Training is critical to the WRPE project's success because operators will need updated knowledge and skills to efficiently and safely operate the advanced technologies that are being installed. When construction is complete, state-of-the-art equipment will replace aging system components that date as far back as the 1950s. Furthermore, the new plantwide distributed controls systems will fundamentally change CPP's operating methods: Operators will have a lesser need to directly control system components because certain functions will be automatically maintained by the distributed controls systems.

AOC has planned and developed training for CPP operators and is implementing this training in stages. AOC's construction management consultant has already provided refresher training, lasting approximately 9 months, for all CPP operators on the fundamentals of chilled water and steam systems.<sup>17</sup> AOC's commissioning agent has started to provide additional training for operators on chiller and boiler systems, as well as on the operation and maintenance of the distributed controls systems. This operator training includes two 8-hour sessions per week, to be offered from November 2005 through March 2006 according to a schedule that will allow operators from all shifts to receive instruction. AOC's intent is to provide each operator with 8 hours of training every other week. Finally, AOC's commissioning agent will coordinate with the WRPE construction contractor to schedule manufacturer-provided training on specific equipment.

The operator training that AOC is implementing seems designed to help ensure that CPP personnel are trained to operate the modernized plant safely. For example, AOC's contract with the commissioning agent specifies that the training will address, among other topics, safe operating practices and procedures. In addition, under the contract, the commissioning agent will describe training objectives for major system components, identify what operators must be able to do upon completing the training, and test operators' knowledge of the subject matter twice each month.

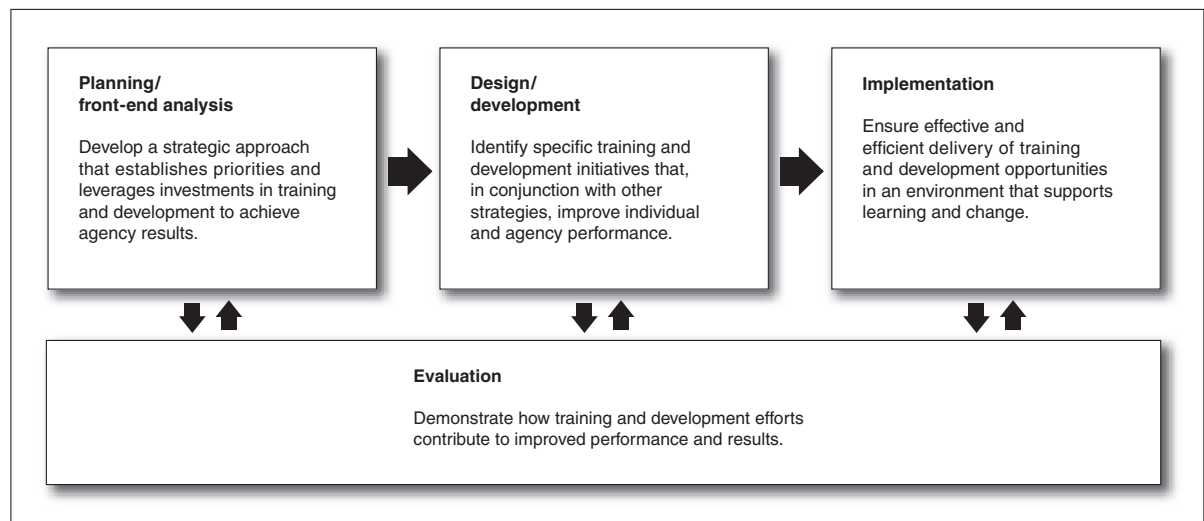
While AOC has planned, developed, and implemented training for CPP operators that addresses safe plant operations, it has not developed a plan for evaluating whether the training is achieving the desired outcome—preparing CPP staff to operate the modernized power plant safely. Our *Guide for Assessing Strategic Training and Development Efforts in the Federal Government* provides a model framework for

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<sup>17</sup>According to a CPP official, weekly 2-hour training sessions were scheduled for operators from February through December 2004.

training.<sup>18</sup> This framework is designed to help organizations target their training and development investments strategically and avoid wasting resources on efforts that are irrelevant, duplicative, or ineffective. Figure 2 shows the four components of this framework—planning, development, implementation, and evaluation—and the relationships between them.

**Figure 2: Strategic Training and Development Process**



Source: GAO.

Without an evaluation component for its training program, AOC lacks a systematic means of obtaining feedback on the training’s results. As our guide indicates, such feedback is important for determining whether training investments are being targeted strategically or being wasted. Additionally, without an evaluation component, AOC managers cannot determine how well the training has prepared CPP staff to operate the plant safely, and they cannot identify and address any specific training gaps or weaknesses. Having objective, consistent information on operators’ performance in training will be important to AOC when it implements its updated staffing plan and makes staffing decisions.

Although AOC has not developed a plan for evaluating its training for CPP operators or evaluated the initial 9-month refresher training, it has some evidence that the initial training was not as effective as intended. For example, some operators achieved low scores on tests administered by the construction management consultant during the initial training. The consultant gave these tests informally, but provided the results to us at our request.<sup>19</sup> Additionally, CPP managers said, some operators were ambivalent about the training and skipped classes. The CPP operators we spoke with about the training varied in their assessments of it. Some acknowledged the training’s value, while others were concerned that the training was not “hands on” or specific to the new equipment being installed as part of the expansion. As discussed, however, “hands-on,” equipment-specific training will be provided by manufacturers during the commissioning process.

<sup>18</sup>GAO-04-546G.

<sup>19</sup>Names of test takers were redacted from documents to maintain confidentiality.

To address concerns about the ability of CPP staff to operate the new equipment, AOC managers said they plan to hire a startup contractor to provide technical assistance to CPP operators for up to 8 weeks after the WRPE contract's completion.

### **Cost to Complete WRPE Project Will Depend on Contract Changes and Operational Issues**

We estimate that the cost to complete the WRPE project will range from about \$98 million to nearly \$106 million, depending on AOC's resolution of proposed contract changes and the level of training and contractor technical support that CPP operators will need. Although the WRPE construction contract is currently scheduled for completion in March 2006, it may be delayed until June 2006 because of contract changes. Our analysis of the cost to complete the project appears in enclosure I.

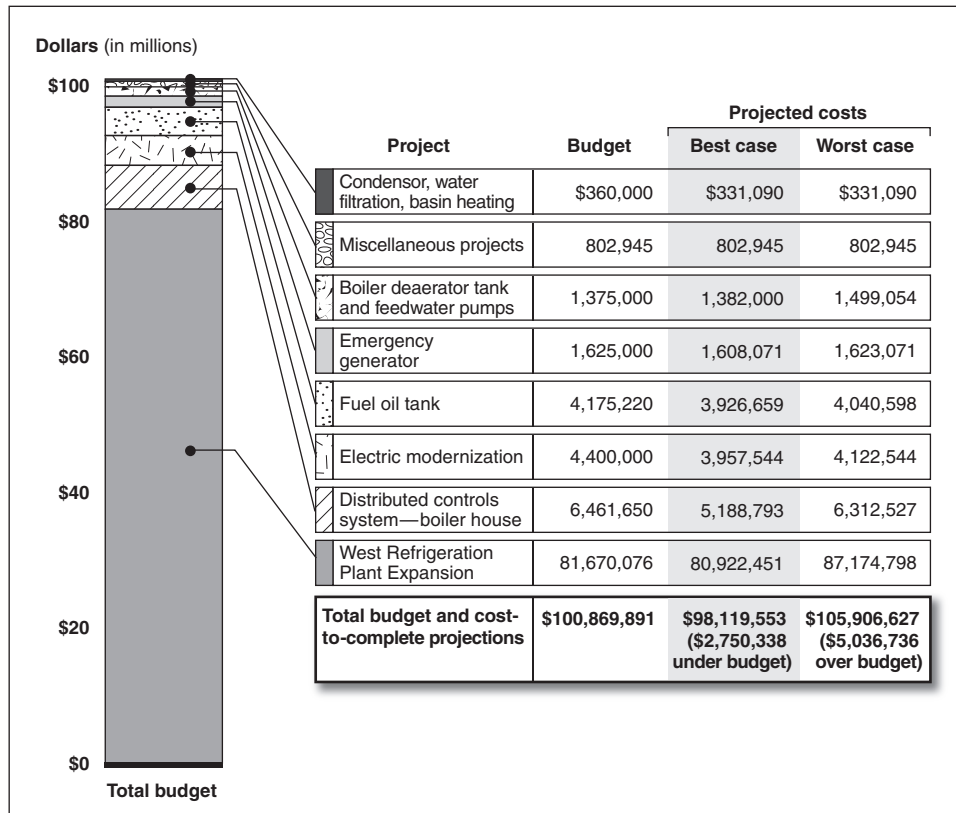
Through October 2005, nearly \$100.9 million has been budgeted for the WRPE project, and over \$95.1 million has been obligated for construction and administrative costs, leaving an unobligated balance of approximately \$5.7 million.<sup>20, 21</sup> AOC's October 2005 progress report on WPRE's construction indicates that future costs may exceed the amount of funding that remains. According to the progress report, 65 contract changes are pending resolution between AOC and its construction contractor. As the project progresses, AOC anticipates additional changes to account for such activities as troubleshooting during commissioning tests and providing technical support to operators during the initial weeks of plant operations. Our analysis to estimate the project's cost at completion provides for a range of costs, from best to worst case, to account for the variability associated with forecasting these changes. Specifically, our analysis shows that the negotiated amount of these changes is likely to result in costs ranging between \$2.9 million and \$10.7 million. Given the project's unobligated \$5.7 million balance, the settlement of these changes will yield approximate results ranging from a \$2.8 million surplus to a \$5 million shortfall (see fig. 3). Our analysis takes into account the likelihood that the project's completion date could be extended from March to June 2006.

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<sup>20</sup>Financial information is based on unaudited CPP project records used in preparing AOC's October 2005 WPRE monthly progress report.

<sup>21</sup>Numbers may not add because of rounding.

**Figure 3: WRPE Budget Breakdown, Including Cost to Complete Projections**



Source: GAO analysis of AOC data.

Pending or anticipated changes that may have a significant impact on the project's cost and schedule include the following:

- Redesign of fire sprinkler system.* After reviewing design documentation for the fire sprinkler system, AOC's Fire Marshall determined that changes were necessary to make the system compliant with the current fire code. Because of the Fire Marshall's decision, the construction contractor needed additional time to make design changes and prepare new submittals. As a result, sprinkler system components have not been ordered. The construction contractor does not expect the installation to be completed until August 2006, but AOC officials believe it can be completed by June 2006. Discussions between the two parties to resolve this issue are ongoing. Even if the fire sprinkler system is not operable when WRPE is turned over to AOC, AOC's Fire Marshall said steps could be taken that would enable him to issue a conditional occupancy permit so that CPP staff could operate the plant and its equipment.
- Reconfiguration of chilled water pipes.* AOC officials indicated that, because of the chiller failure in the East Refrigeration Plant in July 2005, they wanted to gain greater operational flexibility and decided to configure WRPE and the West Refrigeration Plant as separate facilities rather than as one plant, as originally planned. This decision means that AOC needs to add components to

the West Refrigeration Plant's piping system instead of demolishing that facility's chilled water distribution pipes. AOC officials anticipate making changes to the West Refrigeration Plant's piping system under a separate contract at an estimated cost of \$600,000. AOC expects this work to be completed before the WPRE contract is completed in March 2006. AOC officials also expect to receive a \$150,000 credit from the construction contractor for the pipe demolition work that was part of the base WRPE project's scope but is no longer required.

- *Changes to the design of the WRP/WRPE distributed controls system.* Because of an earlier decision to upgrade the distributed controls system for the chillers, AOC stopped installation work on June 24, 2005, in order to resolve procurement issues and redesign the system. In November 2005, AOC issued a modification directing the construction contractor to proceed with the system's installation according to the revised design. The cost of the system upgrade and its impact on the contract's schedule are pending negotiation between AOC and the contractor. CPP project managers indicated that tying the existing WRP into the distributed controls system is contributing to the delay in completing the contract.
- *Commissioning troubleshooting.* According to GSA's guidance, problems should be expected when equipment is tested as part of the commissioning process. In September 2005, AOC estimated, on the basis of its construction management consultant's experience, that \$500,000 may be needed for troubleshooting and repair work. Because commissioning is in its initial stages, it is still too early to assess the impact of troubleshooting on the project's cost and schedule.
- *Operational issues.* As discussed, AOC plans to hire a startup contractor for up to 8 weeks after WRPE is finished to provide technical assistance to CPP operators. AOC managers said they were unsure whether this amount of startup support would be sufficient and recognized that additional support may be needed. To the extent that additional support is needed, AOC's costs are likely to increase.

## Conclusions

AOC's commissioning activities to date and plans for commissioning new CPP equipment, if fully implemented, should allow AOC to test the equipment thoroughly and bring it on line with minimal disruption to current operations. Nevertheless, the majority of the systems testing remains to be done and could prove more challenging than the completed testing. Additionally, the WRPE project still faces budgetary risks and schedule uncertainties, especially those stemming from the impact of contract changes that have not yet been negotiated.

AOC's plans for staffing the modernized power plant efficiently and ensuring that CPP personnel are trained to operate it safely also face risks and uncertainties. AOC has delayed implementing recommendations to reduce CPP's staffing, and now has just a few months to develop an efficient staffing plan before WRPE is scheduled to

be completed. AOC also lacks assurance that CPP staff will be prepared to operate the new equipment safely since it has not yet completed the training of CPP operators, and has not developed a plan to evaluate the training. Additionally, without some form of evaluation, AOC is missing an opportunity to measure its operators' preparedness, prior to implementing its consultant's updated staffing plan.

### **Recommendations for Executive Action**

To ensure that CPP is staffed efficiently and that CPP personnel are trained to operate the modernized power plant safely, we recommend that the Architect of the Capitol

- develop and implement a staffing plan for CPP that is based on the results of its most recent consultant's study and
- evaluate the training provided to CPP operators and use the evaluation results in implementing the staffing plan.

### **Agency Comments and Our Evaluation**

We provided a draft copy of this report to AOC for review and comment. AOC officials provided oral comments in which they generally concurred with our recommendations and offered technical clarifications and updated information concerning staffing and training efforts.

Regarding CPP staffing, AOC indicated that it is continuing to review the draft staffing plan received from its consultant in December 2005 and is working to develop new position descriptions based on this plan. AOC also noted that its 1996 consultant study attributes overstaffing to a lack of system automation and suggested that it will not be possible to begin implementation of revised staffing plans until completion of the ongoing WRPE project. We note, however, that AOC's 2004 consultant report lists additional reasons for CPP overstaffing. Specifically, the 2004 report states that there are no cross responsibilities between different operation segments, and that over many years of operations, additional levels of management have been added.

Concerning evaluation of operator training, AOC indicated that it has modified its training structure to include two weekly tests—one theoretical written test and one field test on actual equipment—that are used to assess operators' knowledge and highlight areas in which additional training may be needed. While this is a step in the right direction, given the imminent startup of the new equipment, AOC still faces challenges in establishing a systemic means of evaluating training and using the feedback to ensure that its staff is fully prepared to safely operate the modernized plant. This involves a look at not just operators' knowledge, but also an assessment of how training contributes to improving performance and achieving a greater capacity to meet new and emerging challenges.

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As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies of this report to the appropriate congressional committees and the Architect of the Capitol. Copies will also be made available to other interested parties on request. In addition, the report will be available at no charge on GAO's Web site at <http://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-2834 or [goldsteinm@gao.gov](mailto:goldsteinm@gao.gov). Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in enclosure II.

A handwritten signature in black ink, appearing to read 'M. Goldstein', with a long horizontal flourish extending to the right.

Mark L. Goldstein  
Director, Physical Infrastructure Issues

Enclosures



**Estimated Cost to Complete the West Refrigeration Plant Expansion Project**

Tables 1 through 3 provide our estimates of the costs to complete the Architect of the Capitol’s (AOC) West Refrigeration Plant Expansion (WRPE) project. As shown in tables 1 and 2, the entire project consists of the expansion and several smaller capital projects. Table 1 shows the amounts provided, obligated, and remaining for each project through October 2005. Table 2 shows the additional amounts that we estimate will be required for each project in the best and worst cases. These amounts will depend on the outcomes of negotiations over potential change orders and other actions. Finally, table 3 shows our estimates of the costs to complete the entire project and the remaining funds in the best and worst cases.

**Table 1: Funds Provided to AOC, Obligated, and Remaining for the WRPE Project**

<b>Project</b>	<b>Funds provided<sup>a</sup></b>	<b>Obligations<sup>b</sup></b>	<b>Unobligated balance<sup>c</sup></b>
West Refrigeration Plant Expansion	\$81,670,076	\$78,028,511	\$3,641,565
Distributed controls system—boiler house	6,461,650	5,188,793	1,272,857
Fuel oil tank	4,175,220	3,913,059	262,161
Boiler deaerator tank and feedwater pumps	1,375,000	1,375,000	0
Electric modernization	4,400,000	3,957,544	442,456
Emergency generator	1,625,000	1,580,071	44,929
Condenser water filtration and basin heating	360,000	331,090	28,910
Miscellaneous projects <sup>d</sup>	802,945	802,945	0
<b>Total</b>	<b>\$100,869,891</b>	<b>\$95,177,013</b>	<b>\$5,692,878</b>

Sources: Federal legislation and AOC.

Notes: Our analysis is based on unaudited project financial information provided by AOC.

<sup>a</sup>Includes appropriations for construction and related activities for fiscal years 2003 and 2004, authorized reprogramming, and Capitol Power Plant (CPP) operation funds.

<sup>b</sup>Through contract modification 48.

<sup>c</sup>Authorized reprogramming would be required to combine the funding for these separate projects.

<sup>d</sup>These projects are being funded with CPP operating funds.

**Table 2: Our Best- and Worst-Case Estimates of Potential Additional Funding Needed for WRPE**

<b>Project</b>	<b>Best case<sup>a</sup></b>	<b>Worst case<sup>b</sup></b>
West Refrigeration Plant Expansion	\$2,893,940	\$9,146,287
Distributed controls system—boiler house	0	1,123,734
Fuel oil tank	13,600	127,539
Boiler deaerator tank and feedwater pumps	7,000	124,054
Electric modernization	0	165,000
Emergency generator	28,000	43,000
Condenser water filtration and basin heating	0	0
<b>Total</b>	<b>\$2,942,540</b>	<b>\$10,729,614</b>

Sources: Federal legislation and AOC.

Notes: Our analysis is based on unaudited project financial information provided by AOC.

<sup>a</sup>Our analysis of best possible outcomes of potential change orders (PCO). This includes PCOs currently being negotiated, identified as estimates of future work, and previously denied.

<sup>b</sup>Our analysis of worst possible outcomes of PCOs. This includes PCOs currently being negotiated, identified as estimates of future work, and previously denied.

**Table 3: Our Best- and Worst-Case Estimates of the Cost to Complete the Entire WRPE Project and Remaining Funds**

<b>Amount/estimate</b>	<b>Best case</b>	<b>Worst case</b>
Funding provided through October 2005	\$100,869,891	\$100,869,891
Obligations through October 2005	95,177,013	95,177,013
Potential additional funding needed	2,942,540	10,729,614
Estimated cost to complete	98,119,553	105,906,627
Remaining funds	2,750,338	(5,036,736)

Sources: Federal legislation and AOC.

Note: Our analysis is based on unaudited project financial information provided by AOC.

Enclosure II

## **GAO Contact and Staff Acknowledgments**

### **GAO Contact**

Mark L. Goldstein, (202) 512-2834 or goldsteinm@gao.gov

### **Staff Acknowledgments**

In addition to the contact named above, Terrell Dorn (Assistant Director), Michael Armes, George Depaoli, Timothy DiNapoli, Elizabeth Eisenstadt, Kimberly Gianopoulos, Susan Michal-Smith, and Walter Vance made key contributions to this report.

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