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FEDERAL POWER

Outages Reduce the Reliability of Hydroelectric Power Plants in the Southeast

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Mr. Chairman and Members of the Subcommittee:

Thank you for the opportunity to report today on the results of our work on issues surrounding the production and marketing of power from federal hydroelectric plants in the Southeast. Over a major portion of the nation, the U.S. Army Corps of Engineers (Corps) and the Department of the Interior's Bureau of Reclamation operate hydroelectric power plants at federal water projects to produce energy, and the Department of Energy's five power marketing administrations market the electricity generated.[1] Concerned about the maintenance and repair of the power plants operated by the Corps in the Southeast, you asked us to examine the extent to which (1) these power plants are experiencing outages and (2) the current planning and budgeting processes allow the Corps to perform timely and effective repairs and rehabilitations of these plants. Separately, we will also report in the next several months on the accounting and ratemaking practices of the power marketing administrations.[2]

In our review, we focused on 11 of the Corps' 23 hydroelectric power plants[3] that generate the power marketed by the Southeastern Power Administration (Southeastern).[4] These 11 plants provided about 71 percent of Southeastern's revenues in fiscal year 1995. We also performed more detailed case-study analyses of 2 of the 11 plants that had experienced lengthy outages stemming from design and technical problems; the results of these case studies are presented in appendixes III and IV.

In summary, Mr. Chairman, our principal points are the following:

- Federal hydroelectric power plants in the Southeast have experienced significant outages, ranging from a few days to several years in duration and degrading the reliability of the Corps' hydroelectric system. The

[1]The five power marketing administrations are the Alaska, Bonneville, Southeastern, Southwestern, and Western Area Power Administrations.

[2]We have also recently testified on the repayment by the Western Area Power Administration of the federal investment in the hydroelectric facilities in the Pick-Sloan Program. See Federal Power: Recovery of Federal Investment in Hydropower Facilities in the Pick-Sloan Program (GAO/T-RCED-96-142, May 2, 1996).

[3]Electric power plants are made up of one or more generating units, whose major components are the generator and turbine. The total capacity of a plant is the sum of the capacity of its generating units.

[4]App. I shows the location of these 11 power plants (Allatoona, Buford, Carters, Hartwell, J. Strom Thurmond, Jim Woodruff, Millers Ferry, Richard B. Russell, Robert F. Henry, Walter F. George, and West Point), and app. II summarizes their characteristics. These plants are operated by the Corps' South Atlantic Division, which has offices in Atlanta, Georgia. The Richard B. Russell power plant has four units that have operated since 1984, and four other units are being tested. This testimony makes no reference to the latter.

availability of these plants to generate electricity declined from about 95 percent in 1987 to 87 percent in 1995—a trend that is paralleled in the Corps' hydroelectric power plants nationwide. According to Corps officials, these outages occur because of the way the power plants are operated and because the plants are aging. Also, these officials said, a few of the plants suffer problems with the way the equipment is designed and installed. As a result of these outages, Southeastern has lost revenues and raised the wholesale electric rates it charges its customers.

- Although the Corps recognizes that long-term, comprehensive planning and budgeting systems are needed to identify and fund key repairs and rehabilitations at its hydroelectric power plants, especially in the current environment of static or declining budgets, its funding decisions are not based on such systems. The Corps gives priority to routine, ongoing maintenance. When the power plants experience unplanned outages, the Corps frequently performs repairs that are reactive and short-term. For the extensive repairs and rehabilitations that eventually become essential, the Corps' budgeting process requires extensive justifications that can take a year or longer to complete. The Corps has taken some actions to address its planning and budgeting needs, but these measures are still ongoing. Finally, although Southeastern markets all of the power generated by the Corps projects we examined, the Corps does not consult with Southeastern for planning and budgeting purposes at the corporate level. At the divisional level in Atlanta, the Corps meets with Southeastern and power customers to discuss planned capital improvements and scheduled maintenance. Because the Corps is in the process of addressing its planning and budgeting requirements, we are not making recommendations at this time for the Corps to improve its planning and budgeting systems.

Background

As the nation's largest supplier of hydroelectric power, the Corps generates about 25 percent of all the hydroelectric power in the United States. The Corps operates hydroelectric power plants at 75 dams with a total capacity of about 21,000 megawatts (MW). The total capital investment in these facilities over the years has exceeded $7.9 billion.[5]

Southeastern markets power for 23 hydroelectric power plants owned and operated by the Corps to 294 wholesale customers in all or parts of 10

[5]This amount is not adjusted for inflation and does not represent the present value of the capital investment in hydroelectric facilities.

southeastern states and Illinois.[6] Southeastern also coordinates with the Corps on the availability of the power to be generated by the Corps' plants. Unlike other power marketing administrations, Southeastern owns no transmission assets. Regional public and investor-owned utilities transmit the power to Southeastern's wholesale customers.

The Corps and Southeastern receive congressional appropriations through the Department of Defense - Civil account and the Department of Energy, respectively, to finance their operations. In fiscal year 1996, the Corps received appropriations for its civil works activities totaling about $3.2 billion.[7] Southeastern is responsible for repaying, with interest, its appropriations as well as the portion of the Corps' construction and operation and maintenance appropriations that are allocated to power.[8]

Repairs to and maintenance of the power plants are funded from the Corps' "construction, general" account or "operations and maintenance, general" account, depending on their scope. Funds from the "construction, general" account are used for major rehabilitation projects that exceed $5 million, including work pertaining to the designs, plans, and specifications for such projects. Major rehabilitation projects are identified at the Corps' projects and districts, and the ensuing budget proposals are justified, examined, and ranked in the Corps' field offices and headquarters. The Department of the Army's Assistant Secretary for Civil Works and the Office of Management and Budget then examine and approve or disapprove the requests for funding for the individual projects. Funds from the "operation and maintenance, general" account are used for routine repairs and maintenance and for emergency repairs of hydroelectric and other facilities.

The 11 power plants that we examined account for about 63 percent of Southeastern's generating capacity. These hydroelectric power plants, located on six river systems, range in generating capacity from 30 to 500 MW.

[6]These plants are part of multipurpose facilities also serving a variety of nonpower purposes, including flood control, irrigation, navigation, and recreation.

[7]The dollars are current dollars.

[8]Multipurpose projects have both specific and joint costs. Specific costs are related to, or for the benefit of only one purpose, whereas joint costs are shared by all authorized purposes of the projects. Southeastern is responsible for repaying all specific and joint costs allocated to power.

Outages at Plants in the Southeast Have Reduced System's Reliability

The Corps' hydroelectric power plants in the Southeast have experienced lengthy outages, resulting in declines in reliability and availability.[9] For example, from 1987 to 1995 the availability of the plants in the Corps' South Atlantic Division dropped from 95.4 percent to 87.2 percent. Nationwide, during this same period, the availability of the Corps' hydroelectric power plants dropped from 92.9 percent to 87.9 percent (see app. V). According to Corps officials, the outages have occurred because of the ways in which the units are operated[10] and because they are aging. In a few cases, Corps officials said, the units were also poorly designed and installed. According to Southeastern officials, the outages contributed to revenue losses for Southeastern and led to increases in its wholesale electric rates.

From 1986 through 1995, all 11 of the power plants we examined experienced forced and/or scheduled outages, ranging from 30 days to over 3 years. Thirty-seven of the 43 units at these 11 power plants experienced at least one outage (see app. VI), and several units experienced outages simultaneously (see app. VII). For example, from January through March 1993, eight units at the Allatoona, Carters, Hartwell, Robert F. Henry, Millers Ferry, J. Strom Thurmond, and Walter F. George power plants, representing about 395 MW of capacity (or 13 percent of the capacity available to Southeastern from the Corps' facilities), were out of service at the same time.

Many of the Corps' hydroelectric power plants in the Southeast are aging. The average age is about 30 years, and four have been in service for over 35 years. According to Southeastern officials and studies by the Corps, key components of the hydroelectric units are designed to last about 35 years and can be expected to need repair or replacement. However, according to the Corps, the need to repair or replace a component is based not solely on age, but also on test results and operational performance. For example, in 1984 the responsible Corps district office requested approval to perform a scheduled repair of a generator component at Allatoona—the oldest of the power plants that we examined, which has been in service since 1949. The generator component had reached 35 years—the anticipated end of its useful life—and the unit's performance had declined in the late 1970s and early 1980s, after a failure in 1967. Corps headquarters did not approve the request because it did not believe that the district had submitted adequate

[9]Reliability is the capability of a power plant to generate power consistently when called upon to do so. Availability is a measure of the power plant's availability to generate power over a period of time.

[10]For instance, according to Corps officials, the Corps operates some units at a level that exceeds their designed nameplate capacities.

justification. After the unit failed again in 1990, the Corps continued to operate the unit by bypassing the damaged component.[11] In 1991, the Corps' district office again requested approval to repair the affected generator as well as another unit of similar age. Both units were repaired in 1993 and 1994, at a cost of about $8 million.

Also, according to Corps officials, some units are poorly designed by the manufacturer and not properly installed by the contractor, and other units are adversely affected by the way in which they are operated. For instance, the Jim Woodruff power plant has experienced operational problems because its turbines are poorly designed. Specifically, the turbines, intended to function under conditions of changing water flow, experienced severe vibrations and had to be welded in place, leading to decreased efficiency in the power plant when water conditions changed (see app. IV). In addition, according to Corps officials, the conventional hydroelectric generating units at Carters, which are used to start the pumpback units,[12] were not designed to consistently handle startups. Operating the conventional units for startups over the years damaged the insulation in the generators, causing the units to fail. According to a Corps report on the rehabilitation of the Hartwell power plant, Hartwell's turbines are significantly oversized in comparison with the generators. According to the Corps' analysis, with the larger turbines and thus greater horsepower available, the generators failed because they were consistently operated at 125 percent of their rated capacity. Southeastern officials added that, in their view, the units failed because they were 30 years old and thus approaching the end of their useful lives. Also, according to Corps officials, four units at the Robert F. Henry power plant required major repairs within 6 years of beginning operation because major components of the generators were not properly manufactured and installed. The components became loose during operations, causing severe vibrations and deterioration of the generators' insulation.

When hydroelectric power plants experience unexpected outages at the same time and/or these outages are extended, utilities generally have to purchase replacement power at higher prices. For example, from 1990 through early 1992, two or more of the four units at the Carters power plant were out of service at the same time for periods ranging from about 3 months to almost 1 year. An official of Southeastern estimated that

[11]The affected part was a generator coil. Units can be operated, sometimes at reduced capacity, if a coil is bypassed. Eventually, Corps officials said, more extensive repairs are performed. According to Corps officials, this practice is standard throughout the electric utility industry.

[12]Pumpback units reuse water from downstream of a dam in order to supplement the water supply that is available for the conventional generating units to use when the demand for electricity peaks.

Southeastern's utility customers purchased replacement electricity costing about $15 million more than they would have paid for electricity marketed by Southeastern.[13]

Extended outages, Southeastern officials estimate, have resulted in lost revenues of about $13 million to Southeastern since fiscal year 1986. The impact was most acute when units at the Carters power plant were out of service. Moreover, according to Southeastern officials, because of the unplanned outages, a severe drought in the late 1980s, and increases in operation and maintenance costs, Southeastern increased its wholesale power rates. For example, customers on the Georgia-Alabama-South Carolina system paid 22 percent more in 1990 than they had in the previous year.[14] According to Southeastern, reductions in the amount of hydroelectric power available because of the drought, combined with the inefficient operation of the Jim Woodruff project, contributed to an increase in the wholesale rates charged to customers of the Jim Woodruff system of nearly 100 percent, phased in from January 1991 to September 1993.[15]

Corps' Capital Planning and Budgeting Processes Do Not Facilitate Timely and Effective Repairs

Although the Corps recognizes that long-term, comprehensive planning and budgeting systems are needed to identify and fund key repair and rehabilitation projects, especially in the current environment of static or declining budgets, its funding decisions for the power plants are not based on such systems. The Corps gives priority to routine, ongoing maintenance. However, when the power plants experience unplanned outages, the Corps frequently performs repairs that are reactive and short-term. For the extensive repairs and rehabilitations that eventually become essential, the Corps' budgeting process requires extensive justifications that can take a year or longer to complete. The Corps has taken some actions to address its planning and budgeting needs and recognizes that these efforts should be continued.

[13]Southeastern's estimates are based on the average wholesale rates on the Georgia-Alabama-South Carolina system and the average commercial wholesale electric rates in the region.

[14]The average wholesale rate increased from 2.3 cents per kilowatt-hour to 2.8 cents per kilowatt-hour.

[15]As of January 1991, Southeastern's average wholesale rates were 1.43 cents per kilowatt-hour, but they increased to 2.85 cents per kilowatt-hour by September 1993.

Corps Faces Difficult Funding Decisions in Current Budget Environment

The Corps' budget has been declining in real terms over the last 10 years—by about 18 percent between fiscal years 1986 and 1996, from about $3.8 billion to $3.1 billion.[16] According to a report prepared by the Corps' Institute for Water Resources,[17] because of the need to address the federal budget deficit, this funding trend is expected to continue. In such a budget environment, finding adequate funding to properly maintain, rehabilitate, and repair the aging hydroelectric power plants will be increasingly difficult.

Furthermore, the capital investment to maintain and repair the Corps' power plants is expected to increase by about $1 billion. For example, the Corps stated that from 1993 through 2004, it would spend about $410.3 million to rehabilitate hydroelectric units at eight power plants nationwide.[18] Moreover, the Corps projected that it would need to spend $558 million through the year 2004 to repair and rehabilitate other hydroelectric power plants.[19]

The need to spend more to maintain and repair the Corps' aging hydroelectric power plants will compete with the need to maintain and repair other Corps facilities, such as those related to commercial navigation, flood damage reduction, hurricane and storm damage reduction, and the restoration and protection of environmental resources (including fish and wildlife habitat). For example, with its budget submissions to the Congress, the Corps includes a "capabilities list" that identifies additional funds for necessary repairs and rehabilitations for the power plants, as well as for other purposes—such as dredging, recreation, and navigation—not included in the initial target budget request. For the fiscal year 1996 budget proposal, the list contained repair and rehabilitation projects totaling $72 million—including $8 million for hydroelectric power plants. However, the list does not rank the proposed repair and rehabilitation projects by importance or need.

[16]In constant 1995 dollars.

[17]Hydroelectric Investment Strategy for the Corps of Engineers, Working Draft Report, Version 5.1, Institute for Water Resources, June 21, 1994.

[18]According to the Corps, the plants involved and the projected expenditures for rehabilitations are Bonneville, Oregon/Washington ($113.1 million); Dardanelle, Arkansas ($29.7 million); Hartwell, Georgia/South Carolina ($17.7 million); Jim Woodruff, Florida ($30.6 million); J. Strom Thurmond, Georgia/South Carolina ($69.7 million); The Dalles, Oregon/Washington ($86 million); Walter F. George, Alabama/Georgia ($27.4 million); and Garrison, North Dakota ($36.1 million).

[19]According to Corps officials, much of the $558 million for capital investment in hydroelectric assets can be funded from the "operations and maintenance, general" account.

Moreover, according to Southeastern's Administrator, although Southeastern markets the power generated at the Corps' power plants, the Corps does not consult Southeastern at the corporate level for budgeting and planning purposes. However, according to Corps and Southeastern officials, the Corps' South Atlantic Division consults with Southeastern in preparing major rehabilitation proposals and in long- and medium-range planning for maintenance. Moreover, according to Corps and Southeastern officials, the Corps meets with a group of Southeastern's wholesale customers and with Southeastern at least twice a year to discuss scheduled maintenance and capital projects planned for the next 10 years. According to Southeastern officials, this group is not an advisory group on capital planning and budgetary matters; it only meets to share information.

Priority Is Given to Routine, Ongoing Maintenance Work, and Gaining Approvals for Extensive Repairs Is Often a Lengthy Process

The Corps gives priority to routine, ongoing work, such as the operation of power plants and recreation facilities, or maintenance work that is needed to keep the projects operating through the fiscal year. Nonroutine work or work that can be deferred to the next year has been given lower funding priority. After the Office of Management and Budget informs Corps headquarters of the Corps' budget ceiling, headquarters sets budget targets for the Corps' divisions, which in turn set budget targets for the Corps' districts. The districts decide how to allocate the amounts to various projects within the funding levels established annually by Corps headquarters. The baseline level of funding represents the annual fixed, nondiscretionary costs required to operate and maintain the projects. When major repairs are needed, the Corps must follow a system of approvals and justifications to comply with budgeting procedures and to explain the repairs to such parties as the Department of the Army's Assistant Secretary for Civil Works and the Office of Management and Budget. Satisfying these requirements delays funding the expensive repairs and rehabilitations needed to keep the hydroelectric system operating effectively. Because of these approvals and justifications, after the need to repair or rehabilitate a plant is identified at the project or district level, it has taken from about 10 months to almost 5 years to begin the needed repairs.

Given the emphasis on routine and ongoing maintenance and repair work and the lengthy justification processes that must be followed for extensive repairs when units break down unexpectedly, the Corps frequently performs repairs that are short-term and reactive. However, such actions only postpone the need to make more extensive repairs. For example, after a failure of the Hartwell power plant's unit 1 in November 1989, the

Corps bypassed the damaged part and brought the unit back into service at a reduced operating capacity. Three months later, the unit was taken out of service for 59 days while a contractor replaced the damaged part. Then, in May 1990, the same kind of problem put unit 2 out of service for 54 days. The Corps repaired the unit, but it failed again in January 1992. The Corps bypassed the damaged part and returned the unit to service. The unit continues to operate at a reduced capacity, along with the other three units. As a result of these reductions, Southeastern has lost about 40 MW of capacity. The Corps estimates that it will need about $17.7 million to repair the four units.

Before extensive and costly repairs or rehabilitation can begin, in order to justify capital investments, the relevant field location must perform a lengthy study to document the problem. The study can take 18 months to complete, and then another year or longer may be needed for the proposal to clear the review levels within the Corps and receive funding. According to a Corps official, the process is lengthy because (1) the documentation and analysis submitted by field staff do not always satisfy the requirements of Corps headquarters and (2) lengthy examinations and reexaminations of a proposal are required within the field structure, headquarters, the Department of the Army's Assistant Secretary for Civil Works, and the Office of Management and Budget. A Corps headquarters official explained that this lengthy analysis and documentation process is applied even if a hydroelectric unit is out of service and needs immediate repair because the Corps needs to show the need for costly capital investments in hydroelectric power plants to the Department of the Army's Assistant Secretary for Civil Works and the Office of Management and Budget.

For example, at the three-unit Millers Ferry power plant, one unit failed in 1987 because the insulation in the unit's generator had deteriorated. The unit was repaired and returned to service within 30 days. After a second unit failed in 1992 for the same reason, the responsible district office requested approval from the division in 1993 to repair all three units. The district office believed that all three units suffered from the same problems and would need repairs in the future. However, Corps headquarters interceded and requested additional analysis and justification to support repairing all three units. During 1993 to 1995, while the district office complied with certain requests from Corps headquarters and completed design specifications and the request for proposal, the remaining two units also failed. These units were temporarily repaired and returned to service but operated at a reduced capacity. As a result,

Southeastern lost about 31 MW of capacity. More extensive repairs, according to Corps officials, will not be completed until 1998, at an estimated cost of $7 million.

Corps Has Taken Some Actions to Address Planning and Budgeting Needs

The Corps has recognized that when budgetary resources are relatively scarce, it cannot continue to fund all of the activities it performed in the past, such as operating some recreation sites. Corps officials have also said that in times of budget shortfalls, it becomes increasingly important to implement long-term, systematic, and comprehensive capital planning and budgeting systems. Such systems allow agencies to anticipate projects that need to be funded in the future and to consider the tradeoffs that are inherent in assigning funding to different purposes. Given that obtaining additional funds for hydroelectric investments will be difficult, the Corps began, in the early and mid-1990s, to take steps to improve its corporate planning and budgeting processes. However, these measures are still ongoing.

The Corps commissioned a study by its Institute for Water Resources on its capital planning process for hydroelectric power plants.[20] In its 1994 working draft report, the Institute concluded that in light of the power plants' aging and the continued prospects for budget constraints, the Corps should develop a 10-year plan for future capital investments for its hydroelectric program and develop, in coordination with the power marketing administrations and their customers, procedures for ranking hydroelectric investment needs on the basis of such criteria as economic, environmental, and engineering factors. According to a Corps headquarters official, in response to these recommendations, Corps headquarters directed all of its field locations, including those in the Southeast, to compile lists of proposed, nonroutine hydroelectric capital improvement projects that had to be accomplished within 10 years. Although these lists were compiled on a national level during fiscal years 1993 and 1994, no lists were compiled in fiscal year 1995. The fiscal year 1994 list shows a projected need through 2004 of over $900 million to repair and rehabilitate the Corps' 75 hydroelectric power plants nationwide. However, the criteria for ranking the proposed repair and rehabilitation projects have not been established. The responsible Corps headquarters official explained that in fiscal year 1995, the effort was suspended because of higher priorities. He said he intends to direct the field locations to undertake the effort again during the summer of 1996, in

[20]Hydroelectric Investment Strategy for the Corps of Engineers, Working Draft Report, Version 5.1, Institute for Water Resources, June 21, 1994. The report has not been finalized.

time to be considered for the fiscal year 1998 budget. Currently, Corps headquarters does not use this list for the agency's annual budget process but rather encourages its use at the district level for long-range planning. Corps officials said they recognize the need to pursue formal use of the list for planning and budgeting nationwide.

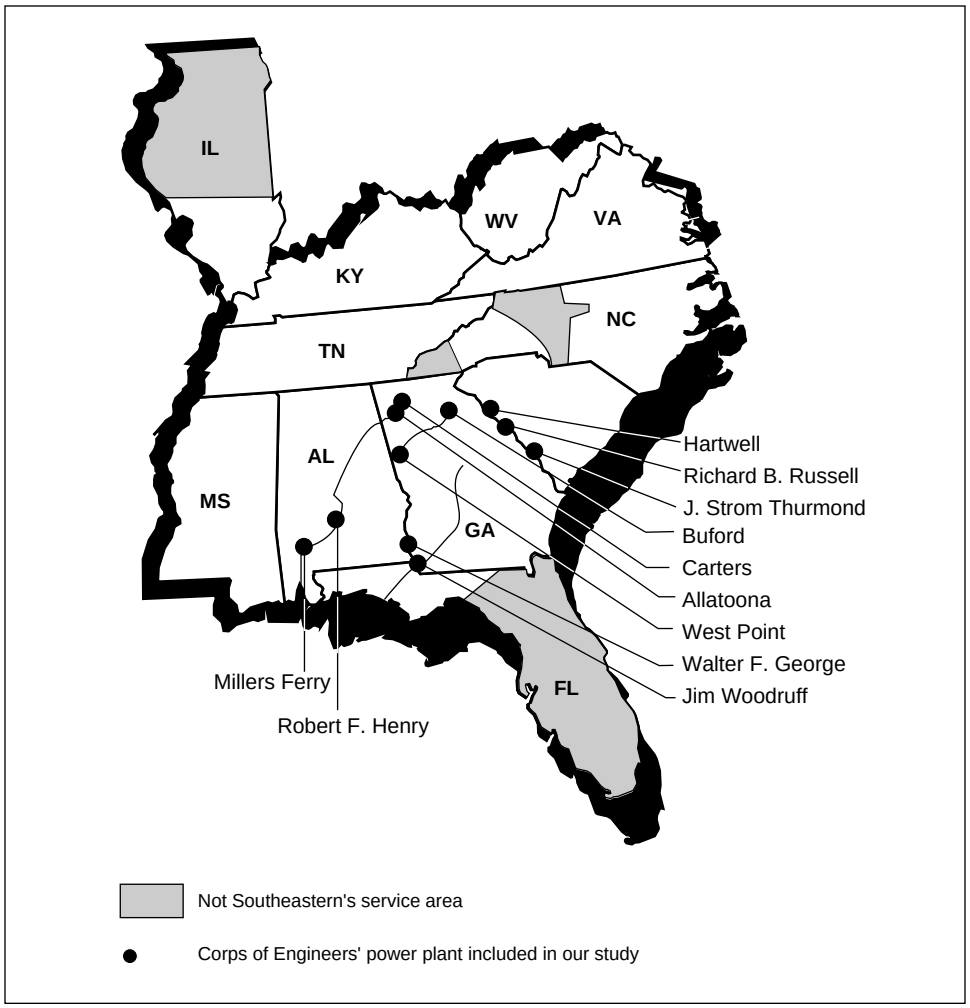
In addition, according to a Corps official, the Corps recognized in the early 1990s that the outages at its power plants were reducing the reliability of its hydroelectric power system. Consequently, from fiscal year 1993 through fiscal year 1997, the Corps requested appropriations for major rehabilitations of eight hydroelectric plants, four of which are in the Southeast.[21] In March 1996, the Corps estimated that from 1993 through 2004, it would spend about $410 million to rehabilitate these eight power plants. According to the Corps, as of the end of fiscal year 1996, the Corps had obtained appropriations of about $22 million for this purpose.

We provided a draft of this statement to and discussed its contents with Corps officials, including the Chief, Operations, Construction and Readiness (headquarters); Hydropower Coordinator (headquarters); Chief, Construction and Operations Division (South Atlantic Division); and the Chief, Hydropower Operations (South Atlantic Division). We also discussed the statement and its contents with Southeastern officials, including the Administrator; Assistant Administrator for Finance and Marketing; and the Chief, Operations. These officials generally agreed with the facts presented in our statement and said that we had fairly represented the condition of the federal hydroelectric power plants in the Southeast. Corps officials agreed that historically the agency's planning and budgeting systems did not expedite planning and budgeting for multiple-year capital improvement projects for the Corps' hydroelectric power plants. Corps officials said, however, that they have taken steps to improve their planning and budgeting systems for these plants. Corps and Southeastern officials also discussed efforts under way within the Corps' South Atlantic Division to consult with Southeastern and with power customers about the maintenance of the hydroelectric power plants in the region. These officials also suggested several technical revisions to our statement, which we have incorporated as appropriate. We conducted our review from January through June 1996 in accordance with generally accepted government auditing standards.

[21]The projects located in the Southeast are Hartwell (Georgia/South Carolina), Jim Woodruff (Florida), J. Strom Thurmond (Georgia/South Carolina), and Walter F. George (Alabama/Georgia).

This concludes our prepared statement. It also concludes our work on this issue for the Subcommittee. Details of our objectives, scope, and methodology are presented in appendix VIII. We would be glad to answer any questions you may have at this time.

Southeastern Power Administration's Service Area and Power Plants Included in Our Study



Source: Based on an illustration from the Southeastern Power Administration.

Characteristics of Power Plants Included in Our Study

Power plant	River system	Number of hydroelectric units	Fiscal year of initial operation	Average age of units (years)	Plant's total nameplate capacity (MW)[a]	Authorized purposes[b]
Allatoona	Etowah	3	1949	47	74	HP,FW,FC,NV, RE,WQ,WS
Buford	Chattahoochee	3	1957	39	86	HP,FW,FC,NV, RE,WQ,WS
Carters	Coosawattee	4	1975	20	500	HP,FW,NV,RE, WQ
Hartwell	Savannah	5	1962	30	344	HP,FW,FC,NV, RE,WQ,WS
J. Strom Thurmond	Savannah	7	1953	43	280	HP,FW,FC,NV, RE,WQ,WS
Jim Woodruff	Apalachicola	3	1957	39	30	HP,FW,NV,RE, WQ
Millers Ferry	Alabama	3	1970	26	75	HP,FC,NV,RE
Richard B. Russell	Savannah	4[c]	1984	11	300	HP,FW,FC,RE, WQ,WS
Robert F. Henry	Alabama	4	1975	21	68	HP,FC,NV,RE
Walter F. George	Chattahoochee	4	1963	33	130	HP,FW,NV,RE, WQ
West Point	Chattahoochee	3	1975	21	73	HP,FW,FC,NV, RE,WQ
Total		**43**		**30[d]**	**1,960**	

[a]The generator nameplate capacity refers to the full-load continuous rating under specified conditions, usually indicated on a plate attached physically to the equipment. Because water flow largely dictates the amount of water available for generation, the average megawatts (MW) available for power generation from a hydroelectric facility may differ from the nameplate capacity. These numbers are rounded to the nearest MW.

[b]HP = hydropower; FW = fish and wildlife; FC = flood control; NV = navigation; RE = recreation; WQ = water quality; WS = water supply.

[c]Four additional units are being tested.

[d]The average age of the units in our study was 30.

Source: Based on information from the U.S. Army Corps of Engineers.

Case Study: Millers Ferry Power Plant

Millers Ferry began producing power in 1970. The power plant's three generating units have a history of operational problems, and the Corps has taken remedial action to keep them operational from the outset. However, one of the units has been shut down for nearly 4 years, and the other two units are operating at reduced capacity. Delays in repairs have been caused by the documentation and review the Corps requires to justify expenditures for major repairs. In April 1996, the Corps awarded a contract for major repairs to the units at an estimated cost of $7 million.

Background

Millers Ferry Lock and Dam is located in southwest Alabama on the Alabama River. Millers Ferry aids navigation along the Alabama River and generates electric power, which is marketed by Southeastern to wholesale customers. The reservoir and surrounding park have become a popular recreational facility. The power plant's three 25-MW units have a total nameplate capacity of 75 MW.

Operational Problems at the Plant

When the generating units came on line in 1970, they produced extraordinarily high noise and vibration levels, which over the years contributed to the generators' aging at an accelerated rate. Also, because the noise levels were high enough to damage human hearing, the Corps took several actions to protect personnel in the powerhouse. For example, noise absorbing panels were installed on the ceilings and walls of the powerhouse, and sound enclosures were installed around each of the three generators. Since 1970, the Corps has spent about $700,000 on noise abatement measures.

According to the Corps, although the excessive noise is caused by vibration within the generator, the Corps had no recourse against the manufacturer because the design specifications did not address acceptable noise levels. The Corps decided to keep the units operating rather than shut them down to correct the exact cause of the noise.

In addition, all three of the power plant's generators have failed during the past 9 years. Unit 3 failed in June 1987 and was shut down for 27 days for repairs. Unit 1 failed in July 1992, and the damage was so extensive that the unit has been shut down for nearly 4 years. Unit 3 failed again in June 1994 and was shut down for 21 days for repairs. The most recent failure occurred when unit 2 failed in November 1995 and was shut down for 45 days for repairs. However, after units 2 and 3 were temporarily repaired and returned to service, they were operated at reduced capacity

to prevent further damage. As a result, Southeastern lost about 31 MW of capacity.

The Corps attributes these failures to deterioration in the generators' insulation caused by frequent changes in internal temperatures. According to the Corps, the insulation used in the units is not as tolerant of heat as the insulation used in older units in other power plants.

In addition, the enclosures installed around the generators for noise abatement increased the operating temperatures, thus shortening the life of the units. These enclosures also contributed to increases in maintenance costs and in the time needed to perform maintenance because they make it more difficult for repair crews to access the generators. For example, it takes three employees 6 days to disassemble and then reassemble a noise abatement enclosure to access a generator.

Repair of Units Has Been Delayed by Internal Reporting Requirements

According to a Corps official, the delay in repairing the units has been caused primarily by the internal documentation and review process that the Corps requires to justify expenditures for major repairs. After unit 1 failed in 1992, the Corps' district office in January 1993 requested approval from the Corps' division to repair not only unit 1 but also the other two units, which were in poor operating condition. The district estimated that a contract could be awarded by April 1994. However, Corps headquarters interceded and requested additional documentation to support the repair of all three units. A Corps headquarters official said the district office had not provided the required analyses and justifications for the proposed repair work. The official said that this documentation is necessary to satisfy Corps management, the Department of the Army's Assistant Secretary for Civil Works, and the Office of Management and Budget of the need to make extensive repairs.

As noted earlier, the Corps did not award the contract for the repairs until April 1996, more than 3-1/2 years after unit 1 failed. The other two units also failed during the intervening period, while the Corps' district office complied with the Corps headquarters' request for additional reports, including tests and economic analysis, and completed design specifications and request for proposal. The Corps estimates that the repair of the three units will cost $7 million and will be completed in early 1998.

Case Study: Jim Woodruff Power Plant

The Jim Woodruff power plant has a long history of operational problems stemming from the poor initial design of the turbines and changing operating conditions. The plant has experienced major outages resulting in costly repairs. Over the years, the Corps has taken remedial measures that permitted continued use of the plant but at the same time limited the plant's range of operations and efficiency. Because of increasing operational costs and declining efficiency, the Corps requested federal funds to repair the plant. In November 1995, the Congress approved the Corps' plan to rehabilitate the plant. The Corps estimates that the cost of repairs will be over $30 million.

Background

Jim Woodruff Lock and Dam is a multipurpose project located 37 miles northwest of Tallahassee, Florida, on the Apalachicola River. In addition to generating electric power for northern Florida, the project aids navigation on the Apalachicola River below the dam and on the Chattahoochee and Flint Rivers above the dam. The navigation lock serves commercial water transportation and recreational boating.

The power plant has been producing electric power since 1957. It has a total nameplate capacity of 30 MW, provided by three 10-MW generating units. The plant provides over 200 million kilowatt-hours of energy per year to Southeastern, which markets the energy to six wholesale customers in Florida. Small amounts of excess energy are sold to the Florida Power Corporation.

Problems With the Plant

The plant has experienced problems with reliability since the 1970s. Combined with the age of the plant (39 years), the cumulative effects of the poor initial design of the turbine and erosion of the downstream river channel since the plant was constructed have caused major outages, reduced efficiency, increased operations and maintenance costs, and reduced revenues to Southeastern.

Poor Design and Changing Conditions Have Led to Outages

The plant's variable pitch turbines are a unique design—only eight were ever manufactured. The turbines were designed for variable pitch in order to operate efficiently under a wide range of water flow conditions. For two of the plant's three turbines, the operating linkages that allow the variable pitch feature to function have failed.

In addition, erosion of the downstream river channel since the plant was constructed and the resulting increase in the operating head[22] have placed major stress on the turbine blades. The operating heads at the plant routinely exceed those for which the turbines were originally designed, thus decreasing the extent to which the turbines are submerged. As a result, the units have exhibited increasingly severe vibration problems, leading to outages for repairs.

Major outages have continued since the 1970s. For example, after unit 1 was shut down in October 1977 for 2 days for repairs, it was shut down again from July 1983 to May 1984, for a 313-day outage, and in April 1988, for a 60-day outage. In unit 2, cracks in the turbine blades were repaired in 1974; the Corps made additional repairs to the unit from July 1986 through February 1987, for a 207-day outage, and again in December 1988, for a 5-day outage. In unit 3, the Corps discovered and repaired cracks in the turbine blades in 1974 and 1975; additional repairs were made in April 1987, for a 59-day outage.

Plant's Performance and Costs Have Been Affected, Prompting Complaints From Southeastern

Because of continuing operational problems, the Corps welded the plant's turbine blades into a fixed position in 1988. This action improved the availability of the plant, but reduced the plant's efficiency, because fixed turbine blades cannot be adjusted to take advantage of the varying release rates necessary to maintain adequate water depths for navigation. Loss of efficiency reduces the amount of energy that can be produced at the power plant, affecting its ability to fulfill contracts for power generation. The Corps estimated that the plant's average annual output has been reduced by about 17 percent, or over 36 million kilowatt-hours per year, because of the welding of the blades into a fixed position.

In addition, the costs of operating and maintaining the plant have increased over the years. According to the Corps, these increases are attributable to major maintenance work, the design and specifications for the major rehabilitation, and the addition of on-site operators. Five maintenance personnel are directly assigned to the plant, and additional personnel are brought in from other projects if the maintenance is extensive.

The operational problems at Woodruff prompted Southeastern to complain to the Corps about a loss of revenue. In a letter to the Corps

[22]The operating head is the difference in elevation between the water surface above and below a hydroelectric power plant.

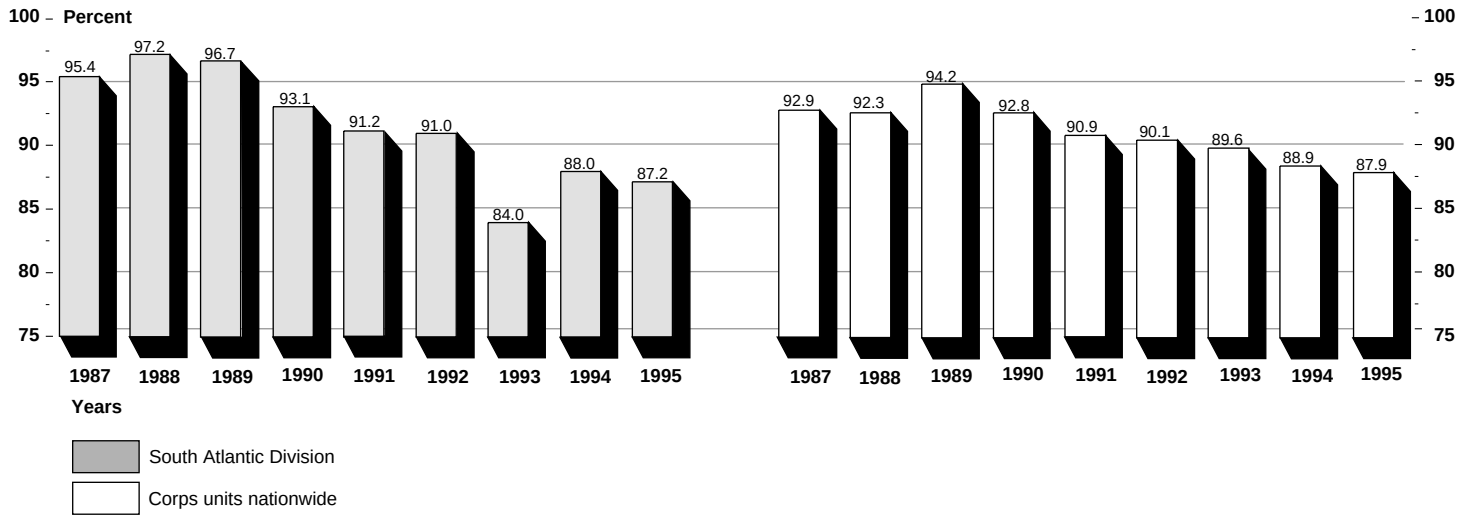
dated September 19, 1990, Southeastern expressed concerns about the plant's operations, stating that the plant has not been able to operate at its fullest, resulting in reduced output and a loss in revenue. According to Southeastern, the Corps had to spill water because of the need to decrease the vibrations that occurred as the units operated. Southeastern added that the loss to its customers was even greater because the customers must replace the missing power by purchasing power from another utility at a higher rate. The letter further stated that the plant's inefficient operation and the resulting loss in revenue had a significantly negative impact on the repayment schedule for the project and had caused Southeastern to seek a substantial increase in the power rates charged to its customers. According to Southeastern, the combined effects of the plant's inefficient operation and the droughts of the late 1980s caused it to raise its wholesale customer rates on the Jim Woodruff system by nearly 100 percent from 1991 to 1993.

Corps Is Planning to Rehabilitate the Plant

Because of the plant's increasing operations and maintenance costs and declining efficiency, the Corps in 1991 started a study for a major rehabilitation of Woodruff. The study, completed in 1993, recommended replacing the three turbines, rehabilitating the three generators, and replacing several peripheral electrical components, most notably the transformers, to restore the plant's lost reliability and efficiency.

According to the Corps, the field office submitted the major rehabilitation report to Corps headquarters in March 1992 for fiscal year 1994 funding. Corps headquarters rejected the report in May 1992. In March 1993, the field resubmitted the report to headquarters for fiscal year 1995 funding, and headquarters approved it in November 1993. However, the major rehabilitation plan, included in the Corps' fiscal year 1995 budget request, was rejected by the Office of Management and Budget because the President's fiscal year 1995 budget did not include any money for "new starts." In 1994, the Corps included the plan as part of its fiscal year 1996 budget, and it was approved by the Office of Management and Budget in December 1994. In November 1995, the Congress made funds available to the Corps to rehabilitate the plant. Thus, it took the Corps about 2 years to prepare and approve the rehabilitation study and another 2 years to get congressional approval for the funding. It is estimated that the rehabilitation will be completed in 2001—about 10 years after the beginning of the study. The Corps estimates that the cost to rehabilitate the plant will be $30,600,000.

Availability of Corps' Hydroelectric Units in the South Atlantic Division and Nationwide, Fiscal Years 1987 Through 1995



Note: According to the Corps, for the first two quarters of fiscal year 1996, the Corps-wide availability of hydroelectric power plants was unchanged from the previous fiscal year at 87.9 percent. The availability of hydroelectric power plants operated by the Corps' South Atlantic Division increased from 87.2 percent in fiscal year 1995 to 90.2 percent for the first two quarters of fiscal year 1996.

Source: U.S. Army Corps of Engineers.

Outages of Thirty Days or Longer for Corps' Hydroelectric Units in Our Study, Calendar Years 1986 Through 1995

Plant	Unit	Start date	End date	Duration (days)	Reason
Allatoona	2	Jan. 29, 1993	Apr. 15, 1994	441	Generator repair (forced)
	1	Apr. 26, 1994	Dec. 31, 1994	230	Generator repair (scheduled)
Buford	1	May 1, 1995	June 9, 1995	39	Inspection (scheduled)
Carters	3	Mar. 25, 1989	Jan. 13, 1990	299	Turbine repair (scheduled)
	2	Dec. 21, 1989	Feb. 19, 1992	790	Generator repair (forced)
	4	Jan. 15, 1990	July 19, 1990	186	Turbine repair (scheduled)
	1	Apr. 2, 1990	Mar. 11, 1991	343	Turbine repair (forced)
	1	Sept. 16, 1991	Mar. 12, 1992	178	Generator repair (forced)
	1	Sept. 21, 1992	May 13, 1993	233	Generator repair (forced)
	2	Sept. 22, 1992	Oct. 27, 1992	35	Inspection (scheduled)
	2	Sept. 25, 1995	Nov. 9, 1995	45	Inspection and turbine repair (scheduled)
Hartwell	3	Nov. 14, 1986	Jan. 16, 1987	63	Generator repair (scheduled)
	4	Mar. 23, 1987	May 8, 1987	46	Inspection (scheduled)
	1	Feb. 1990	Apr. 1990	59	Generator repair (scheduled)
	2	May 1990	July 1990	54	Generator repair (forced)
	5	Oct. 29, 1990	July 1, 1993	976	Turbine repair (forced)
J. Strom Thurmond	4	Apr. 1987	May 1987	30	Inspection and turbine repair (scheduled)
	6	Nov. 1992	Jan. 1993	42	Generator repair (forced)
	2	Jan. 1993	June 1993	137	Transformer repair (forced)
	3	Jan. 1993	June 1993	147	Transformer repair (forced)
	5	Aug. 1993	Oct. 1993	67	Testing for plant rehabilitation report (scheduled)
	1	Oct. 1994	Dec. 1994	73	Transformer repair (forced)
	3	Dec. 1994	Jan. 1995	36	Turbine repair (forced)
	6	Jan. 1995	Sept. 1995	245	Transformer repair (forced)
	7	Jan. 1995	Sept. 1995	245	Transformer repair (forced)
Jim Woodruff	1	Apr. 7, 1986	June 13, 1986	67	Inspection and maintenance (scheduled)
	2	July 14, 1986	Feb. 6, 1987	207	Turbine repair (scheduled)
	3	Apr. 20, 1987	June 18, 1987	59	Turbine inspection and repair (scheduled)
	1	Apr. 25, 1988	June 23, 1988	60	Inspection and generator repair (scheduled)
	1	July 14, 1988	Sept. 9, 1988	57	Generator repair (scheduled)
Millers Ferry	1	July 6, 1992	Dec. 31, 1995[a]	1274	Generator repair (forced)
	2	Nov. 28, 1995	Dec. 31, 1995[b]	34	Generator repair (forced)
Richard B. Russell	1	Feb. 18, 1986	July 25, 1986	157	Generator repair (forced)

(continued)

Plant	Unit	Start date	End date	Duration (days)	Reason
	3	Apr. 23, 1986	May 29, 1986	36	Generator repair (forced)
	2	Aug. 4, 1986	Sept. 16, 1986	43	Generator repair (scheduled)
Robert F. Henry	2	Dec. 25, 1990	Mar. 29, 1991	94	Generator repair (forced)
	1	Mar. 23, 1992	Aug. 1, 1995	1226	Generator repair (forced)
	3	Dec. 10, 1992	Mar. 2, 1993	82	Excessive ozone emissions (forced)
	3	Mar. 5, 1993	Dec. 31, 1995[c]	1032	Excessive ozone emissions and generator repair (forced)
Walter F. George	2	Aug. 1, 1990	Nov. 6, 1990	97	Generator repair (forced)
	1	Apr. 1, 1991	June 12, 1991	72	Inspection (scheduled)
	3	Mar. 30, 1992	May 8, 1992	37	Inspection (scheduled)
	2	Jan. 25, 1993	Mar. 24, 1993	58	Generator repair (scheduled)
	4	Aug. 30, 1993	Sept. 29, 1993	30	Inspection and turbine repair (scheduled)
	3	Jan. 18, 1994	Feb. 25, 1994	38	Inspection and turbine repair (scheduled)
	1	May 30, 1995	July 6, 1995	37	Inspection (scheduled)
West Point	3	June 2, 1986	July 31, 1986	59	Turbine repair (scheduled)
	3	May 11, 1992	June 19, 1992	39	Inspection (scheduled)
	2	Sept. 14, 1992	Oct. 23, 1992	39	Inspection (scheduled)
	1	Sept. 13, 1993	Oct. 18, 1993	35	Inspection (scheduled)
	3	May 31, 1994	June 30, 1994	30	Inspection (scheduled)
	1	Aug. 2, 1995	Dec. 31, 1995[d]	152	Generator, turbine, and transformer repairs (scheduled)

[a]On April 24, 1996, the Corps signed a contract for repairs on all three units; the estimated completion date is February or March 1998.

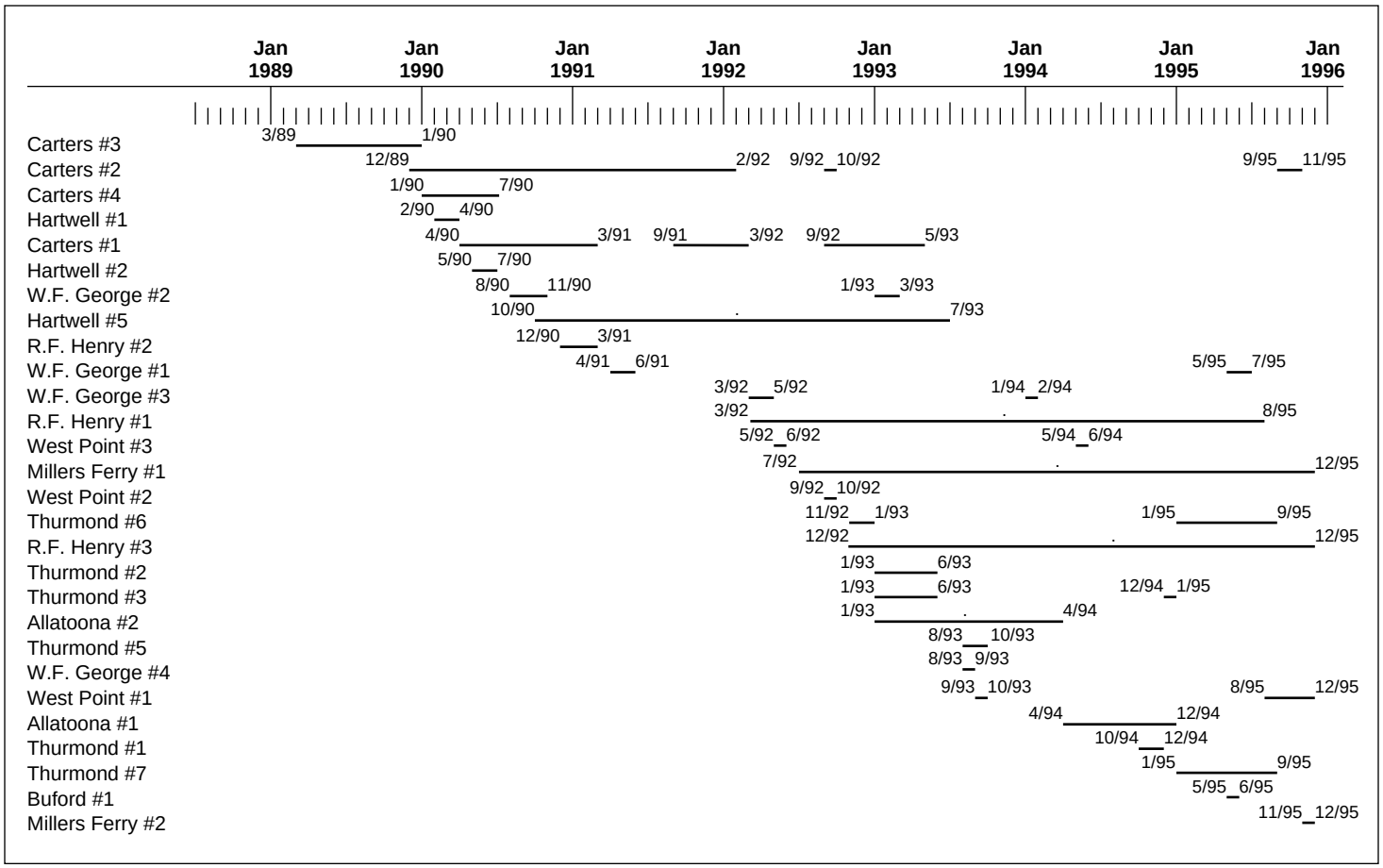
[b]Unit returned to service on January 12, 1996.

[c]Unit returned to service on February 12, 1996.

[d]The Corps estimates that the unit will be returned to service in November 1996.

Source: U.S. Army Corps of Engineers.

Outages of 30 Days or Longer for Hydroelectric Units Included in Our Study, Calendar Years 1989 Through 1995



Source: U.S. Army Corps of Engineers.

Objectives, Scope, and Methodology

On December 18, 1995, the Chairman, Subcommittee on Water and Power Resources, House Committee on Resources, requested that we examine certain operational and financial issues related to the Department of Energy's power marketing administrations. As agreed in subsequent discussions, this statement focuses on the maintenance and operational efficiency of the hydroelectric power plants operated by the Corps that generate the power marketed by the Southeastern Power Administration (Southeastern).[23] Specifically, we examined the extent to which (1) these power plants are experiencing outages and (2) the current planning and budgeting processes allow the Corps to perform timely and effective repairs and rehabilitations of its hydroelectric assets.

To determine the extent to which the Corps' hydroelectric power plants in the Southeast are experiencing outages, we interviewed Corps officials in Washington, D.C.; Atlanta, Georgia; Savannah, Georgia; and Mobile, Alabama. We also contacted the Administrator and former Acting Administrator of the Southeastern Power Administration and other agency officials in Elberton, Georgia, and at the Department of Energy's headquarters in Washington, D.C. From the Corps' headquarters and South Atlantic Division, we obtained operating statistics (i.e., nameplate capacity) and information on the plants' reliability and availability. We also obtained data on plant outages from 1986 through 1995. We focused on outages of 30 days or longer in order to avoid less important outages and discussed maintenance procedures with Corps and Southeastern officials. From Southeastern, we obtained estimates of the reduced revenues and increased rates that resulted from outages at the hydroelectric power plants in the Southeast; however, these estimates pertained to specific outages and were not applicable to the entire electric system from which Southeastern markets power.

To explore in depth the reasons for any outages and the way the Corps responded to them, we concentrated our efforts on 11 hydroelectric power plants (which include 43 generating units) operated by the Corps' South Atlantic Division (Atlanta, Georgia) and the division's districts in Savannah, Georgia, and Mobile, Alabama. These 11 plants on the combined Georgia-Alabama-South Carolina and Jim Woodruff systems[24]

[23]As also requested, we addressed the use of the funds appropriated for future irrigation projects in one hydroelectric program in our testimony Federal Power: Recovery of Federal Investment in Hydropower Facilities in the Pick-Sloan Program (GAO/T-RCED-96-142, May 2, 1996). For a future report, we are also determining whether the power rates charged by the power marketing administrations recover all relevant costs.

[24]Allatoona, Buford, Carters, Hartwell, J. Strom Thurmond, Jim Woodruff, Millers Ferry, Richard B. Russell, Robert F. Henry,Walter F. George, and West Point.

have a total generator nameplate capacity of 1,960 MW (about 63 percent of the generating capacity from which Southeastern markets power) and account for 71 percent of Southeastern's power revenues.

Corps and Southeastern officials agreed that these plants were generally representative in age and operating condition of the plants from which Southeastern markets power. For example, we selected power plants ranging in age from relatively new (11 years) to relatively old (47 years) and ranging in capacity from relatively small (30 MW) to relatively large (500 MW).

From the 11 plants, we selected Millers Ferry and Jim Woodruff for more detailed case-study analysis. Although all 11 power plants we reviewed experienced outages from 1986 through 1995, these two plants had experienced lengthy outages stemming from problems in their design and the installation of their equipment.

To determine whether the current planning and budgeting processes allow the Corps to perform timely and effective repairs and rehabilitations of its hydroelectric power plants, we obtained and reviewed Corps budget data from the agency's headquarters in Washington, D.C., and South Atlantic Division. We analyzed trends in the availability of appropriated funds from fiscal years 1986 through 1996, and we adjusted the funds for inflation by applying the gross domestic product deflators for the appropriate years. We attempted to determine the exact amounts of funds requested, appropriated, and spent for the operation, maintenance, rehabilitation, and repair of the 11 Corps hydroelectric power plants in our study from fiscal years 1986 through 1996. However, the data we requested were either not available or were not reported consistently by the Corps. We also interviewed representatives of the Corps, Southeastern, and the association of Southeastern's wholesale customers to obtain their views on the adequacy of the funding for operating, maintaining, and rehabilitating the Corps' hydroelectric power plants.

We interviewed Corps budgeting and planning officials at headquarters, the South Atlantic Division, the Savannah District, and the Mobile District and obtained the guidelines for compiling annual budgets and studies on ways in which the Corps could improve its budgeting and planning systems. We reviewed lists compiled by Corps headquarters and the field offices on repairs that have been proposed over the next 10 years and the cost of these repairs. We also obtained Southeastern's views on the Corps'

planning and budgeting functions and Southeastern's role in those processes.

We performed our work from January through June 1996 in accordance with generally accepted government auditing standards.

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