Duquesne Light and Shippingport: Nuclear Power Is Born in Western Pennsylvania

By William Beaver

ON May 26, 1958, America's first nuclear power station was formally dedicated at Shippingport, Pennsylvania. A speech by President Eisenhower, delivered via electronic hook up from the White House, highlighted the dedication ceremonies attended by dignitaries from many foreign countries, as well as utility executives and various government officials.[1] All those present hoped that, with the startup of operations at Shippingport, mankind would begin to reap the benefits promised by this wondrous technology.

Enthusiasts had predicted that nuclear power would raise the public's welfare, revamp industrial techniques, and increase America's standard of living.[2] Shippingport promised to commence an era of low cost abundant energy which, in the long run, would raise western civilization to new levels in much the same way as practical applications of coal and petroleum had done.[3]

None of the participants was more enthusiastic than Philip Fleger, Chairman of the Board of Pittsburgh's Duquesne Light Company. In his remarks during the dedication ceremony, Fleger stated:

> It is all together fitting that this station should be located close to the birthplace of the petroleum industry and on top of one of the world's greatest coal fields. For the history of industry and man's progress is closely bound to the history of fuel. . . . [I]n a larger sense progress is the real significance of Shippingport. This comes from the work of free men, with free hands and free minds, in a free society.[4]

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1 *Pittsburgh Post-Gazette,* May 26, 1958.

2 See for example, Richard G. Hewlett and Oscar E. Anderson, *The New World 1939-1946: Volume I of the History of the United States Atomic Energy Commission* (University Park, 1962).

3 American Society of Mechanical Engineers, *Historical Achievement Recognized: The Shippingport Atomic Power Station,* 1980, 2.

4 *Ibid.,* 4-5.

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With the startup of operations at Shippingport, Fleger's dream had been realized, to have his company involved in the operation of the nation's first nuclear power plant. Shippingport would mark an epoch for Duquesne Light, by participating with the Atomic Energy Commission (AEC) and Westinghouse Electric Corporation in operating a technical marvel.

This essay will briefly trace the history of Duquesne Light, noting the positive role technology had played in that development, then relate the significant events pertaining to Shippingport construction and plant operation, and finally attempt to examine the impact Shippingport had on Duquesne Light. In general, Shippingport would prove to be a successful venture, to a large extent because it meshed well with utility traditions of using consultants and manufacturers for implementing new technology. Of course, at Shippingport the AEC would provide the technical expertise.

Duquesne Light: A Brief Retrospective

The Duquesne Light Company was incorporated in 1903 to provide electrical service for the eastern sections of Pittsburgh. In the early 1900s, several other small companies generated electricity for different sections of the city. All of these small companies, including Duquesne Light, were eventually absorbed by a holding company, the Philadelphia Company. In 1912 the Philadelphia Company designated Duquesne to operate various power plants in the greater Pittsburgh area, which included Allegheny and Beaver counties, covering 750 square miles.[5]

Holding companies like the Philadelphia Company played a crucial role in the development of the nation's utilities. Commonly, holding companies were organized by financiers and entrepreneurs, who would buy out or acquire controlling interest in smaller utilities. Their small power plants could either be closed, made into substations or technologically updated to increase capacity and efficiency. Holding companies served as vehicles for capital formation to fund technical improvement.[6]

Holding companies developed pyramid type organizational structures. At the top, the board of directors ultimately controlled all company activity. To accommodate the needs of smaller acquisitions, a second layer of subsidiary companies were formed. The second-tier

5 "100th Anniversary Edition," *Duquesne Light News*, Mar. 1980, 4.
6 Thomas P. Hughes, *Networks of Power* (Baltimore, 1983), 363.

provided services such as technical consulting, as well as financial and managerial planning.[7] Thus, holding companies not only provided capital for equipment and expansion, but also expertise for local companies.

In 1913, Duquesne Light, under the direction of the Philadelphia Company, purchased the Brunot Island steam power plant located on the Ohio River. Due to its central location and large capacity (116 megawatts), Brunot Island became the company's main generating plant; as a result, many of the existing smaller stations were turned into substations.[8]

The 1920s would prove to be a decade of unprecedented growth and prosperity for Duquesne Light, when system capacity customers more than doubled. To accommodate increasing demand, the Colfax power station was constructed incorporating the latest technology, significantly reducing fuel usage.[9] To smooth operations, the company interconnected its central generating stations and signed power sharing agreements with West Penn Power and Ohio Power. These interconnections allowed the company to have access to more electricity if needed.[10]

By the 1920s, the organizational structure of Duquesne had taken hold. The company had departments of sales, service, operations and construction. The president coordinated all activity and reported to the board of directors. Of course ultimate authority still rested with the Philadelphia Company. In 1926, an important change occurred within the Philadelphia Company, with the forming of the Byllesby Engineering and Management Corporation.[11] Byllesby would serve as systems planners, as well as offer technical and managerial advice for Duquesne Light, allowing company officials to concentrate more on the pure "business," non-technical aspects of running a utility.

The 1930s began with the opening of the John D. Reed Power Station, designed and constructed by Byllesby. The Reed Station, the most efficient in the system, allowed Duquesne to close down inefficient smaller stations and continue its policy of buying out smaller

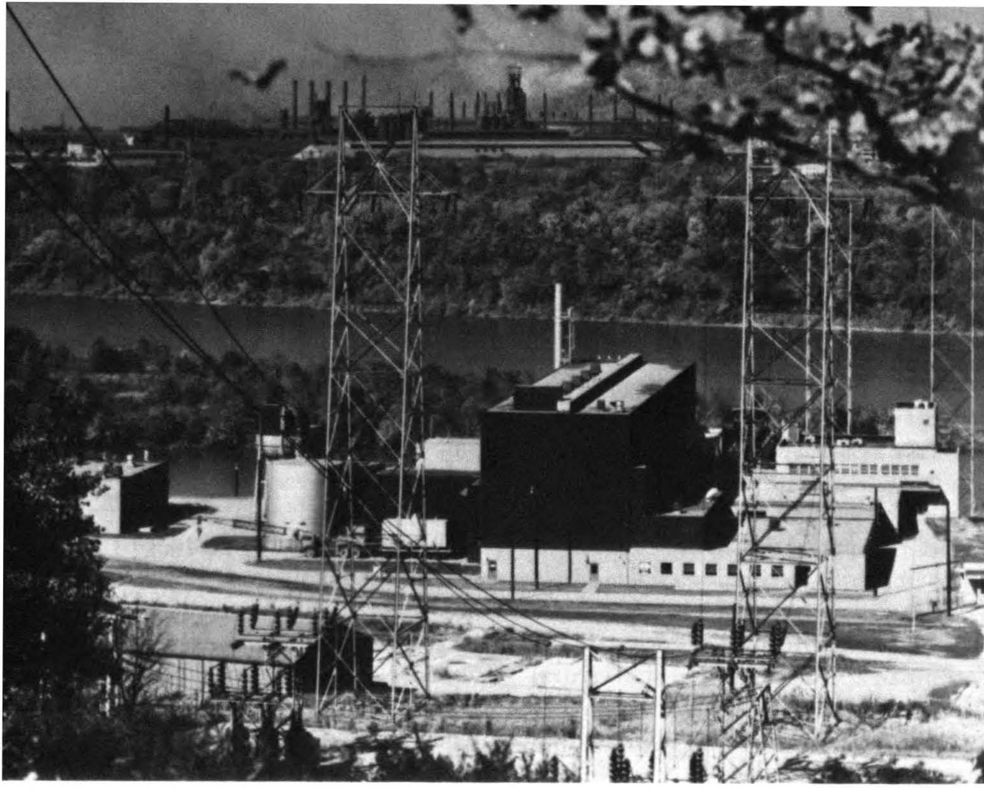
7 John Bauer and N. Gold, *The Electric Power Industry: Development, Organization and Public Policy* (New York, 1939), 132-33.

8 M.E. Church, "Some Factors That Have Influenced Power Plant Location in the Pittsburgh Area," unpublished masters thesis, University of Pittsburgh, 1954, 3-4.

9 Duquesne Light Co., *Annual Report to the Stockholders 1924*, 7.

10 *Duquesne Light News*, *op.cit.*, 5; and *Annual Report 1923*, 4.

11 *Annual Report 1926*, 5, and *Annual Report 1935*, 5.



Shippingport Atomic Power Station, named after a village of the same name and built 25 miles northwest of Pittsburgh. (Courtesy Duquesne Light Co.)

isolated power companies throughout the Pittsburgh area.[12] Despite the Depression, the company continued to grow, with sales and revenues increasing modestly. The steadily declining price of electricity was perhaps the most important reason for the continued prosperity, making electricity increasingly attractive to potential customers. In 1920, Duquesne Light sold electricity for 6.5 cents per killowatt-hour; by 1939 the price had fallen to 4 cents per kwh.[13] Improved technology in generation, transmission and distribution was the major reason for declining prices. Most importantly, technological innovation allowed for greater economies of scale. That is, unit costs declined as the scale of production increased. Simply put, Duquesne, like other electric utilities, discovered that technological innovation made for higher profits and more satisfied customers.

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12 Duquesne Light Co., *The Dedication of the John S. Reed Power Station,* 1930, 9-20, and *Annual Report 1934* and *1935.*

13 *Annual Report 1939,* 17. During the 1930s, revenues per kwh increased by approximately 7 percent, while sales increased by approximately 7.5 percent. See *Annual Report 1930* to *1939.*

Early on, the utility industry had developed a vendor orientation in regard to technological innovation. Companies such as Duquesne Light became dependent upon the manufacturers of electrical equipment, most notably General Electric and Westinghouse, for new technology. Over the years a tradition of partnership developed among utilities, consultants (like Byllesby), and manufacturers.

Typically, utility managers would express their needs to consultants, who then planned a system or addition and then, in conjunction with a manufacturer, selected the appropriate equipment. Quite often the consulting firm would act as general contractor for construction of the new system.[14] Manufacturers, usually as part of the initial agreement, would make sure the equipment worked and service the equipment, once again allowing utilities to operate as straight-forward business enterprises. Utility managers saw little need to employ large technical or engineering staffs, when it was easier to purchase services, engineering expertise and equipment.[15]

Some mention should be made of the role regulation played in technical innovation. Regulated industries, not having to compete in the market place, may feel less of a need to utilize new technology. But, as mentioned, new technology produced greater scale economies, so utilities saw advanced technology as a key to success. While this makes utilities extremely capital intensive, the cost of capital expansion becomes part of the rate base, providing security that only regulated firms can enjoy.[16] These facts help to explain the utilities' favorable attitude toward technological innovation, and why some utility executives would take such a positive stance toward nuclear power in future years.

While 1920 to 1940 were prosperous years for Duquesne Light, company fortunes turned downward in the 1940s. According to company records, revenues increased 100 percent from 1939 to 1950, while expenses increased 150 percent. The reason for the decline can be traced to the government freeze on expansion during the war years, high inflation, and what the company called the continued upward spiral of wages, material and taxes.[17] On the positive side, the Frank R. Phillips Power Station opened in 1943. The Phillips

14 Bauer and Gold, *op.cit.*, 12-35, and James E. Connor, "Prospects for Nuclear Energy," in *The National Energy Problem*, Academy of Political Science, Dec. 1973, 65-73.

15 Philip Sporn, *Vistas in Electrical Power* (London, 1968), 89.

16 Wm. Capon (ed.), *Technological Change in Regulated Industries* (The Brookings Institution, 1971), 3-5.

17 *Annual Report 1950*, 3, 7, and *Annual Report 1939* to *1945*.

facility, planned before the war by Byllesby, used hydrogen cooling to achieve higher turbine speeds and helped the company meet record demand incurred during World War II.[18]

After the war, economic prosperity returned to the Pittsburgh area. In 1949 alone six new industrial plants were built, including Continental Can, Crucible Steel and Fisher Body. The "rebirth of Pittsburgh" proved problematic for Duquesne Light; it experienced great difficulty in meeting demand, but interconnection with other utilities allowed Duquesne to meet system needs. Company officials felt un-

"Without such a positive balance sheet or the expectation of steadily increasing demand, it is unlikely that . . . Fleger would have seriously entertained the idea of an atomic power plant."

comfortable with this growing dependence, and decided to undertake the largest building program in Duquesne Light's history, culminating with the opening of the 310 MW Elrama plant in 1952.[19]

In the early fifties, the company experienced a significant organizational change. The U.S. Securities and Exchange Commission ordered the divestiture of the Philadelphia Company. Although Duquesne had operated somewhat independently since 1935, the divestiture meant the loss of Byllesby, which had, since the mid-twenties, provided system planning and technical expertise. Henceforth, Duquesne would have to supply these services independently. In the utility tradition, the company hired the engineering and consulting firm of Stone and Webster to perform many of the services Byllesby had provided.[20]

In the years just prior to the construction of Shippingport, prosperity returned to Duquesne Light. Between 1950 and 1955 income rose at an average rate of 8 percent annually, increases not experienced since the twenties. The reasons for the good times were easy enough to understand: constantly increasing demand which rose an average of 6.25 percent yearly from 1950 to 1954.[21] Without such a positive balance sheet or the expectation of steadily increasing demand, it is

18 *Annual Report 1942*, 10.
19 *Annual Report 1949*, 4, 13.
20 *Annual Report 1953*, 12; and *Annual Report 1956*, 9.
21 *Annual Report 1950* to *1955*.

unlikely that the Chief Executive Officer, Philip Fleger, would have seriously entertained the idea of an atomic power plant.

Duquesne Light and Shippingport: Initial Developments

Philip Fleger had been trained as a lawyer and joined Duquesne Light in 1939. He served the company in various capacities before being appointed to the top position in 1950.[22] Fleger's leadership was strong. Although he would seek out the opinions of his officers, Fleger always made the difficult decisions himself.[23] Early on, Fleger had become enthusiastic about nuclear power, and his affinity for the atom could be traced to several factors. First, utility executives understood that historically, new technology eventually meant higher profits and nuclear power promised large scale economies which undoubtedly interested utility executives. Secondly, coal posed problems. After World War II, the price of coal rose dramatically, so it was thought that an alternative source of fuel would help hold down the cost of coal. Periodic coal strikes also had plagued the company. During the strike of 1949-50, only a ten-day supply of coal remained at one point, which surely produced anxiety among Duquesne's executives. Finally, a nuclear plant, which emits no smoke, fit nicely into a region that was trying to change its smoky image.[24]

In the early 1950s, Fleger and some of his executives took courses in nuclear technology at the Carnegie Institute of Technology.[25] In 1952, Fleger, on his own, consulted with an independent firm, Walter Kiddle Labs, about the possibility of a joint atomic venture with the AEC.[26] Fleger's interests peaked in October 1953 when AEC commissioner Thomas H. Murray delivered a speech in Chicago entitled "Far More Important Than War." Murray encouraged utilities to go nuclear, proclaiming, "It would be a major set back for this country in the world

22 *Annual Report 1939*, 13; and *Annual Report 1950*, 3-4.

23 Interview with author, S. G. Schaffer, Duquesne Light Co. (President 1968-83), Jan. 24, 1985.

24 Richard Rhodes, "A Demonstration at Shippingport," *The American Heritage*, vol. 52, June-July 1981, 7; and *Annual Report 1947* to *1952*. Although the cost of fossil fuels would level off as the decade wore on, and even decline in the case of oil because of cheap Middle East crude, coal problems (pollution, price and availability) would continue to be a driving force in Duquesne's interest in nuclear power.

25 P. A. Fleger, I. H. Mandil and P. N. Ross, "Shippingport Atomic Power Station, Operating Experience, Developments and Future Plans," U.S. and Japanese Atomic Industrial Forum, Tokyo, Dec. 5-8, 1961. Copy in Department of Energy archives, Germantown, Maryland.

26 *Annual Report 1953*.

to allow present leadership in nuclear power to pass out of our hands." [27]

In November 1953, the AEC invited the nation's utilities to participate in a joint venture with the AEC to operate the nation's first civilian nuclear power plant. Duquesne Light, under Fleger, was well prepared to make an offer. In all, nine utilities submitted bids. Not surprisingly, the most attractive offer came from Duquesne Light. The company offered to furnish the site, provide a staff to operate the plant, build and maintain the conventional electric generating portion of the plant, and contribute $5 million to the reactor section of the facility. In addition, Duquesne agreed to purchase the steam produced by the reactor (which the AEC owned) for 8 mills/kwh, a price the Commission felt quite generous in light of Duquesne's average system cost for conventional power stations of 3.5 mills/kwh.[28] The AEC calculated that over the course of a five-year contract, the total contribution by Duquesne Light would be $30 million. The next most attractive bids, submitted by Philadelphia Electric and Pennsylvania Power, were $24 million.[29] The Commission accepted Duquesne's offer.

Fleger, called a man of "vision and courage" by AEC Chairman Lewis Strauss, stated that the company would gain significant experience by operating a nuclear plant. Company officials also believed that they were performing a valuable service for the entire utility industry by demonstrating that nuclear power was at least technically feasible. Duquesne was under no illusion that the plant would pro-

FIGURE 1

Duquesne Light Power Stations, 1954

Brunot Island (1902)	116 MW
Colfax (1927)	262 MW
J. H. Reed (1930)	180 MW
F. R. Phillips (1943)	190 MW
Elrama (1952)	310 MW

Source: Moody's Public Utility Manual 1954.

27 Thomas E. Murray, "Far More Important Than War," Oct. 22, 1953. Copy in DOE archives.

28 U.S. AEC, *14th Semi-Annual Report,* Dec. 1953, 19, and *Moody's Public Utility Manual 1954,* 868.

29 Letter from Lewis Strauss to W. Sterling Cole, Mar. 13, 1954. Copy in DOE archives.

duce inexpensive electricity, due to its experimental nature. Even with substantial AEC subsidization, operating costs would be higher than a conventional plant.[30] Finally, Fleger also hoped that the historical significance of Shippingport would bring publicity to Duquesne Light and Pittsburgh, a city in the middle of its renaissance. A positive forward-looking image would be highly valued.[31]

For its part, the AEC would finance 90 percent of the reactor costs, build the reactor plant and assume legal liability for it. Most importantly, the AEC would supervise all activity in the nuclear portion of the plant. Hyman Rickover of the AEC's Naval Reactors Branch was selected to manage the entire project.[32]

The AEC choose Rickover largely because of his successful experience in developing the Mark I prototype submarine reactor, in conjunction with Bettis Laboratories of Westinghouse Electric. Rickover, one of the most forceful personalities ever in American government, had the reputation of a man who could get the job done.[33] By using a proven reactor design (based on the Mark I) the entire project could be constructed more rapidly, allowing America to maintain its nuclear superiority.

Rickover's major interest was in developing reactors for naval vessels,[34] and he had proposed construction of a large reactor to power an aircraft carrier. When the carrier project fell out of favor with the Eisenhower Administration, Rickover decided to support the civilian reactor project. At the time, it seemed the only way to achieve the construction of a larger reactor and undoubtedly many of the design aspects of a civilian reactor could be adopted by the Navy.[35] Hence, Shippingport had its roots in military projects.

Rickover mandated an organizational arrangement for Shippingport that emphasized tight control over all contractors and centralized decision-making by the Naval Reactors office. As Rickover stated, "All we have to have is one good accident in the United States, and it might set the whole reactor game back for a generation." [36] Besides

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30 *Annual Report 1954*, 10.

31 Richard G. Hewlett and Francis Duncan, *Nuclear Navy, 1946-1962* (Chicago, 1974), 239.

32 U.S. AEC, *Semi-Annual Report*, July 1954, 222; and Hewlett and Duncan, *op.cit.*, 233-34.

33 See, for example, N. Polmar and T. B. Allen, *Rickover: Controversy and Genius* (New York, 1982).

34 *Ibid.*, 607.

35 Hewlett and Duncan, *op.cit.*, 226-31.

36 Joint Committee on Atomic Energy, *Naval Reactors Project and Shippingport*, 85th Congress, first session, 1957, 29.

fitting his personal style of management, the Admiral believed that centralized control of Shippingport was essential. Rickover felt that no utility possessed the technical expertise to manage the nation's first civilian reactor.[37] Undoubtedly Rickover was well aware of the vendor orientation that had developed within the utility industry. In many ways then, Naval Reactors and Bettis Engineers of Westinghouse would serve as consultants, manufacturers and technical advisers — consistant with utility traditions — and would be a major reason for the plant's successful completion and later, its reliability.

From the beginning, a tense relationship developed between Rickover and Fleger. Fleger, to some degree, expected a spirit of mutual respect and cooperation to prevail between the two parties. To Rickover, Duquesne Light had been employed by the Commission to perform a service — to man and operate Shippingport. To accomplish this, Rickover and his staff constantly tried to impress upon the company the seriousness and difficulty of the task. At times, the constant scrutinizing of Duquesne's performance caused resentment by Fleger and other company executives. Fleger found Rickover's style insulting and especially disliked the subservient relationship Rickover fostered.[38] Yet, despite the tensions, the managerial style of Rickover did, in the end, produce an efficient operation, which of course was beneficial to Duquesne Light.

Plant Construction and Operation

Actual plant construction began in April 1955, under supervision of Naval Reactors. Westinghouse was selected to serve as general contractor, largely because of the company's experience in constructing the Mark I prototype reactor. Dravo Corporation was awarded the contract to construct and install the reactor portion of the plant. Duquesne Light chose the firm of Burns and Roe to build the conventional electric generating portion of the plant.[39] Plant construction provided a stimulus to the Pittsburgh economy; at one point the total workforce at the construction site reached 1,800.[40]

To directly manage construction, Rickover set up a three-member

37 Interview with author, Richard G. Hewlett, Mar. 3, 1985. Hewlett is the author of *Nuclear Navy*.

38 Interviews with author, Donald Couchman (Shippingport Project Officer, Naval Reactors 1958-60), Feb. 1, 1985; and S. G. Schaffer, Duquesne Light, Apr. 1, 1985.

39 *The Shippingport Pressurized Water Reactor* (Reading, Mass., 1958), 503.

40 *Pittsburgh Post-Gazette*, May 26, 1958.

President Dwight D. Eisenhower, via electronic hook-up from his Denver White House annex, used a "neutron wand" to officially launch the Shippingport project September 6, 1954. Passing the wand over a neutron counter flashed an electronic signal to a piece of earth moving equipment at Shippingport which turned the first scoop of soil. (Courtesy Duquesne Light Co.)

coordinating committee representing Duquesne Light, Westinghouse and Naval Reactors. At Naval Reactors headquarters in Washington, a project officer headed the entire project.[41] To keep Rickover informed, the committee communicated with Naval Reactors in Washington on a daily basis, in addition to bi-weekly visits to the site by Rickover. As with all Naval Reactors' projects, Rickover kept well informed, not only through the committee, but by his constant surveillance and scrutinizing of the firms involved. Just the threat of Rickover's intervention was often motivation enough for those involved at Shippingport.[42]

Because much of the construction was unprecedented, problems soon developed. For example, the plant required 80,000 feet of piping, which involved 25,000 welds. It had to be assured that all of the welds were leak proof, because radioactive water would flow through much of the piping. A loss of coolant accident is among the most feared mishaps in a nuclear plant because of the danger that the fuel core will overheat. A special x-ray technique was invented to inspect the welds. Other problems included the pouring and forming of the roof deck, and the placing of the reactor pressure vessel, which weighed 153 tons.[43]

The project soon fell behind schedule. Rickover became convinced that the delays, in part, were caused by poor management on the part of Dravo. Naval Reactors convinced Dravo to place a senior official at the site to spur construction and authorized a sixty-hour work week for Dravo.[44] At the beginning of 1957, Rickover increased the pace of the work. Westinghouse hired an additional contractor to finish the pipe installation and complete the radioactive waste disposal system. Senior officials of the firms involved virtually lived at the site in an attempt to get the plant on line as soon as possible.[45]

The original construction schedule had optimistically called for the plant's completion in March 1957, a schedule which became impossible to meet. Nevertheless, the reactor was installed in October and the plant was completed and ready for testing in December 1957, approximately nine months behind schedule, which by today's

41 Jack M. Holl and Francis Duncan, *Shippingport: The Nation's First Atomic Power Station* (Washington, 1983), 14; and interview with author, John E. Gray, Duquesne Light Co. (Project Manager 1955-60), Feb. 14, 1985.

42 Hewlett and Duncan, *op.cit.*, 248-49.

43 *The Shippingport Pressurized Water Reactor*, *op.cit.*, 510-16.

44 Memo, Rickover to Kenneth Davis, Director of AEC's Reactor Development, Mar. 27, 1957. Copy in DOE archives.

45 Polmar and Davidson, *op.cit.*, 610-11.

standards is hardly a delay at all. The project did go over budget, by about $18 million. Final costs for the entire plant ran in the area of $75 million, of which Duquesne Light contributed some $20 million, roughly the same amount as a conventional power station would have cost.[46]

The Shippingport construction provided a valuable lesson. A "hands on" managerial approach must be taken to keep a handle on costs (the AEC did not consider the $18 million excessive) and to ensure construction plans remain reasonably on schedule. Rickover's ability to keep on top of the project, by communicating with all parties involved, and his insistence that the job be done right played a crucial role. Experience has since shown that without such active involvement in technical matters during construction, nuclear plants will suffer major construction delays and huge cost overruns.

Many utilities, for instance, set up entire nuclear management divisions within the company after beginning nuclear projects in the early 1970s and experiencing well-publicized delays in construction and enormous cost overruns. In fairness, few regulations existed in the 1950s for nuclear plants, making Shippingport construction easier and quite unlike the regulatory morass that developed in the 1970s. Moreover, Shippingport was a "Model T" in technical complexity compared to the larger nuclear plants of the 1970s. There is little doubt that even Rickover would experience great difficulty in supervising construction of a modern nuclear plant.

The 60 MW light water reactor, designed and built by Bettis Labs, took four years to complete. Many of the reactor components were scaled up versions of the Mark I prototype. Light water reactors would become the industry standard, largely because of research and development activity of companies such as Westinghouse, which was funded by the Navy to initially develop submarine reactors. Testing of the reactor and all plant parameters began in December 1957 and was completed in April 1958.

While plant construction was getting under way, another problem had to be solved: training Duquesne's supervisory personnel. Training facilities equivalent to Shippingport simply didn't exist. One of the few places available for nuclear training was the Navy test facility at Arco, Idaho, often referred to as a submarine reactor in the desert. The Arco facility was managed by Naval Reactors and staffed by Bettis engineers, so it made sense to have Duquesne Light personnel

46 Hewlett and Duncan, *op.cit.*, 247.

train there.[47] According to former Duquesne President S. G. Schaffer, the company chose many of its best young employees for training. Company officials felt that Duquesne Light would be on national display and wanted to demonstrate its competence in operating the plant.[48]

Training began in April 1954 involving forty-eight Duquesne employees and lasted two to eleven months, depending on the needs of a position. The training consisted of both "hands on" experience and classroom work and was described as intense, difficult and effective. In fact, it was the best training available at the time, and would contribute significantly to smoothing plant operations. Many Duquesne staffers trained alongside the crews that would man America's first nuclear powered submarine, the Nautilus.[49] There were those in the company who felt that Shippingport had absorbed too much of Duquesne's young talent. To these critics the main focus of the company was coal-fired stations. After all, Shippingport generated only 5 percent of the company's power, so many felt young engineers should be steered toward conventional technology rather than nuclear.[50]

Just before the start of operations in Fall 1957, a controversy flared between Fleger and Rickover. Convinced that he lacked adequate authority to ensure safe operations, Rickover insisted upon placing a personal representative in the control room (at all times) who would have authority to shut down the reactor any time the "shift rep" felt the plant was not operating safely. Fleger strongly opposed this. Placing such a person in the control room directly interferred with Duquesne's operating responsibilities. The contract language was fuzzy on the issue, but Rickover persisted and finally won. Fleger, however, protected company interests in acquiesing to Rickover's demands.[51] Had a serious accident occurred, the responsibility was clearly with Naval Reactors. The incident does illustrate Fleger's concern about protecting company interests. Company officials were not content to play a passive role in Shippingport operations. Rickover, undoubtedly, would have preferred the type of relationship he enjoyed with Bettis Labs, where his control was almost unlimited. Although the company didn't win all the battles, neither did Rickover.

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47 *The Shippingport Pressurized Water Reactor, op.cit.*, 557-58.

48 Interview, Schaffer, Jan. 24, 1985.

49 Various interviews with Duquesne Light personnel.

50 Interview, L. R. Love, Duquesne Light Co. (General Superintendent of power stations 1966-71), Feb. 2, 1985.

51 Holl and Duncan, *op.cit.*, 20, and interview, Gray, Feb. 14, 1985.

For example, Rickover had little success in influencing the selection or removal of Duquesne Light personnel at Shippingport. Mal Oldham, Duquesne's plant superintendent from 1957 to 1968, had previously worked at one of the company's conventional stations. Although Oldham possessed an understanding of nuclear technology, he was not a nuclear engineer. Rickover felt the plant superintendent should be a nuclear expert, much like his submarine commanders. Oldham's most valuable skills lay in public relations, administration and labor relations, skills which the company felt were needed at the plant. Moreover, Oldham tended to smooth the sometimes difficult relations between company and Naval Reactors personnel. Duquesne employees, at times, resented the military style and overbearing manner of some Navy personnel.[52] Rickover would have liked Oldham removed, but Duquesne Light always exercised its right to staff the plant as it saw fit, rarely giving into the Admiral's demands.[53]

The tight controls used by Naval Reactors during plant construction would continue during the operation of the plant. As mentioned, three groups participated in Shippingport operations. Naval Reactors managed the nuclear section and oversaw plant operations. A staff of eight, headed by a project manager who reported directly to Rickover, represented Naval Reactors at Shippingport. In Washington, a project officer (who also reported directly to Rickover) reviewed contractor performance, helped solve technical problems and, in general, had the responsibility of seeing that the plant ran smoothly. Of course, if things didn't go well, project officers had to be prepared to answer to the Admiral.

Bettis engineers of Westinghouse served as nuclear engineers and technical consultants for the reactor and related equipment. Duquesne Light provided a staff to operate the plant, which at one point numbered more than 200. Duquesne had full authority to operate the conventional (non-nuclear) electrical generation portion of the plant.[54]

During the early years of operation, testing of the reactor and nuclear equipment was the first priority. The test program was carried out by Duquesne Light personnel in conjunction with Bettis engineers, under the general authority of Naval Reactors. Testing was essential,

52 Interview, Francis C. Duvall, Duquesne Light Co. (shift reactor engineer 1957-66), Mar. 22, 1985.

53 Interview, Couchman, Feb. 1, 1985.

54 Interviews, Peter Judd, Shippingport Project Manager (Naval Reactors 1959-65), Jan. 28, 1985, and Couchman, Feb. 1, 1985. See also, contract no. At(11-1)-292, between Duquesne Light Co. and AEC, DOE archives, Germantown, Md.

for the knowledge gained would be used in future nuclear plants.[55] In 1965, a larger reactor was installed (150 MW), in which power generation for the Duquesne Light system became the major consideration. The company discovered that Shippingport fit well into its grid, especially as a back-up station. The reactor could reach full power in forty minutes, and be shut down in twenty minutes. In contrast, Elrama, Duquesne's most modern conventional plant, required almost three hours to reach full power and nearly four hours to close down.[56] In the late 1960s and early 1970s, Duquesne Light once again faced coal strikes at its local mines and coal was in short supply. According to F. J. Bissert, former Shippingport superintendent, operation of the nuclear facility allowed the company to avoid potential brownouts.[57]

The plant operated until 1974, when turbine problems developed. At this point, with the station out of service, the AEC decided to install a light water breeder reactor, which went on line in 1977.[58]

Although the cost of operating Shippingport was high due to its experimental nature, the plant worked very well technically. On only two occasions did the "shift rep" shut down the plant for safety reasons. The reactors performed well, with most of the problems occurring with auxiliary equipment such as pumps and valves. Some problems were also experienced with the turbine generators in the conventional part of the station.[59] By 1962, the plant was available 97 percent of the time for power generation, not counting scheduled maintenance and testing.[60]

The most important reason for the plant's success, especially in light of more recent history, was the managerial style of Rickover and Naval Reactors.[61] Early on, Rickover realized the potential danger of nuclear power: "No carelessness can be tolerated anywhere, for the

55 Joint Committee on Atomic Energy, *AEC Authorization Legislation, Fiscal Year 1963*, 87th Congress, second session, 1962, 295.

56 *Nucleonics*, vol. 14, no. 20, May 1962, 90.

57 Interview, F. J. Bissert, Duquesne Light Co. (Shippingport Superintendent 1968-73), Feb. 14, 1985.

58 Holl and Duncan, *op.cit.*, 33.

59 See, for example, U.S. AEC, *Analysis of Nuclear Power Plant Operations and Safety Related Experience Vol. II*, Hn-185, 1965, part 5. Costs of operation during the early years of operation were very high, about 64 mills per kwh.

60 AEC, *Operational History of U.S. Nuclear Reactors*, TID-8214, 1968. The capacity factor including scheduled shutdowns of the Shippingport plant was about 80 to 85 percent. Modern nuclear plants have capacity factors of approximately 65 percent, including scheduled shutdowns.

61 See, for example, "America's Big Risk," *Newsweek*, Apr. 27, 1987, 58-60.

entire chain of events can prove disastrous."[62] Simply put, mistakes that might not be significant in a conventional power station could have very serious consequences in a nuclear one. Strict operational and maintenance procedures were formulated and followed to the letter. Procedures for all aspects of operations were formulated by Duquesne officials in conjunction with Bettis engineers before the start up of plant operations. After a procedure had been worked out, it was reviewed by Naval Reactors in Washington, which either accepted the procedure or suggested changes. If operating experience demon-

"Any person who knowingly violated procedures answered directly to Rickover."

strated the need for procedural change, meetings were held at Shippingport between Duquesne, Bettis and Naval Reactors personnel. Out of these meetings would come recommendations that were reviewed by Naval Reactors in Washington. Once all parties were in agreement, a recommendation (depending on the magnitude of the change) would be taken to Rickover for his approval. Very minor procedural changes could be made in the control room with the approval of the shift representative.[63] Any person who knowingly violated procedures answered directly to Rickover. As one former Duquesne official put it, "You always knew who was in charge."[64] In addition to the operating procedures, training of personnel was ongoing and updated when necessary, and extensive record keeping allowed operators to spot potential problems, which also improved daily and long range planning.

With Shippingport, the ideal way to operate a nuclear plant was established: tight controls, attention to details, clear lines of authority, and active involvement by management possessing expertise. The traditional ways of running a utility — using vendors and consultants to solve system problems and allowing utility executives to concentrate on the business and financial aspects of management — would not

62 Joint Committee on Atomic Energy, *Naval Propulsion Program*, 91st Congress, second session, 1970, 96.

63 Interviews, G. I. Rifendifer, Duquesne Light Co. (Shippingport engineer 1957-60), Feb. 22, 1985; Love, Feb. 2, 1985; and Peter Judd, Shippingport project manager (Naval Reactors 1959-65), Jan. 28, 1985.

64 Interview, J. A. Werling (Shippingport engineer 1957-73), Jan. 19, 1985.

work with nuclear power. Utilities were forced to develop in-house technical and managerial expertise to handle the higher level of technical complexity, to say nothing of the legal and economic problems nuclear power would bring with it. Again, well-publicized problems have shown some utilities to be more diligent than others.

The Shippingport experience had significant impacts on Duquesne Light. In 1954, the company selected some of its best young personnel to work as supervisors at Shippingport. Obviously, many of these young men were aggressive and forward-looking. Over the years, they continued to climb in the Duquesne Light organization. In fact, by the mid-seventies, the company president and four of the five vice presidents had been part of the original Shippingport staff.[65] The success of the Shippingport staff was not accidental. Shippingport provided excellent managerial training, such as advanced planning, attention to detail, and perhaps most importantly, the long hours (twelve-hour days were common) and high standards of work demanded by Naval Reactors. Although one could argue that many of these men would have risen to higher positions without Shippingport, all those interviewed agreed that Shippingport played a major role in their upward mobility. Unfortunately, many of these Shippingport staffers were promoted to non-technical areas of Duquesne Light, denying the company a organized cadre of nuclear experts that might have facilitated operations at Duquesne's Beaver Valley I plant, which went on line in 1976 and experienced operational problems.[66]

From the outset, company officials hoped that Shippingport would bring positive publicity to Duquesne Light and the Pittsburgh area. In the early years, this goal seems to have been achieved. By 1968, more than 70,000 people had toured Shippingport as part of the company's public visitation program.[67] Fleger and Rickover were the recipients of various awards for their contributions to Shippingport and in 1959, the city of Pittsburgh honored Duquesne Light for participation in the Shippingport project.[68] On different instances both plant supervisors and company executives delivered papers at national and international conferences. For example, Fleger traveled to Japan in 1961 to discuss operations at Shippingport when the Japanese began to consider nuclear power as an energy alternative.[69]

65 *Duquesne Light News*, Oct. 1982, 11.

66 *Pittsburgh Post-Gazette*, July 5 and Dec. 8, 1979.

67 *Pittsburgh Post-Gazette*, Nov. 18, 1967.

68 *New York Times*, Mar. 20, 1959; and *Pittsburgh Post-Gazette*, Sept. 28, 1959.

69 See, P. A. Fleger, I. H. Mandil, and P. N. Ross, "Shippingport Atomic Power

Much of the beneficial publicity, however, was counterbalanced by events that unfolded in the early 1970s. Dr. Ernest Sternglass, a University of Pittsburgh engineering professor, maintained that Shippingport represented a serious health hazard for the Pittsburgh area. Sternglass reported dramatic increases in the levels of radiation in the Shippingport area since 1965. According to Sternglass, infant mortality, heart disease, leukemia and other forms of cancer had risen because of higher levels of Strontium-90 in the soil and Iodine-131 found in the soil and milk produced by local dairies. Moreover, he accused the Environmental Protection Agency and the AEC of conspiring with Duquesne Light to suppress radiation data. The AEC, the EPA and the state of Pennsylvania, after conducting extensive tests, found nothing to substantiate the Sternglass allegations. Duquesne Light stated that radiation levels in the Shippingport area represented only 19 percent of the allowable levels of those substances. Rickover also felt the charges were baseless, saying that the amount of radiation discharged at the plant during 1972 amounted to dosages of many common medical tests.[70]

Whether or not Shippingport or any other nuclear plant poses long-term health threats remains a hotly debated issue, but the entire episode put Duquesne Light on the defensive. Organized demonstrations took place at the plant, to protest not only the supposed health hazards, but also construction of Beaver Valley I, the company's independent nuclear station. The city of Pittsburgh, under the leadership of Mayor Peter Flaherty, announced its opposition to the Beaver Valley plant.[71] Duquesne Light expended a great deal of time and effort in defending itself, to mitigate the impact of Dr. Sternglass. The episode certainly highlighted the growing nuclear debate, in which utilities became the center of a national political controversy.

Conclusions

The Shippingport project began in the 1950s during a period of prosperity and optimism for Duquesne Light. The company was able

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Station, Operating Experience, Developments, and Future Plans," U.S. and Japanese Atomic Industrial Forum, Tokyo, Dec. 5-8, 1961. Copy in DOE archives.

70 The "Sternglass Affair" was widely covered in both the local and national media. For a summary see, Joint Committee on Atomic Energy, *Naval Reactors Propulsion Program,* 92nd Congress, second session, 1972-73, 185-86, and Appendix I-II, 235-43.

71 *Pittsburgh Post-Gazette,* Dec. 12, 1972.

to participate in a landmark venture, at costs that were not an economic burden because of AEC subsidization. The project promised to bring forth increasing prosperity, as new technologies traditionally had for the utility industry. Much of the project's success could be traced to the AEC providing technical and managerial expertise to operate the plant, in much the same way that vendors and consultants had done for Duquesne and other utilities in the past.

Shippingport should have signaled the need for major changes in the managerial thinking of not only Duquesne Light executives, but utility managers in general. The traditional approach to managing and operating a utility do not work with nuclear power. This is an important lesson of Shippingport, and certainly would be a difficult one for Duquesne Light and other utilities to learn in later years. ■