Upper Mississippi River Nine-Foot Channel Project,
Lock and Dam Complex Number 19
Spanning the Upper Mississippi River between
Keokuk, Lee County, Iowa
and
Hamilton, Hancock County, Illinois

HAER No. IA-27

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
Rocky Mountain Regional Office
National Park Service
U. S. Department of the Interior
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HISTORIC AMERICAN ENGINEERING RECORD

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Location: Located on the Upper Mississippi River, adjacent to downtown Keokuk, Iowa, and just upstream from Hamilton, Illinois. The complex is 364.5 river miles upstream from the confluence of the Ohio and Mississippi rivers. The complex stretches across the river at the lower end of a narrow reach of river that extends upstream about 25 miles. The limestone bluffs on either side of the river are a mere three-quarters of a mile apart for most of this distance. The site was also at the foot of the notorious 11.25-mile-long Des Moines Rapids which extended from Keokuk to Montrose, Iowa. The 1952-57 1,200-foot-long lock adjoins the Iowa shore. A now-abandoned 1910-1914 drydock lies on the riverward side of this lock. The now-abandoned 1910-1913 lock and its appurtenant structures adjoin the riverward side of this structure. The 1910-1913 power plant is located slightly upstream from this lock on its riverward side. The 1910-1913 dam extends from the power plant across to the Illinois shore. HAER photograph numbers IA-27-1 through IA-27-79.

Dates of Construction: 1867-1877; 1883-1889; 1910-1914; 1952-1957

Present Owner: U. S. Government
Rock Island District
Corps of Engineers
(Des Moines Rapids Canal bullnose, both locks, dry dock and appurtenant structures)

Union Electric Company
(power plant, dam and appurtenant structures)

Present Use: River navigation/Hydroelectric power generation/hydrology control

Significance: Rare, intact example of nationally significant historic engineering -- listed on the National Register of Historic Places as part of the Lock 19 National Register District.

The U. S. Army Corps of Engineers Nine-Foot Channel Project (1927-1940) represents the culmination of a 100-year effort to improve the navigability of the Upper Mississippi River between the mouth of the Missouri River and Minneapolis, Minnesota. This specific project arose as a response to the farm crisis of the 1920s. Proponents of the New Deal adopted the project and gave speed to its construction as a means of providing public employment during the more general depression of the 1930s. By the 1940s, the completed project had converted over 650 miles of free-flowing river into a series of interconnected reservoirs which ensured enough water for fully loaded modern boats and barges to navigate the system. This constituted a significant

alteration of the natural environment of the Upper Mississippi River. However, the project also brought economic benefits to the communities along and around the river corridor and lead to new recreational opportunities for the entire region.

The Upper Mississippi River Nine-Foot Channel Project inaugurated a new development in slack-water navigation system dam practice in the United States: the adoption of a non-navigable dam containing both roller and Tainter gates. Prior to the Corps' 1930 decision to build non-navigable dams on the Upper Mississippi River, United States Army engineering practice had, nearly universally, been to construct navigable dams, permitting open-river navigation at higher river stages. By 1930, European engineers had been using roller gates in dams extensively for over 25 years. However, only ten such structures had been built in the United States, and these were all located on reaches of rivers where ensuring navigability of any sort was not a design concern. It was not until 1925-1926 that civilian engineers pioneered the use, in the United States, of roller gates in combination with other types of gates. Most of the Corps' Upper Mississippi River project dam designs expanded upon this development, incorporating both roller and Tainter gates. The Corps' shift from navigable to non-navigable dams demonstrate the influence of shipping techniques on navigable waterway improvement technology. It also exemplifies the cautious nature of American Army engineers response to changes in shipping. The Corps' choice of this particular type of non-navigable movable dam illustrates the influence of the hydraulic characteristics of individual rivers on the selection of waterway improvemcnt technologies. It also evidences the manner in which critical engineering design developments are disseminated and become accepted.

Ironically, the Upper Mississippi River Nine-Foot Channel Project also resulted in the obsolescence, by the project's end, of combination roller and Tainter gate dams. Technological advances resulting from the research and development incidental to the design and construction of the 26 lock and dam systems in this project enabled U. S. Army Corps of Engineers to develop both submersible and non-submersible Tainter gates which nearly matched the capabilities of the roller gates. Once these less expensive and easier operated and maintained gates had been developed, American engineers ceased designing or constructing combination roller and Tainter gate dams. The Corps' creation of a new dam type and its subsequent obsolescence during the course of a single project dramatically illustrates both the evolutionary nature of American engineering in general and the Nine-Foot Channel Project in particular (Text, pages 11 and 49-50. See HAER No. IA-23 for complete history, footnotes and bibliography).

Historian: Mary Yeater Rathbun

August 1988

PART I. HISTORICAL INFORMATION

A. Physical History:

1. Dates of Erection: 1867-1877; 1883-1889; 1910-1914; 1952-1957

2. Architect/Engineer: 1867-1877--U. S. Army Corps of Engineers, Keokuk Engineer Office; 1883-1889--U. S. Army Corps of Engineers, Keokuk Engineer Office, Montgomery Meigs; 1910-1914--Hugh L. Cooper; 1952-1957--U. S. Army Corps of Engineers, Rock Island District.

3. Original and Subsequent Owners:

Des Moines Rapids Canal bullnose, locks, dry dock and appurtenant structures	U. S. Government, Army Corps of Engineers
Power plant, dam and appurtenant structures	Keokuk and Hamilton Power Company (1910-1913), Mississippi River Power Company (1913-1925), Union Electric Company (1925-present)

4. Builders, Contractors, Suppliers:

1867-1877 General Contractors--Embankment and Prism Construction: William Heegen and Son, Mt. Vernon, Ohio (1867-1868) and J. J. Dull, Harrisburg, Pennsylvania (1868-1877)

Supplier of Magnesian Limestone: Sonora Stone Quarries, Illinois

Stone Dressing: Stone Yards, Nashville and Price's Creek, Iowa

Manufacturer of Lock Operating Machinery: Buckeye Foundry, Keokuk, Iowa

1883-1889 General Contractor--Dry dock and Canal Shops: U. S. Army Corps of Engineers, Rock Island District (using hired labor)

1910-1914 General Contractor: Stone & Webster Engineering Company, New York, New York

1952-1954 General Contractor-Stage I (construction of lock lower approaches): McCarthy Improvement Company, Davenport, Iowa

Subcontractors:

Abells Electric Company.....Installed electrical work in
Keokuk, Iowa government field office
Hauston Brothers Heating Co. .....Installed heating system in
Keokuk, Iowa government field office
Howard Steel Erecting Co. .....Erected pre-fab steel warehouse
Davenport, Iowa and office building for use of prime contractor
Kitmann Construction Co. .....Constructed government field office
Keokuk, Iowa
N. C. Patterson and Sons.....Installed plumbing in government
Keokuk, Iowa field office
Raid Brothers.....Crushed excavated rock and disposed
Denmark, Iowa of same
Vale, Inc. .....Wrecked old buildings and boatyard
Davenport, Iowa area

1954-1956 General Contractor--Stage II (construction of practically all the essential features of the lock): Jones Construction Company, Charlotte, North Carolina

Subcontractors:

H. N. Rogers and Sons Company.....Earth and rock excavation and earth
Memphis, Tennessee backfill
A-1 Electric Service.....All electrical work
Keokuk, Iowa
R. W. Reade Company.....Painting
Berkeley, California
Seither and Cherry.....Plumbing--all pipe work
Contracting Engineers
Keokuk, Iowa
Raid Brothers.....Crushed excavated rock
Denmark, Iowa
Cyclone Fence Company.....Erected chainlink fence
Davenport, Iowa
R. L. Patton Construction Co. .....Constructed concrete roadways,
Keokuk, Iowa sidewalks, and dry dock slope paving
C. R. McDowell Construction Co. ...Placed stone base for roadways and
Keokuk, Iowa parking access
Cameron and Joyce Company.....Placed roadway surface material
Keokuk, Iowa
A. N. Hegal.....Placed and graded top soil
Quincy, Illinois

Avondale Marine Ways, Inc. .....Provided lock miter gates, lock
New Orleans, Louisiana valves, and operating machinery
Bethlehem-Sperrows Point.....Provided upstream lock gates
Shipyard, Inc.
Bethlehem, Pennsylvania

1954 General Contractor--Stage III (furnishing mechanical and electrical equipment for the lock and mechanical and electrical engineering services to supervise the erection and testing of equipment): Oil Gear Company, Milwaukee, Wisconsin

1956-1957 General Contractor--Stage IV (power, control, and lighting system, and miscellaneous construction): Evans Electrical Construction Company, Omaha, Nebraska

Subcontractors:

Burlington Tent and Awning Co. ....Roofing and roof insulation
Burlington, Iowa
Economy Builders.....Earth and concrete work
Keokuk, Iowa
George H. Holiday.....Painting
Keokuk, Iowa
Corahunter Tile and Marble Co. ....Installed quarry tile
Lincoln, Nebraska
Galesburg Glass Company.....Glazing
Galesburg, Illinois
Westcott Construction Company.....All masonry work
Fort Cook, Nebraska
Clifton Dunlon.....Plastering
Keokuk, Iowa
Saether & Cherry.....Plumbing and heating
Keokuk, Iowa
Koraboj Construction Company.....Construction utility building and
Blair, Nebraska two control houses and installation
of boat davets

5. Original Plans and Construction:

1867-1877--U. S. Army Corps of Engineers, Keokuk Office, resident engineer, Lieutenant colonel James H. Wilson (1867-1870); plans for canal done by D. C. Jenne; resident engineer (1870-1872) Colonel John N. Macomb; original design for lock operating machinery, by resident engineer Major Amos Sickney (1872-1877).

1883-1889--U. S. Army Corps of Engineers, Keokuk Office, resident engineer-Montgomery Meigs.

1910-1914--plans, Hugh L. Cooper; construction supervision, U. S. Army Corps of Engineers, Keokuk Office, Rock Island District, resident engineer-Montgomery Meigs.

1952-1957--Plans, U. S. Army Corps of Engineers, Rock Island District, Upper Mississippi Valley Division; and Office of the Chief of Engineers; direct construction supervision, U. S. Army Corps of Engineers, Rock Island District.

6. Alterations and Additions:

Item	Year
Addition-Dry Dock and Canal Shops	1930
Construction-Keokuk and Hamilton Water Power Company Dam, power plant, lock and appurtenant structures	1910-1913
Closed and began filling in Des Moines Rapids Canal--wall attached to bullnose demolished	1912
Demolition Des Moines Rapid Canal Dry Dock and Canal Shops	1912
Construction--new dry dock	1912-1914
Government assumption of ownership 1910-1913 lock and appurtenant structures	1913
Government assumption of ownership 1912-1914 dry dock	1914
Addition-ladies restroom and lockman's shop atop 1910-1913 lock power house	1927
Installation stage recorder on Des Moines Rapids Canal bullnose	ca. 1930
Major rehabilitation lock miter gates, replacement anchorage system with adjustable anchor bars provided with turnbuckles, installation of pressure lubricating system for lubrication of pintels	1934

Replaced parts of four-cylinder discharge valves in lock	1939
Addition-two upper approach mooring piers at lock	1941
Rewinding of 6 of 15 generators at 1910-1913 power plant to produce 60 hertz power	ca. 1950
Demolition sawmill, lumber shed, ice house, store house and shops which are part of 1910-1913 dry dock complex	1952-1954
Construction-new lock	1952-1957
Removal from service-1910-1913 lock	1957
Construction-visitor's center	1961
Dewatering of 1910-1913 lock; sheet pile and cell closure built upstream; an earthen cofferdam put across downstream end; upstream and downstream guidewall additions to the river wall removed	1977
Removal from service and dewatering of 1912-1914 dry dock; sheet pile and cell closure built upstream; dominant gantry crane assembly which spanned the chamber removed; land wall covered with new cement	1977
Abandonment-1910-1913 lock operator's house and lock power house	1977
Modification-1910-1913 power plant control room for computer operations	ca, 1980
Replacement-light posts and light fixtures around 1952-1957 lock	1984

B. Historical Context:

Although serving as a component of the Upper Mississippi River Nine-Foot Channel system since its conception, Lock and Dam Complex 19 was not built as part of the Corps of Engineers' 1927-1940 Nine-Foot Channel Project. One element was built as part of the Corps of Engineers'

1966-1878 Four-Foot Channel Project. Other extant elements were built between 1910 and 1914 by the Keokuk and Hamilton Water Power Company (later renamed the Mississippi River Power Company as a private project individually authorized by Congress in 1905. Still other elements were built by the Corps of Engineers between 1952 and 1957 with funds appropriated by Congress in 1953, well after the majority of the Nine-Foot Channel Project had been completed.

The complex, unlike all the other Nine-Foot Channel complexes in the Rock Island District, has national significance as an individual complex. It includes rare, intact examples of nationally significant historic engineering. It is associated with the lives of individuals significant in the nation's past, including several of the nation's greatest engineers. It represents the work of several of the nation's masters of waterway improvement and hydraulic engineering.

The oldest element of the complex is the Des Moines Canal bullnose which was simultaneously the termination of the canal embankment and the downstream end of the riverwall of the third lock in that canal system, the Keokuk lock. The canal was built between October 1867 and 1870 by constructing an embankment in the water 200 or more feet from the shore to form the riverside of the canal. As completed for a cost of $4,155,000, it had a riprap toe of broken rock, varied from 60 to 90 feet at its base, with a slope of 1.5 to 1. This made it approximatcly 10 feet wide at top. It varied in height from a low of 16 feet to a high of 27 feet. Then, a prism was to be excavated to a depth of five feet between the embankment and the shore. Next, between 1870 and 1874, three locks were built within the prism: two lift locks and one guard lock. The guard lock with no elevation change at standard river stage was at Nashville, while one lift lock was 5.1 miles downstream from there and the other 7.6 miles downstream from Nashville--at the foot of the canal in Keokuk. The locks were constructed of dressed magnesian limestock blocks laid in hydraulic cement. The embankment served as their riverward walls. Each lock had a chamber 310 feet long by 80 feet wide at surface, giving a usable chamber to 291 feet by 78 feet.

Although the lower end of the Des Moines Rapid Canal and its Keokuk lock were covered by nearly 50 feet of fill between the fall of 1912 and the spring of 1914, the bullnose remains. It has been tied to the downstream wall of the drydock since that element of the complex was constructed bctween 1912 and 1914.

The extant dry dock at complex 19 was not the first dry dock at the complex. The Rock Island District added a dry dock to the Keokuk lock complex of the Des Moines Rapid Canal between 1883 and 1889. Designed by Montgomery Meigs, that dry dock lay on a piece of lower ground on the river side of the canal embankment just aBove the middle of the lock. It utilized the combined canal embankment/river wall of the lock as its land wall. Therefore, the extant Des Moines Canal bullnose is a remnant of this element of the complex, too. The 1883-1889 dry dock's river wall and downstream end were clay covered in riprap. Together, the three walls and a set of gates providing an 80-foot-wide entry-way enclosed a 400-foot by 100-foot basin. The dry dock was filled and emptied by culverts opening into both the river and the canal. The culverts were fitted with closing valves. Once completed in 1889 at a cost of $133,000, this dry dock received almost constant use, as it was the only one on the Upper Mississippi and the Corps leased it to private companies so that they could repair private boats there when the district was not using it to repair its own boats. The main body of this 1883-1889 dry dock,

along with the machine and storage sheds for boat building and repair which were situated at its lower end, were demolished along with the lower end of the canal and the canal lock between the fall of 1912 and the spring of 1914.

Construction of the dam, power plant, lock, and appurtenant structures began in January 1910 and was completed in June 1913. Stone and Webster Engineering began building the dry dock and its appurtenant structures in its appurtenant structures in the fall of 1912 and completed them in 1914. The lock, a dry dock, and the Keokuk Power Plant were all located on the Iowa side of the river adjacent to the city of Keokuk in a spot that encompassed the site of the first lock of the Des Moines Rapid Canal. At the time that they were completed, the dam was longer than any other dam in the world except the Aswan Dam across the Nile River and only the power plant at Niagara Falls included two power houses; the plant at Keokuk had only one. Thus, the Keokuk plant was the largest capacity single power house in the world as well as being the largest low head hydroelectric station in the world. The dam and power plant are still functioning and relatively unaltered today, over 60 years later. The plant remains one of only two commercial hydroelectric power producers on the Upper Mississippi. The other is at the high dam at Lock Number 1 in St. Paul. Lock and Dam Number 1 was authorized in 1894, but was not built then. Its design was only changed to allow it to incorporate a hydroelectric power generation facility in 1910, after the Keokuk plant was already under construction. Lock and Dam Number 11 is much smaller than the Keokuk facility and was not completed until 1917, four years after the Keokuk installation.

The same act that authorized the Nine-Foot Channel Project in 1930 also authorized the Corps to construct a new, standard 110-foot by 600-foot lock at Keokuk, but did not authorize the Corps to build a new dam. Planning for this new lock began in 1930, but there were serious problems concerning where to locate it without interfering with the operation of either the commercial power plant or the dry dock. Because of the 40-foot lift at Keokuk, the engineers considered deviating from the standard Nine-Foot Channel lock design. But, in 1945, before the engineers had completed detailed plans and specifications and model studies on this lock, Rock Island District planners recommended that the length of the new lock be expanded to 1,200 feet to allow what were becoming standard long tows to pass through the lock as one piece. In 1952, Congress authorized the Corps to begin construction on this new lock. The lock, two control houses, a utility building, and a lockwall esplanade were constructed in four stages with separate contracts let for each stage. This was primarily due to problems connected with the preparation of construction plans and specifications and the timing of funding. Stage I, carried out between 1952 and 1954, consisted of the construction of the lock lower approach. Stage II, carried out from 1954 to 1956, consisted of construction of the lock proper, including installation of lock gates, valves, and lock operating machinery. Stage III, carried out in 1954, involved a supply contract for the manufacture and delivery of certain electrical equipment and the upstream gate operating equipment. Stage IV, carried out in 1956 and 1957, consisted of the installation of the power, control, and lighting system and some miscellaneous construction.

As completed in 1957 at a cost of approximately $13,500,000 (considerable more than the $640,000 it cost to build the old lock in 1910-1913), the new lock provides a useable chamber 110 feet wide and 1,200 feet long, with a depth over the upper sill of 15 feet and over the lower sill of 13 feet. The maximum lift at low water stage is 38.2 feet. During the peak of construction, 415 people were employed on the project. It was placed in operation as a unit of the Upper Mississippi navigation system on May 14, 1957.

Dam 19, of course, went on line much earlier, on May 31, 1913. It consists of 119 rectangular sliding gates between 120 piers on 36-foot centers. During the peak of its construction, 1,200 men were employed on the project. Most skilled workers were native-born Caucasians. Most laborers were Irish or German immigrants or blacks. Normal upper pool elevation is 480.0 feet; the difference between this and the tail waters below the dam at low water is 38.2 fect.

PART II. TECHNOLOGICAL INFORMATION - LOCK

A. General Statement:

1. Design Character: 1910-1913 Keokuk Lock--Variant of Standardized Panama Canal Design. 1953-1957 Lock--Varient of Standardized Ohio-Mississippi Lock Design.

2. Condition of Fabric: 1910-1913 Keokuk Lock: Good, but suffering from deferred maintenance since permanently abandoned and dewatered in 1977. 1953-1957 Lock--excellent.

B. Description of General Layout and Principal Elements:

1. Overall dimensions: 1910-1913 Keokuk Lock: Chamber--110 feet wide by 358 feet by 57 feet high. Lift--40 feet. Drawing Numbers 2054 and M-L 19-1 110/4 and M-L 19/2 10/12. 1953-1957 Lock--Chamber-110 feet wide by 1,200 feet long by 59.25 high. Lift-38.2. Drawing Number 19-1 20/32.

2. Foundations: Bedrock. Drawing Number M-L 19-1 110/3; M-L 19-2 20/2; 20/3; 20/4.

3. Walls: Reinforced concrete. Land wall of 1953-1957 lock adjoins Iowa shore; river wall adjoins land wall of 1912-1914 dry dock. River wall of dry dock also serves as land wall of 1910/1913 Keokuk lock. River wall of lock ties to lock power house on east. Drawing Numbers 2054 and M-L 19-1 110/4 and M-L 19-2 10/12.

4. Structural System: Monolithic concrete/structural steel

5. Bullnoses: 1866-1877 bullnose termination of Des Moines Rapids Canal embankment on downstream end of riverwall of Keokuk lock--cut and dressed limestone blocks approximately 2 feet by 3 feet by 18 inches laid in courses on a limestone bedrock foundation.; The upstream end ties to the downstream wall of the 1912-1914 dry dock.

The downstream end of the bullnose is horizontally rounded and faces south. On the curve, approximately one course down from the top, is a carved relief shield representing an anchor. A water level gauge shelter sits on the structure. Drawing Number M-L 19-1 110/4; M-L 19-2 10/3. 1910-1913 bullnoses--concrete configurations extending from downstream ends of both lock walls 20 feet from the top of the walls. Connected to tops of walls by concrete simple, exposed concrete stairways. 1953-1957 bullnose--rounded concrete configuration at the downstream end of the permeable river wall extension of the lock, downstream from highway bridge swing span pier. Drawing Number M-L 19-1 110/3; M-L 19-2 20/28.

6. Guidewall: 1953-1957 Lock: 605-foot-long and 33.5-foot-high monolithic concrete wall extending the land wall of the lock along shore downstream to serve as a retaining wall for fill added in construction and to assist in guiding barge traffic into downstream end of lock. Top of guidewall connected to top of land wall over 25 feet above by simple, exposed concrete stairway.

7. Riverwall Extension: 1953-1957 lock--550-foot-long and 33.5-foot-high permeable extension to downstream end of riverwall encasing the swing span pier of the highway and railroad bridge joining Hamilton, Illinois, and Keokuk, Iowa. Top of riverwall extension connected to top of riverwall of lock by simple, exposed concrete stairway. Drawing Numbers M-L 19-1 110/3; M-L 19-2 10/3.

8. Stage Recorder: Small shelter housing located on 1866-1877 bullnose. Equipment housed for the recording of river stages.

C. Mechanical Equipment:

1. Lock Valves: 1910-1913 Keokuk Lock--Four cylindrical air-pressure powered filling valves situated vertically above the penstock itself embedded in riverwall of lock. Remotely controlled by lever switches on the main control panel located on the second floor of the lock operator's house located on the riverwall of the lock beside the upper gates. Valves and operating system apparently intact but not operated since 1977. 1953-1957 lock--four 14.5-foot by 15.5-foot cable driven Tainter valves of steel construction with electric motorized assembly. Valves located in wells extending to two culverts, one in each chamber wall. Operated by four sets of duplicate switches located in the control stations on each side of upper gate and in weatherproof control cabinets, one cabinet on either side of the downstream gate recesses. These lower control cabinets have been surrounded by metal and glass shelters since mid-1970s. Drawing Numbers M-L 19-2 25/1; 28/1.

2. Lock Gates: 1910-1913 Keokuk Lock--downstream gates: one pair vertically mitered curved steel skin-plated leaves with buoyancy chambers in their lower third; each leaf balanced on pintel. Operated by strut connected to air pressure-operated engines located in shelter houses, one beside each gate recess. Engines remotely controlled by lever switches on the main control panel situated on the second floor of the lock operator's

house located on the riverwall of the lock beside the upper gates. Gates have not operated since 1977 when lock permanently dewatered and cofferdam placed across lower gate recess, pinning gates in open position. Upstream gates: two identical gates, with the guard gate lying upstream from the service gate. The guard gate allowed the service gate to be repaired and could also be used in emergencies if the service gate failed. The top of both gate is wide enough to serve as a service bridge, giving access to the lock power house and the commercial power plant. Both gates are single-leaf, submergible, vertical lift, floating gates, operated by air pressure conducted to them in pneumatic pipes by way of steel towers (one serving each gate) on the riverwall of the lock next to the gates. The full extent of each gate, when open, fits into a large slot in the floor of the upper breast wall of the lock. After having been lifted by air pressure, their tops are at the same level as the lock walls and they are secured in placed by catches. Gates have not operated since 1977, when lock permanently dewatered and cell closure was built upstream from upper guard gate. Gates kept in closed position. Drawing Number 2876. 1953-1957 lock--downstream gates: one pair miter gates balanced on stainless steel pintels operated by arms, geArs, and electric motor assemblies. Motor assemblies housed in machinery pits in lock walls adjacent to each leaf. Motor assemblies are operated by four sets of duplicate switches located in the control stations on each side of upper gate and in weatherproof control cabincts, one cabinet on either side of the downstream gate recesses. These lower control cabinets have been surrounded by metal and glass shelters since mid-1970s. Upstream gates: two identical gates. The upper service gate is just downstream from the upper guard gate. The upper guard gate serves to protect the service gate from tow damage; serves as a bridge to the commercial power plant, as well as the old lock and dry dock; and allows dewatering of the service gate area. Both gates are single-leaf, submergible, vertical lift, hydraulically operated. They are controlled by switches in the abovementioned control cabinets. Drawing numbers M-L 19 21/1, 22/1, 23/1, 24/2.

3. Lighting: 1953-1957 lock-various freestanding single and double head lighting standards, installed in 1984.

4. Plumbing: 1910-1913 Keokuk Lock--Lock is watered by cylindrical valves(see previous page) serving a system of cast-in-place tunnels that enable water level to be controlled on the interior of the lock. System is apparently intact, but not operated since 1977. Drawing number 2054. 1953-1957 Lock--Lock is watered by Tainter valves (see previous page) serving a system of cast-in-place tunnels that enable water level to be controlled on interior of lock. Drawing Number M-L 19-2 20/36.

D. Other Elements:

1. Dry Dock--overall dimensions: waterproof chamber formed by gate, three walls, and floor is 130 feet wide by 463 feet long by 20 feet high. Foundation: bedrock. Reinforced concrete, cut stone, and rock-filled walls. Landwall is riverwall of 1953-1957 lock and on the chamberward face is sloped to its top. New concrete surface put on this slope in 1977. Riverwall is land wall of 1910-1913 lock and is vertical and now straight, although originally

had arches to hold extensions of the land wall of the 1910-1913 lock. Four cylindrical, air pressure-operated filling valves (similar to those which controlled the filling and emptying of the 1910-1913 lock) situated above penstock in the land wall controlled the filling of the dock. When the valves were open, the penstock fed water to longitudinal tunnels in the dry dock floor.

When the valves were closed, no water could enter the chamber. The chamber was emptied directly into the downstream pool through two discharge tunnels in the downstream wall of the dock. The discharge flow was controlled by hand-operated valves in the downstream wall. The access gate is a single-leaf, submergible, vertical-lift, pneumatically-operated floating gate identical to the service gate and guard gate on the 1910-1912 lock. The pneumatic operating system is controlled by lever switches on the main control panel in the second floor of the lock operator's house on the land wall of the lock beside the upper gates. Structure abandoned and permanently dewatered in 1977. The dominant gantry crane which spanned the chamber removed. The structure is suffering from deferred maintenance. Drawing Numbers 2054, M-L 19-1 110/4, 110/3, M-L 19-2 10/11, 10/12.

2. 1910-1913 Lock and Dry Dock Power House: Developed all the air pressure needed to operate the lock and dry dock operating machinery.

   a. Exterior--overall dimensions: Main power house--ca. 40 feet by 240 feet by 30 feet high above the water line forms east-west connecting wall between river wall of 1910-1913 lock and the incomplete commercial power house extension wall. 1927 lockman's shop and ladies restroom addition on top of main power house-ca. 12 feet by 50 feet with a sloping stairway cover on east end. Main power house--reinforced concrete walls and structural system. Addition--masonry structural system, walls brick covered with concrete stucco. Openings: in main power house--two ice chutes extending from upstream to downstream side of structure at east or riverward side of structure; two water intakes toward center of upstream side connected to trash racks leading to scroll chambers containing turbine runners; scroll chambers connected in turn to two steel draft tube which discharge directly into downstream pool from downstream side of structure; six large arched metal casement windows on downstream side; and four-paned windows; two doorways and doors. Main roof--reinforced concrete. Addition roof--hipped with tile shingles.

   b. Interior--main house-ca. 125-foot by 30-foot three-bay room, first level below top of main power house contains two 200 hp 262 rpm S. Morgan Smith Company turbines with individual governors attached to double 165 rpm 15-foot by 116-foot Ingersoll Rand Company air compressors. Transmission belts are prominent feature. Simple, reinforced concrete stairway leads from addition to main room and from main room further down in structure to accessway to tunnels carrying pneumatic pipes, water pipes, electric conduit, etc., from power house to lock and dry dock. Drawing Number 2357. Addition--one large 12-foot by 33-foot workroom on west; ca. 10-foot by 7-foot restroom to east. No interior doors between two rooms.

PART III. TECHNOLOGICAL INFORMATION--MOVABLE SECTION OF DAM

A. General Statement:

1. Design Character: Movable sliding gate dam system.

2. Condition of Fabric: Good.

B. Description of Exterior

1. Overall Dimensions: 4,620 feet in length.

2. Foundation: Bedrock

3. Structural System: Monolithic concrete/structural steel.

4. Openings: 119 water channels, each ca. 30 feet wide.

5. Piers: 120 on 36-foot centers.

6. Service Bridge:

a. Shape: Arched spans in a segmental series.

b. Materials: Concrete

C. Description of General Layout and Principal Elements:

1. Access Plan: Access to service bridge through large doors in upstream end of main generator room of commercial power plant. Walkway railway extends full length of service bridge. Direct ground level access off east end of service bridge to storage yard.

2. Flooring: On service bridge deck--reinforced concrete.

3. Hardware: Brass

D. Mechanical Equipment

1. Movable Gates: 119 rectangular, steel skin-plated, sliding gates. Each gate is either entirely open or entirely shut. Flow is controlled by the number of gates that are open. Gates are operated by a traveling gantry crane which moves on rails on the outside of the entire length of the service bridge atop the dam.

2. Traveling Gantry Crane: See above.

3. Coal Boiler Car: Box car equipped with steam boiler unit, used to thaw gates. Rides on set of rails extending full length of the service bridge inside the Traveling Gantry Crane rails.

4. Air Pressure Operated Crane Car: Flat car equipped with crane used to repair gates. Rides on same set of rails as coal boiler car.

5. Electric Trolley Car: Flat car used to repair and move gates. Rides on same set of rails as coal boiler car, air pressure operated crane car, and electric trolley car.

6. Electric Powered "Hand" Car: Flat car used to transport people. Rides on same set of rails as coal boiler car, air pressure operated crane car, and electric trolley car.

7. Lighting: Fixtures as of time of installation 1912-1913--rewiring may have taken place over the years--extent is unknown.

8. Transmission Towers: Metal towers adjoining service bridge on full length of downstream side and carry power lines.

E. Other Elements:

1. Storage Yard: Area extending from the eastern end of the movable section of the dam. Contains various sheds and service building erected from time to time as demands required, including ruins of original construction mixing plant, metal shed, concrete and brick storage building, and brick power transmission building. All astylisic utilitarian buildings. None have particular significance or contribute to the site.

2. Ice Fender: ca. 1,500-foot-long, curved, concrete, non-overflow dike extending northwest behind commercial power plant towards IowA shore upstream from the locks.

3. Commercial Power Plant: Conventional, rectangular, run-of-the-river hydroelectric power house which generates 135,000 kilowatts at capacity. Six of 15 generators rewound to produce 60 hertz power, rather than original 25 hertz power.

   a. Exterior--overall dimensions: ca. 150 feet by 1,600 feet including ca. 150 foot by 800 foot base for expansion-foundation, underwater turbine wells and tubes, and a west wall that connects to the lock power house. ca. 150-foot by 800-foot completed section is equivalent to 10 stories. Bedrock foundation. Reinforced concrete walls and structural system. Openings: 38 ca 20 foot by 50 foot metal frame casement windows with an arch-topped light above; ca. 66 smaller metal frame casement windows with arch-topped light above. Variety of single leaf, double leaf, and overhead doors. Water enters from forebay on west side. Flows through trash racks into game room and continues into scroll chambers for each of 15 generating units before flowing downward into draft tube which discharges into

tailrace on east side of plant. Flat roof covered in membrane/tar composition. Transmission towers on roof.

b. Interior--main room is on east side of building over thrust deck and contains 15 generators, each about 25 feet wide. Generator rotors connected to turbine runners at centers of spiral scroll chamber below thrust deck by 25-inch diameter vertical shaft.

Offices, operations center, and utility rooms are located on the top two floors of the building. Stairways: reinforced concrete.
Flooring: in main generating room, offices operations center, and utility rooms are tile; on thrust deck and lower level utility room and access ways--concrete. Walls: concrete. Ceiling: in main generating room--open metal truss. Control room modernized to make use of computer technology. Hardware throughout: brass.

PART IV: TECHNOLOGICAL INFORMATION-ESPLANADE AREA

A. Description of Esplanade--General Layout:

1. Design Character: Park/Service area and access road component. Current one is fourth such complex to occupy this general area. This one originally designed in 1952 to accommodate utility/office shop building, parking, and access road, and other service-related function. Site alterations have occurred since that time and are noted in the following items as are the major outlines of the other three now-demolished esplanades.

2. Architectural Character: Astylic utilitarian.

3. Historic Landscape Design: Unique.

B. Condition of Site and Structures: Altered

1. Initial 1877-1889 Esplanade: Served Des Moines Rapids Canal and Keokuk Canal Lock. Included 27-foot square building housing engine, and lockmaster's and lockmen residences and service building. All were demolished between 1912-1914.

2. 1889-1912 Esplanade: Served 1883-1889 dry dock as well. Included machine and storage sheds for boat building and repair, along with structures from 1877-1889 period. All were demolished between 1912-1914.

3. 1912-1953 Esplanade: Served 1910-1913 lock and 1912-1914 dry dock. Included office, warehouse and lumber shed, saw and planing mill; two store houses; blacksmith shop; machine shop; yard office and storage; ice house and oil storage facility. All were demolished in 1953. Drawing Number M-L 19-1 110/4.

4. 1957-Present Esplanade: Serves 1953-1957 lock and includes structures noted above as well as utilitarian buildings added as needed, including 1962 two-story visitor's center. Drawing Number M-L 19 38/2.

PART V: SOURCES OF INFORMATION

A. Original Architectural/Engineering Drawings: Full set for 1910-1913 dam available at Union Electric Company, Keokuk Plant, Office, Keokuk, Iowa. Partial set for 1910-1913 lock and dry dock stored with Rock Island District, Clock Tower Building, Rock Island, Illinois. For 1953-1957 lock-full set available as operations folio, March 1937, file no. GP65-2; First Stage Construction, file no. GP65-25; Second Stage Construction, file no. GP65-27; Public Restroom, 1961-1965, file no. GP65; Sheet Pile Closure, as built drawings 1977, file no. GP65, Rock Island District, Clock Tower Building Annex, Rock Island, Illinois.

B. Early Views: Over 6,000 high quality 8x10 black and white construction photographs: Twenty-eight volumes containing 80 to 100 photographs, each covering 1910-1914 construction, Operations Office, Union Electric Company, Keokuk Plant, Keokuk, Iowa. Lock and Dam Number 19-Photo Book groups 121.1 (11 of 12 volumes covering 1953-1957 construction); "Repairs to Keokuk Lock;" "Keokuk Iowa Lock Dam, Power House-1912;" "Lock 19 Photographs, Towboat approaching from downstream;" and "Lock 19-Keokuk Boat Dock, Rock Island Arsenal, Rock Island, Illinois. Isolated entries, J. F. C. Schott Collection of Dr. Carl Hagler Collection at Quincy Historical Society, Quincy, Illinois.

C. Interviews: Present and past personnel--Lock and Dam Number 19.

D. Bibliography:

1. Primary and unpublished sources: National Archives Record Group 77, Entry 81, Chicago National Archives and Records Center; National Archives Record Group 77, Entries 111 and 112, Washington National Records Center, Suitland, Maryland; National Archives Record Group 77, National Archives, Washington, D.C.; Montgomery Meigs and Family Papers, 1866-1931, Illinois State Historical Society, Springfield, Illinois; Chief of Engineers Annual Reports, 1966-1987; see also bibliography in HAER No. IA-23 narrative history.

2. Secondary and published sources: See bibliography in HAER No. IA-23 narrative history.

E. Likely Sources Not Yet Investigated: National Archives Record Group 77, Entry 107 (132 linear feet), Washington National Records Center, Suitland, Maryland; National Archives Record Group 77, Entry 1656, and National Archives, Record Group 77, Entries 608, 609, 610, National Archives, Washington, D.C. Montgomery Meigs was an avid amateur photographer. He was the motivator of much of the extensive photography done by the Rock Island District from the 1880s on. His personal photographic collection.