THIRTIETH STREET STATION,
POWER DIRECTOR CENTER
30th and Market Streets in the Amtrak
Railraod Station
Philadelphia
Philadelphia County
Pennsylvania

HAER No. PA-404-A

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORDS
National Park Service
Northeast Region
Philadelphia Support Office
U.S. Custom House
200 Chestnut Street
Philadelphia, P.A. 19106

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HISTORIC AMERICAN ENGINEERING RECORD

THIRTIETH STREET STATION, POWER DIRECTOR CENTER

HAER No. PA-404-A

Location:	30th and Market Streets in the Amtrak Railroad Station Philadelphia, Philadelphia County, Pennsylvania
UTM Coordinates:	USGS Philadelphia, PA. - N.J. Quadrangle, Universal Transverse Mercator.

Zone	Easting	Northing
18	484480	4422700

Date of Activation:	March 3, 1935
Engineers/Desiguers:	Gibbs & Hill, New York, NY
Manufacturer:	Kellogg Switchboard & Supply Company, Chicago, Illinois.
Present Owner:	National Railroad Passenger Corporation (Amtrak); Washington Union Station, 60 Massachusetts Ave. N.E. Washington, DC 20002
Present Use:	Intact but unused. Power Director Model Board was replaced during February of 1994 by a Centralized Electrification and Traffic Control System (CETC).
Significance:	Power Directors Circuit and Switch Indicating Boards were designed to visually and aurally indicate the operating status of the railroad's power system. This particular power director center monitored and supervised operation of all switches in the railroad's power control system from North Philadelphia to Wilmington, Delaware. The power directors working at this site oversaw and continually updated the electrical status of the system. Power directors were responsible for safely de-energizing catenary segments for maintenance and repair. Most commonly, actual physical control of a switch was accomplished by a tower or substation operator responding to telephoned orders from the power director. However, some power switching was done directly by the power director. The power director recorded the position of the switch by manually actuating a corresponding indicating light on the model board. The model board and operational system that evolved represents a pre-computer technology for centralized control of a electrified railroad power network.
Project Information:	This documentation began on March 10, 1995 under a memorandum of agreement between the National Railroad Passenger Corporation and the Pennsylvania Historic and Museum Commission and the State Historic Preservation Officer as a mitigating measure prior to removal of the equipment. The Power Directors Control Room was documented to the professional standards of the National Park Service's Historic American Engineering Record. Additional mitigation includes donation of the equipment to The Railroaders Memorial Museum in Altoona, Pennsylvania for installation as a permanant exhibit.
Industrial Historian:	Robert C. Stewart May 1996

INTRODUCTION

The early years of the 20th century saw the evolution of electrified railways all over the world. Electrical energy was and continues to be an effective, economical, clean and practical source of railroad traction power. Concurrent with the employment of electric power, railroad engineers developed methods of controlling and monitoring its distribution and use. For an electric railroad to work, controlled power had to be delivered to trackside in quantity. Supervision of power distribution and its regulation is the responsibility of workers designated as load dispatchers and power directors. These individuals are charged with the responsibility of overseeing the electrical equipment in the system under their control[1]. Power directors are responsible for coordinating power handling with train dispatchers and maintenance crews to safely allow work on the catenary and transmission system.

In recent years the development of computer-based control systems has made earlier electrical relay control schemes obsolete and susceptible to replacement. In 1976 the Federal Railroad Administration, Amtrak and engineering consultants prepared a specification, which defined the elements for a computer-based control system for the Northeast Corridor. This system centralized train and electrification controls in one room. The new system is designated as the Centralized Electrification and Traffic Control System (CETC). With system reorganization the zone 7 Baltimore Power Director's Office was moved and consolidated with the Philadelphia office in April 1986. This merger was followed by merging Baltimore's zone 6 office in October 1987. Philadelphia's zone 5 followed shortly after that in Deeember 1987. The last zone moved into CETC was zone 4 in May 1994.

THE POWER DIRECTORS OFFICE

Prior to activation of the new CETC system, traction power for the Amtrak trunk lines from North Philadelphia, Pennsylvania to Wilmington, Delaware was controlled and monitored from Philadelphia's Thirtieth Street Station. The control system was explicitly known as the Power Directors Circuit and Switch Indicating Board for zones 4 and 5[2]. It was located in

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[1] A load dispatcher is equivalent to a system operator in a power utility company. A power director is equivalent to a distribution operator in a utility. The whole railroad is a equivalent of load center and the power director operates a portion of the railroad.

[2] Zones 1, 2 and 3 are controlled from a power directors facility in New York City. Zone 4 begins at milepost 76, near Holmsburg prison to just south of Philadelphia and west to Paoli. Zone 5 continues south to Perryman south of the Susquehanna river and ending at Wilmington, Delaware. Zone 6 contains the remainder of southern territory to and including Washington Terminal. Zone 4, 5 and 6 now located in CETC encompass what was Zones 4, 5, 6 and 7. The zones designate responsibility for maintenance or emergency repairs.

room No. 495 on the fourth floor of Amtrak's 30th Street Station in Philadelphia (see location map and partial building plan). The equipment shares room No. 495 with the Load Dispatcher's Office found immediately to its south. The section of the room devoted to Power Director's equipment was 35'-8" wide by 48'-0" long and contained approximately 1712 square feet. The model board itself is seven sided and partially open on the southeast side. The board would be eighty-six feet long had it been designed as a linear facility. It encompasses an area of about 860 square feet (see plan of general arrangement, room No. 495).

OPERATIONS

The model board, control and supervisory consoles exemplify a system used to monitor status of electrical power in the catenary, substations and other components of an electrified railroad. The system uses relay logic coupled with manual input to operate indicating lights on what is an electrical analog of the railroad's electrical system. The main function of the power director's office is to supervise all switching in the railroad power system for purposes of safety, operation and maintenance. The system is an example of precomputer technology used to control and monitor electric power.

Two operating switch consoles, a rotating carousel schematic board and a supervisory switch board are contained within the seven-sided periphery of the model board (see photographs of the model board, supervisory board and carousel). An additional supervisory switch board and control panels are just outside the periphery of the model board and form part of its eastern boundary (see axonometric view of power director center).

The board itself is made up of steel panels, measuring two feet square and 1/8" thick. The panels which face the operator exhibit a schematic representation of the railroad's electrical system corresponding to catenary and track layouts. The backs of the panels form a chassis for the indicating lights, cabling, relays, bells, buzzers and other operating components. A 10 foot high, steel angle iron framework supports the panels. Indicating lights are placed at locations on the schematic diagram of the system. These locations correspond to the actual positions of the breakers and switches they symbolize.

The model board indicating lights operate on 24 volts and the relays on 120 AC. Most wiring is typical of the 1930s, that is, stranded copper with varnished cambric insulation. The builders installed a fire alarm system for detecting fire in the wiring.

The Kellogg Switch Board Company of Chicago built the display board and switch consoles. Kellogg, no longer in operation, was a highly reputable firm and had supplied similar model boards to other railroads. Typically, Kellogg used standard telephone relays, indicating pilot light bulbs and conventional, readily available components in its custom-designed boards and consoles. Telephone parts had a proven record of reliability and were mass-produced to high quality standards by the Western Electric Company. The designers expected that they would be available as repair parts for the foreseeable future.

ORIGINS AND CHANGES

In 1928 the Pennsylvania Railroad located its original power directors office in a substation close to the present site. This substation was abandoned and demolished, probably in the mid-1930s. No trace of the original power director's office equipment was found. It probably featured a non-electric model board with colored pegs which were inserted in a power schematic diagram to indicate electrical status of components. It would have been similar to the octagonal "carousel" schematic board located between the operator's consoles in the present power directors office.

The Engineering firm of Gibbs and Hill, which was prominent in several major railroad electrification projects during the early years of the 20th century, was responsible for the concept and engineering design of the new electrically operated display board. About two years after Philadelphia's present 30th Street Station was completed and electric passenger service inaugurated on January 16, 1933, the power directors office was activated in room 495. An "installer's mark" was found on the column that supports the schematic carousel implying that the facility went into service on March 3, 1935 at 6:00 P.M.

Control engineers modified the board over the years to reflect changes in the system. Substations were added and removed. Management modified track routings, added and removed catenary and shifted responsibilities for operation. An early computer control system manufactured by Quindar Electronics, Inc. was added to the power director's facility in the late 1960s. This was used to control Earnest Substation and Earnest Junction, a switching station. It used simple integrated circuits and state-of-the-art computer technology to replace a degree of operator control.

The organization of the Southeast Pennsylvania Transportation Authority (SEPTA) to take over the Pennsylvania Railroad commuter lines, resulted in significant changes in the model board's appearance. Lines representing Zoo tower and its 44 KV system were painted over in the 1970s. Technicians painted the board dull black (signal black) to ease operator eyestrain. The paint change was of minimal benefit and the original satin black paint was restored. Most of the overpaint was done with a coating which could be easily removed so that the original board layout could be restored. Technicians repaired many operating deficiencies such as short circuits and defective relays in the 1980s and restored the board to full operating condition. Up to the time operational control was switched over to CETC a few minor problems remained, some cut wires were not tagged and differential operating voltages on the relays and indicating lights occasionally caused problems.

In the early 1980s Conrail stopped running electric engines for their trains and Amtrak decommissioned the "Quindar"[3] set. In the mid-1980s the set was rewired to control substation 11 (Lamokin), which had been controlled from Lamokin tower. When CETC was implemented, Lamokin tower and a number of other towers throughout Amtrak's Northeast Corridor were shut down.

FORM AND FUNCTION

Modern model boards usually feature a linear layout. Facilities are generally designed to extend along one wall of a room. The original Philadelphia power directors board may have been designed to fit available space. However, by wrapping the board around an axis, one or two power directors could easily scan their respective zones from a central point. The designers expanded this concept with the carousel schematic board, any part of which was readily accessible from either power director's console (see photographs of the carousel and schematics). The carousel displays schematic circuit particulars in greater detail than is shown on the main model board. By rotating the carousel, the power director could access any detailed schematic without moving away from his station. The carousel board used colored pegs to show circuit status. This peg system was probably adapted from the procedure believed to be used on the original non-electric status board used prior to 1935.

TECHNOLOGY

The model board schematic displays the 138 KV transmission, 12 KV catenary and 6.9 KV signal circuits. It is a passive board, that is, changes in field equipment status do not automatically change indicating lights on the board. Indicating lights were turned on or off by the power director who manually tripped button switches located on a console adjacent to the operator's desks (see photograph of the button board). When a circuit breaker or switch feeding power to the railroad system is opened or closed, the power director recorded its position by raising or lowering the appropriate button. A series of relays inside the model board then energized lights which showed the extent of activation or de-energization of the catenary circuits. The model board displays white lights to indicate line power is off. Green and red lights respectively, denote switches or breakers are open or closed.

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[3] The Quindar (also known as the "Quindette" system) system was built by Quindar Electronics, Inc. It was a general purpose, time-division, multiplexer for remote operation of hydro-electric plants, pumping and compressor stations, communications systems and railroad switching systems. It used audio tones to transmit control and indication signals between master and remote stations. The system was utilized by the National Aeronautics and Space Administration (NASA) on Projects Mercury, Gemini and Apollo.

Amtrak is replacing the New York Power Director's office with a modern computerized Supervisory Control and Data Acquisition (SCADA) system. The railroad's last remaining operational Kellogg power board continues to service the power directors office in Harrisburg, Pennsylvania.

Communication between linemen working along the right-of-way, tower operators, dispatchers and the power director was by telephone. The telephones used were of the coded ringing type and the power director had a key (switch) which would connect him directly to each interlocking location. Operation of this key set up the code for that location and rang the telephone within a period of eight seconds. Substations were grouped together and an electrician in a sub-station could not tell if they were calling him or if the power director was calling another location in the group. The line was a common one and a worker would always have to listen in for a conversation and verify that other workers were not trying to talk on the line before ringing the power director. Wayside phones were located at strategic points along the right-of-way where various workers could call in during the course of duty. These telephones were used extensively by lineman for their switching and clearances. This communication system functioned until replaced in the mid 1980s.

LABOR FORCE

The power director is a highly regarded occupation in railroad labor hierarchy. Linemen in the field depend in large part on the power director for their safety. In the initial years of operation the power director had full authority, taking action on a problem then reporting it to the supervisor. Today, although still an authoritative position, some major decisions which the Power Directors made in the past are referred to their supervisors.

Qualification for a power director's job was normally secured through an apprenticeship. Most power directors started as electricians or linemen and worked in an "Electric Traction" gang. As they became thoroughly familiar with the types and locations of electrical equipment along the right-of-way, an electric traction employee could move on to a job as an assistant power director and remain in that job for twelve to eighteen months, working in the power director's office.

Contemporary practice eliminates the position of assistant power director. A lineman or substation electrician can qualify as power director after a ten to twelve month apprenticeship. The "power director trainee" must pass verbal and written examinations after working side-by-side with an experienced power director. Once 'qualified' they new power director will be added to the 'extra list' until a senior power director permanently vacates a regular position through retirement or promotion. The new power director is allowed to be used for "extra work" created by vacations or absence. He or she remains on a probationary period until they have worked sixty days, then they are listed on the power direetor's roster.

The load dispatchers and power directors belong to the American Train Dispatchers Association (ATDA). Electricians and linemen are members of the Brotherhood of Maintenance of Way Employees (BMWE). One can go from the BMWE to the ATDA without losing seniority via a tri-party agreement with the carrier and the two unions.

While monitoring the system, power directors were in close contact with Amtrak's load dispatcher, substation electricians, linemen, train dispatchers and tower personnel. Power directors arrange and verify switching operations with the electricians in substations. Orders for opening or closing any of the breakers or switches were given by the power director via telephone to the operators in the interlocking towers.

Some switches could be actuated by remote control personally by the power director or along the right-of-way by linemen. After an order for switch operation was given, it was performed and the worker reported back to the power director. For safety, all verbal communication was repeated to verify the order. Written orders were used in cases where a train dispatcher gave orders through a tower operator to a train. Appendix B is a facsimile of a power director's clearance record. Additional records of conversations between workers were secured starting in the 1970s when the railroad started tape recording all dialogue.

Other duties that power directors performed included maintaining the heat chart. This kept a record of what track heaters were turned on or off at various interlocking locations. The track heaters were used to keep track switches from freezing in severe snow or ice storms. Power directors also monitored outside temperatures and directed pre-heating of stored commuter cars on cold days.

The power director's office could be a moderately noisy place. With the hum of hundreds of alternating current components, alarm bells and whistles, relays clicking and buzzing, the office had a unique sound. It could be a little frightening to the uninitiated.

INDIVIDUALS ASSOCIATED WITH THE SITE

Several major engineering firms and contractors were associated with the Pennsylvania Railroad's electrification project. The Vare Construction Company of Philadelphia was responsible for installation of major sections of the line in the Philadelphia area. United Engineers & Constructors, Inc. constructed Pennsylvania (30th Street) Station, a central steam plant and distribution system, a freight station, the coach yards and the catenaries in the terminal zone. The Westinghouse Electric Company was associated with the planning and execution of the electrification program. Westinghouse also designed, built and supplied electric terminal and switching locomotives, freight and passenger locomotives. Other prominent material suppliers were the Bridgeport Brass Company, General Electric, Allis-Chalmers, Union Signal, Baldwin Locomotive and the Lima Locomotive Works.

THE POWER DIRECTOR'S OFFICE IN CONTEXT

Frank J. Sprague, a prominent engineer associated with the electrification of the New York Central, researched the origins of the electric railroad. Sprague claimed that a blacksmith in Brandon, Vermont, by the name of Thomas Davenport, built the first model electric railroad in 1834. Sprague also documented that an electric locomotive ran on the Edinburgh-Glasgow railway in 1838 at a speed of four miles per hour. Other experiments followed during the mid-nineteenth century. In 1840, Henry Pinkus patented the use of rails for conducting current to an electric locomotive-Moses Farmer of Dover, New Hampshire operated an experimental electric railroad car in 1847. In 1850 Thomas Hall had an automatically-reversing car operating on battery power.

Around 1850 Professor Page of the Smithsonian obtained a grant from Congress and built a car with a double solenoid motor. It had a reciprocating plunger and fly wheel that gave its running gear a motion similar to a steam engine. It received power from one hundred "Grove elements" and had its first run on April 29, 1851 using the right-of-way of a railroad running from Washington to Bladensburg, Maryland. Reportedly it attained "a fair rate of speed."

Frank Julian Sprague was an electrical engineer who worked with Edison developing equipment for an experimental electric locomotive in 1885. He built the first large scale trolley system in the United States at Richmond, Virginia in 1888. Once it was available, the public demanded a transportation system that didn't rely on animal power with its need to care for thousands of horses and clean up tons of manure. Consumer demand fueled development of the electrically propelled vehicle which evolved rapidly during the 1880s and 1890s. Investors financed construction of electrified city transit lines and interurban routes, yet common carrier/mainline railroads continued running on steam power.

Sprague also developed a multiple unit (MU) control system which enabled individual electric cars be combined into trains of any length and yet be controlled from a single master unit. He had a long and distinguished career in the electric industry and was known as "the Father of Electric Transportation." He strongly influenced the electrification of the Long Island Railroad.

The Baltimore & Ohio Railroad reached the vicinity of New York City in 1889. Traffic through its eastern Maryland facilities expanded and created a serious operational bottleneck in Baltimore. At the time the railroad used car floats to ferry trains across the Patapsco River, a system that created additional expense and delays. To bypass the float operation, they built a new line, tunneling under central Baltimore. A shallow tunnel would have solved the railroad's problem but venting it would have caused distress to abutting property owners. Electrification, using a 600 volt direct current system was the preferred solution.

In 1895 the Baltimore and Ohio Railroad was close to achieving electric operation through the tunnel under Howard Street in central Baltimore. However, the New York New Haven & Hartford opened an electrified short branch line between Nantasket Beach and Pemberton, Massachusetts on June 3, 1895. This antedates the first operation of the Baltimore and Ohio which was on June 27, 1895; the first train ran on July 1, 1895.

The Pennsylvania railroad experimented with electricity; it had a prototype 600 volt DC system using an overhead trolley operating on the Burlington and Mount Holly branch in NJ in 1895. The Pennsylvania electrification was purely a local transit system and electric locomotives were not used. Service was provided by multiple-unit cars similar to those used on interurban transit systems.

Although the railroads serving metropolitan New York had been experimenting with electric traction for several years, a tragedy in 1902 compelled prompt construction of an electrified system. A wreck on January 8th killed seventeen people in a smoke-filled tunnel leading into the original Grand Central Station. The disaster resulted in legislation banning steam engines from New York City.

In 1904 The New York, New Haven & Hartford Railroad decided to electrify its line from Stamford, Connecticut, to Woodlawn, New York. At Woodlawn, New Haven trains would continue to New York City over the electrified lines of the New York Central, a combined total of 33 miles. This was the first trunk-line electrification in the United States and was powered up in June of 1907.

The Pennsylvania Railroad appreciated the possibilities of the single-phase, high voltage, alternating-current system adopted by the New Haven. Employing a common system would allow maximum interchangeability of equipment and a more dependable power supply. It adapted the pioneering techniques of the Westinghouse Electric and Manufacturing Company and New Haven engineers Calvert Townley and William S. Murray to design an advanced railroad electric traction system.

The first section of the Pennsylvania line to be electrified was from Manhattan Transfer, near Newark, New Jersey, through the two single track tunnels under the Hudson River to the Pennsylvania station in New York City. The electrified section continued through four single track tunnels under the East River to the Sunnyside yard in Queens on Long Island. This section was completed in 1910.

The Manhattan-Sunnyside segment had been electrified earlier by Frank Sprague as a 675 volt direct current third-rail system for the Long Island Railroad which was completed in 1905. The eventual change over to an alternating-current system was planned from the start and tunnels and clearances had been provided for an overhead catenary power supply. They switched over the whole section to alternating current when they built the Manhattan Transfer segment. Electrification of suburban service in the Philadelphia area was inaugurated in 1915 and extended gradually until 1932 when it included all suburban service in the metropolitan district.

The railroad announced plans to electrify the line between Manhattan Transfer and Washington, D.C. in 1928. The Pennsylvania Railroad inaugurated electric passenger service between New York and Philadelphia on January 16, 1933. The project cost 100 million dollars. Electric locomotives moved trains only as far south as Wilmington, Delaware at this time. Electrification of the line as far as Washington was completed by 1935.

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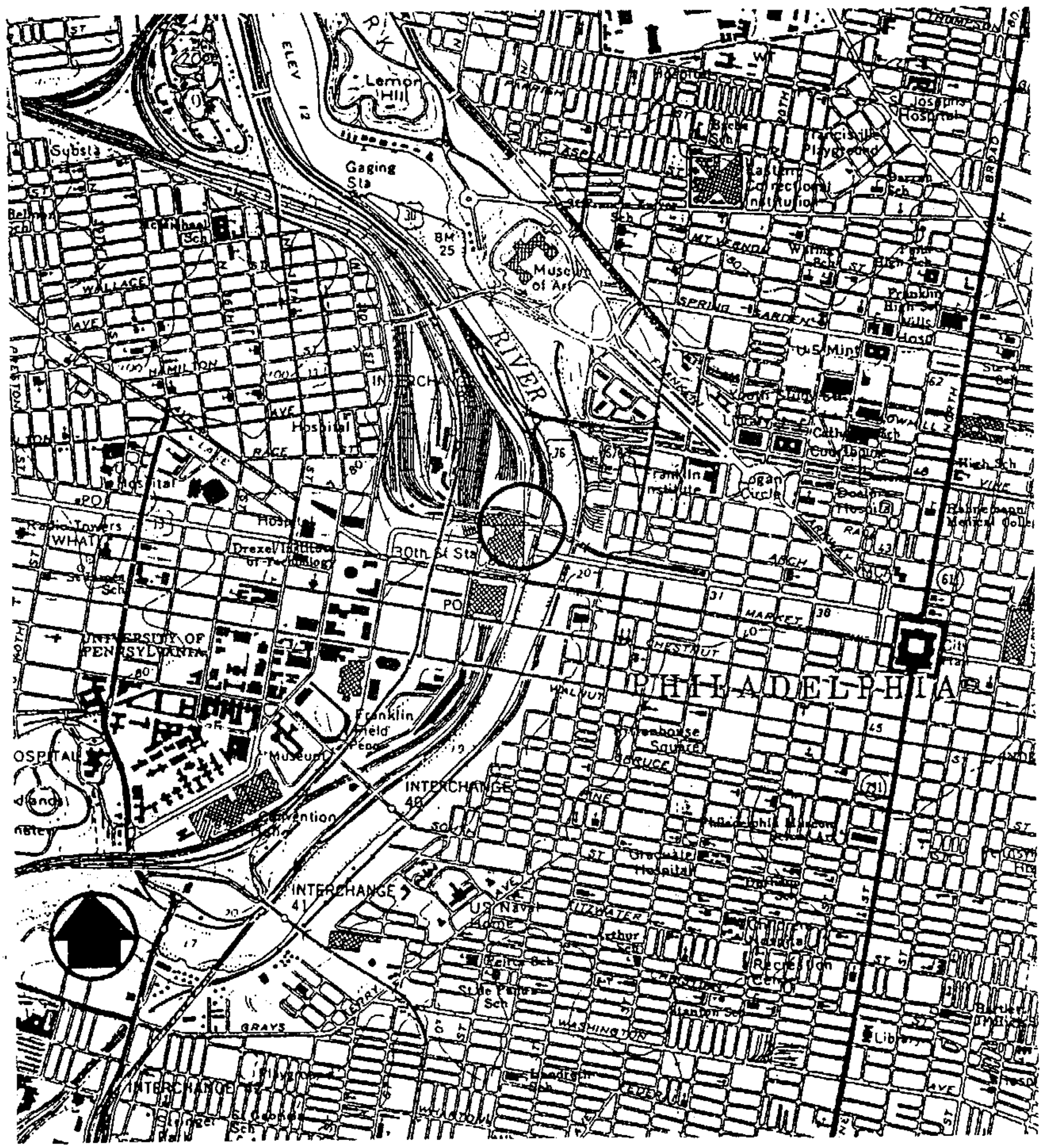
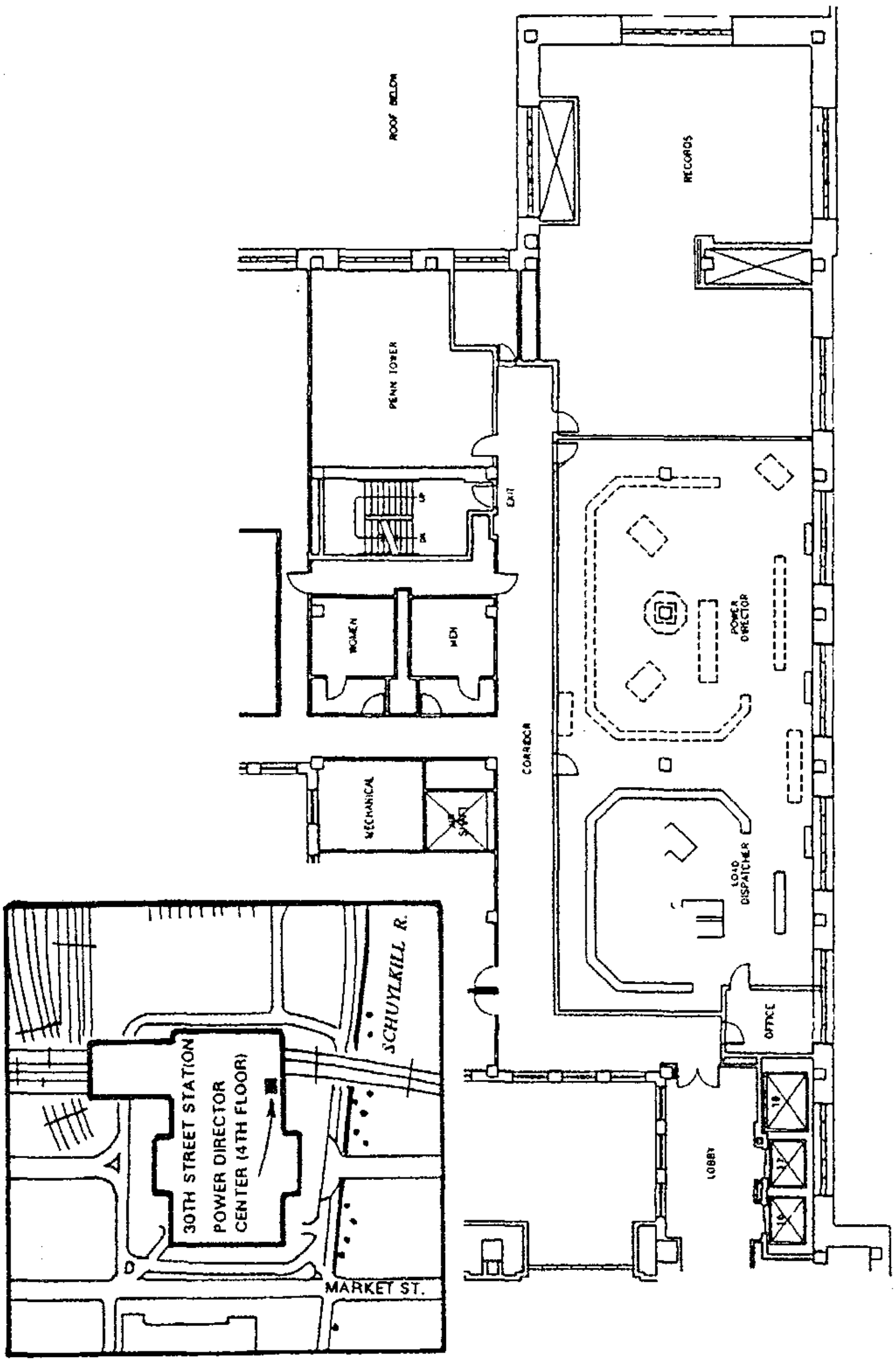
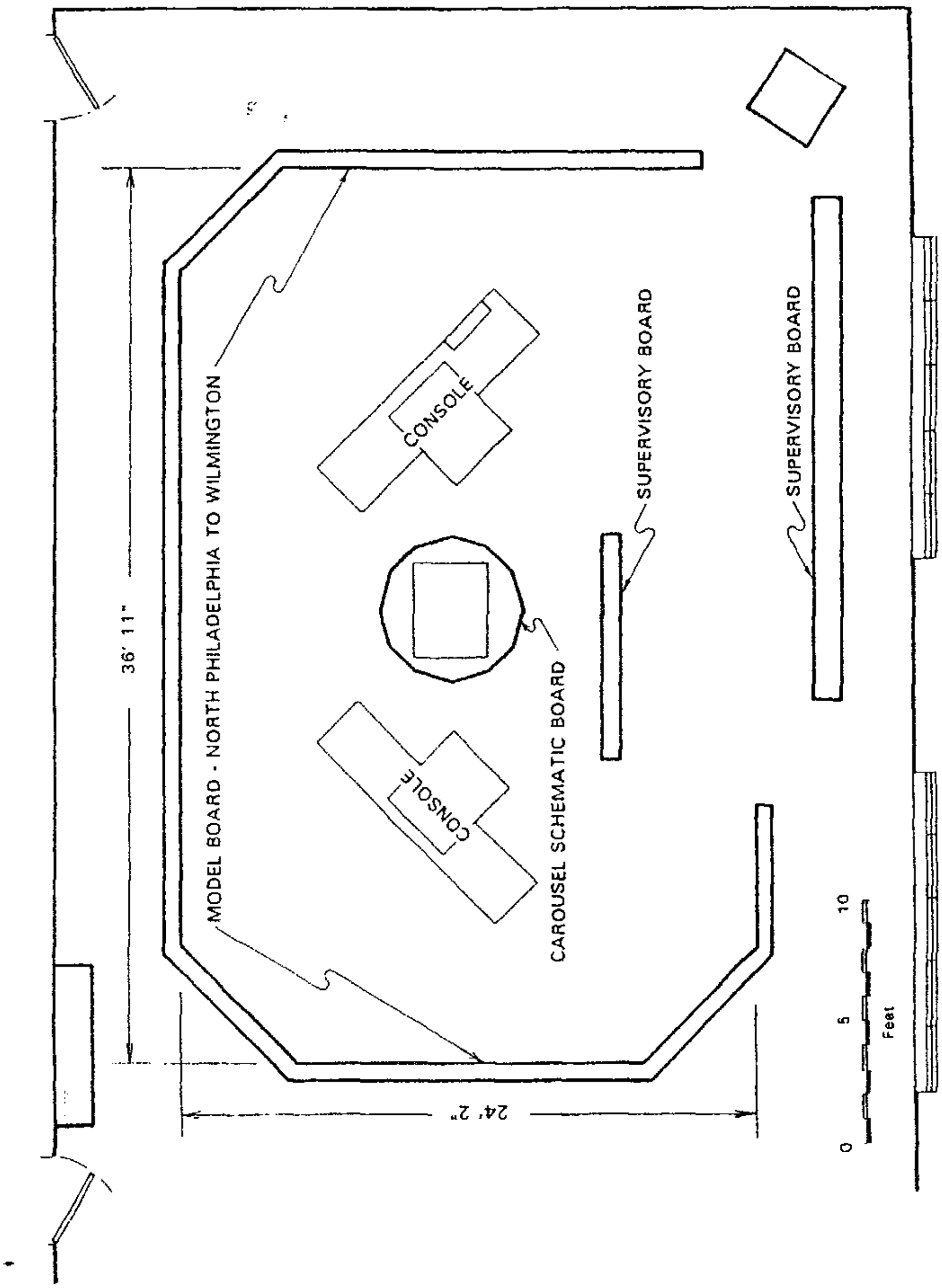


Location Map-Thirtieth Street Station, Power Director Center
Quadrangle; Philadelphia, Pennsylvania 1:24000

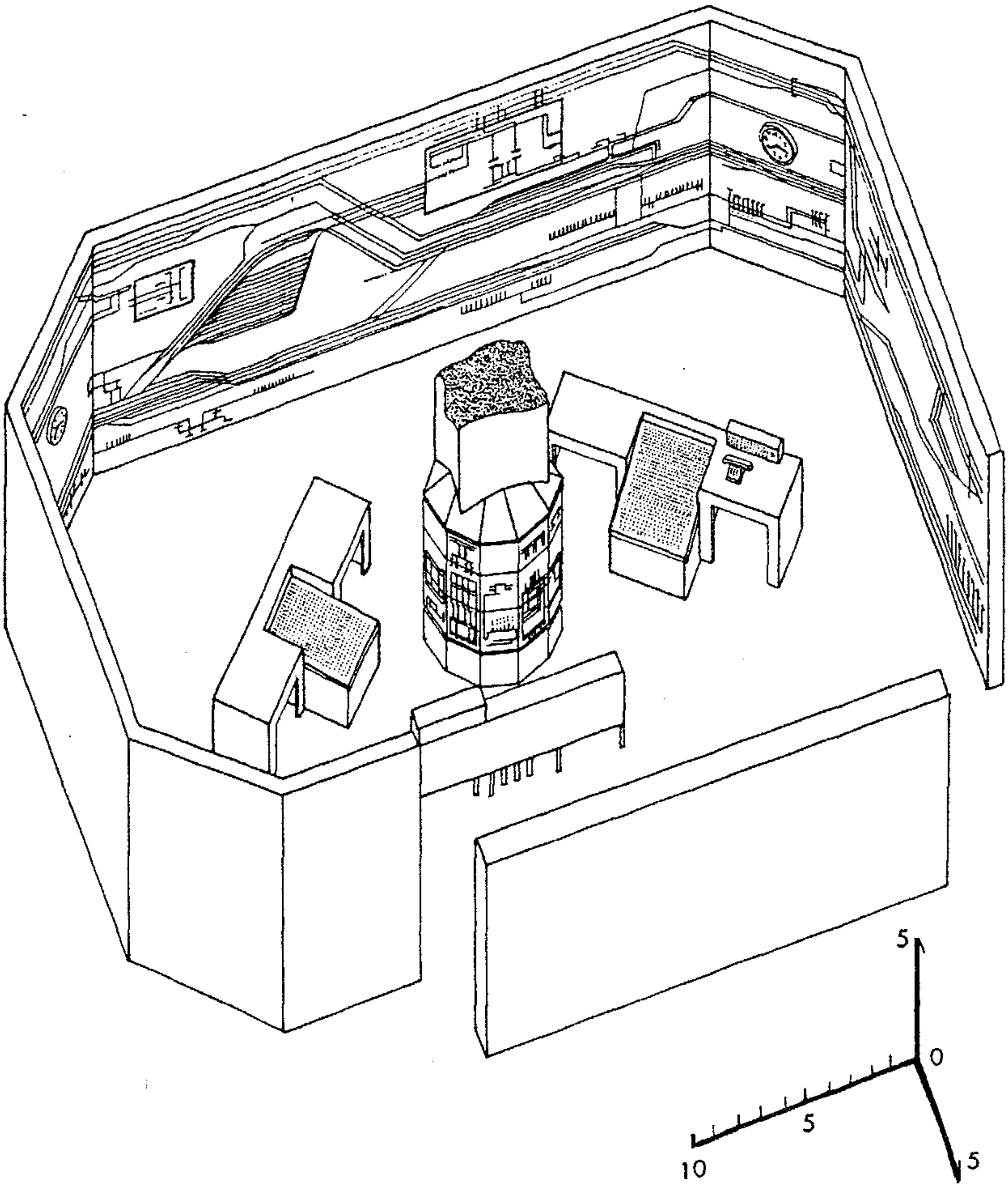


Location of Power Director Center within Station Complex
Northeast corner - Thirtieth Street Station
Fourth floor - Surrounding Area of Room No. 495

THIRTIETH STREET STATION - MAIN CONCOURSE (FIRST FLOOR)



Plan of general arrangement, Room No. 495 - Power Director Center



Consoles, Model Board and Carousel - Axonometric View