Union Junction Interlocking Tower
(Northeast Corridor Project)
Adjacent to railroad tracks in block
bounded by Federal, Guilford, Royal,
and Calvert Streets
Baltimore (Independent City)
Maryland

HAER NO. MD-50

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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
MID-ATLANTIC REGION NATIONAL PARK SERVICE
DEPARTMENT OF THE INTERIOR
PHILADELPHIA, PENNSYLVANIA 19106

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Location:	Adjacent to railroad tracks in block bounded by Federal, Guilford, Royal, and Calvert Streets Baltimore (Independent City), Maryland Quad: Baltimore West
Date of Construction:	1910
Present Owner:	National Railroad Passenger Corporation Suburban Station Building 1617 John F. Kennedy Boulevard Philadelphia, Pennsylvania 19103
Present Use:	Houses interlocking machine which controls signals and switches for train movements
Significance:	The tower is part of the Pennsylvania Station complex, which represented the peak of railroad development in Baltimore. Its design, construction, and associated machinery are representative of railroad construction practices and technology in the early 20th century.
Project Information:	Demolition of the Union Junction Interlocking Tower is to be funded by the Federal Railroad Administration (FRA). Under Section 106 of the National Historic Preservation Act of 1966, mitigative documentation was undertaken by Janice G. Artemel, historian, with the assistance of M. Orelup, L. Crye, and E. Gallagher, for the FRA in 1983.
Transmitted by:	Jean P. Yearby, HAER, 1985

UNION JUNCTION INTERLOCKING TOWER

The equipment that regulates train movements at Union Junction interlocking in Baltimore, Maryland, is housed in a tower near Baltimore's Pennsylvania Station (Figure 1). The existing Union Junction interlocking was built and altered by the Pennsylvania Railroad (PRR) over the number of years. The tower was constructed in 1910, at the same time Pennsylvania Station was being built. Train movement through the interlocking is regulated by an electro-pneumatic interlocking machine installed in the tower in 1935. The track configuration and signals date from 1935, with some modifications over the years.

Union Junction interlocking is located in central Baltimore, north of Mt. Royal Avenue between Calvert Street and Guilford Avenue. It is part of the Pennsylvania Station complex, which was built on a natural embankment formed by Jones Falls creek. Railroad nomenclature is based on a north-south track orientation, but in this area, the track is aligned on a generally east-west axis. Thus northbound trains proceed through the two-track B&P Tunnel west of the station to Pennsylvania Station and then to the three-track Union Tunnels at the eastern (northern) end of the station area (Figure 2). The station is located midway between the B&P and Union Tunnels, which are 3,700 feet apart. Union Junction interlocking tower controls the movement of all rail traffic entering and leaving the Union Tunnels, while an identical tower, B&P Junction, performs a similar function at the west end of the station for the B&P Tunnel. This area is a heavily-used rail corridor, with approximately 65 daily passenger trains and a variable number of freight trains.

Historic Background of Interlockings

An awareness of the principles and historical development of interlockings is instrumental in understanding the function and significance of Union Junction interlocking tower. An interlocking is an arrangement of railroad switches and signals interconnected or interlocked so that one movement must succeed another in a predetermined manner.[1] An interlocking is required when tracks interconnect, and prevents conflicting routes from being set up when trains are switched from one track to another. In an interlocking, the switch moves a section of track and the signal indicates what is happening. Switches and signals are operated from a central location by levers. The levers are grouped together in a common frame, and the assemblage is called an interlocking machine. Generally, the machine is housed near the tracks in a two or three-story structure known as an interlocking tower.

Interlocking originated in England, with the first mechanical interlocking invented by John Saxby in 1856. Saxby's "preliminary latch looking" system became widely popular, and by 1873, there were 13,000 interlocking levers in use on a single British line.[2] The first interlocking machine in the United States was installed in 1870 in Trenton, New Jersey on the Camden and Amboy Division of the PRR.[3] Saxby & Farmer (S&F) of London, England, furnished the material and supervised the machine installation. S&F dominated the early market in American interlocking plants and the two mechanical machine models most frequently used in the U.S. were S&F machines. In the early mechanical systems, the manually-operated levers were connected to the switches with pipe and to the signals with wire, but later, because wire stretched, both switches and signals were connected to levers by pipes.[4]

Within two decades of the first U.S. installation of mechanical interlockings, the mechanical machines were outmoded technologically by powered machines. Powered interlockings needed fewer operators than mechanical interlockings, which saved labor costs and eliminated human error. The first powered interlocking was pneumatic (1876), followed quickly by the hydraulic (1882), the hydro-pneumatic (1883), the electro-pneumatic (1891), and the electro-mechanical (1909). The all-relay system, using miniature free levers, was developed in the 1930s, and has in turn been superseded by remote, computerized, centralized traffic control.[5]

The electro-pneumatic interlocking machine was invented by the Union Switch & Signal Company (US&S), founded by George Westinghouse in 1891. The company first developed a mechanically-interlocked pneumatic/hydraulic system for operating track switches. Track movements and switches were electrically indicated with lights on a track model mounted above the machine. In this way the machine operator could see the exact status of all the switches and signals in this interlocking. Soon afterwards, the US&S eliminated the hydraulic step and created an electro-pneumatic machine.

The electro-pneumatic machine became the favored machine of the PRR as well as other railroads because of its reliability, durability, compactness and ease of operation. By 1914, the electro-pneumatic machine was used in 90 percent of power-operated terminal track systems.[6] The US&S gave the following statistics regarding the reliability of the electro-pneumatic:

> "In the subways of the Hudson and Manhattan Railroad (Hudson Tunnels),...the number of switch, signal and automatic stop operations totalled 39,580,231 in the year of 1913, with but 52 imperfect operations, or one to every 761,158."

"Hoboken Terminal of the Delaware, Lackawanna and Western Railroad, comprising three interlockings controlling 627 signaling units, from April 1913 to April 1914, had 28,721,750 switch and signal operations of which but 36 were imperfect, or one to 797,837." [7]

The electro-pneumatic machine has many advantages over its mechanical counterpart. In a mechanical machine, one lever is connected by piping to one switch; the movement of the lever is transmitted to the switch through the movement of the pipe. However, in an electro-pneumatic machine, one lever can operate many signals and switches. When a lever of an electro-pneumatic machine is moved, an electrical circuit is completed. Electricity, by charging an electromagnet, opens a slide valve on a double acting cylinder at the appropriate switch and compressed air moves the switch. Three wires connect the lever contacts to three electromagnets on the valve. To operate more than one switch from the same lever, the same three wires are extended to other movements with the valves connected in multiple. Thus the electro-pneumatic equipment can handle many more switches with fewer levers. [8]

The electro-pneumatic is also more compact than a mechanical machine because the levers, not functioning as true levers as in a mechanical machine, are smaller and closer together. Generally, the levers of a mechanical machine are five centimeters apart while the levers of an electro-pneumatic machine require only one-half of that space. [9]

Another advantage over a mechanical machine is that the electro-pneumatic is more easily operated. As John Coleman stated in Railroad Gazette in 1899, the electro-pneumatic machine "does not involve that physical restriction, peculiar to the mechanical system, resulting from the natural limitations of the operator's energy and of the period through which he is capable of exerting it". [10]

The electro-pneumatic machine, according to US&S, also has advantages over the electric machine. The electro-pneumatic is a more durable machine. When several switches move in an electric machine, the electricity performs a great deal of work in a short time and therefore there is abnormal resistance to the operation of motors and solenoids which causes "destructive arcs" and overloaded conductors. [11] However, in an electro-pneumatic interlocking machine compressed air moves the switches, while electricity merely opens and closes the valves. The air is compressed to 55-120 pounds per square inch (psi). Pressures were higher than 55 psi in the earlier interlockings, ranging from 80-90 psi, according to John McLemore, operator of Baltimore's Carroll Tower. While a 1914 US&S catalog places

the pressure at 75 psi, a 1952 AAR booklet says 55-85. The main air pipe extends throughout the interlocking and is two inches in diameter. Branch pipes begin with a 3/4" diameter and taper to 1/2" at the switch. [12]

Electricity operates the compressor(s) as well as the valves that control the compressed air, the locks, the indicators, and the relays. A large 20th century station usually had its own power plant and auxiliary equipment. The auxiliary equipment might be as simple as a motor generator and a bank of storage batteries. However, at some stations a delay of fifteen to twenty seconds would be an intolerable interruption, in which case auxiliary equipment might include a continuously-operated motor generator. Ten to sixteen volts (direct current) was sufficient power for most interlocking plants. [13]

In the earlier electro-pneumatic interlockings, semaphore signals and switches were operated pneumatically. A main air line might extend over considerable track mileage and the automatic block signals between interlockings were operated pneumatically from this main air line. After signals were electrified, there was no need for long air lines and the trend began for each interlocking to have its own compressor plant. Several sets of small compressors in instrument cases located along the line supply the air, rather than all force coming from the main plant, which reduces friction loss in the main line.

Union Junction Interlocking Tower

The significance of Union Junction interlocking is tied to the history of railroad development in Baltimore. Pennsylvania Station was built on the site of two earlier stations, on a bend in Jones Falls, approximately 2,000 feet from the water. The first station (Union Station) was built in 1873 when a new rail line was completed between Washington, DC and Baltimore which linked the Baltimore and Potomac (B&P) Railroad with the Northern Central Railroad, Union Railroad, and the Philadelphia, Wilmington and Baltimore Railroad via the new B&P and Union Tunnels. The number of tracks and switches required to maneuver the traffic through the station yard is not known.

Traffic through the station area increased steadily, requiring a new station in 1886, built on the site of the old by the PRR, which had purchased the Northern Central's Baltimore franchise. A new machine was placed in the tower by B&P Tunnel, which was a mechanical fifty-four levers machine installed "to protect the switches south of the station at the junction of the Union Railroad and North Central tracks". [14] Whether other station interlockings were also upgraded at this time is not known. [15] There was not yet a tower at Union Junction's current site. An 1890 Sanborn Insurance map shows a two-story frame structure,

almost certainly an interlocking tower, just south of the site. The structure may be Greenmount Junction Tower, which was demolished before the turn of the century.[16]

In 1891, the PRR installed a seventy-four lever electro-pneumatic machine near the entrance of the B&P tunnel. This machine is the first electro-pneumatic equipment documented at Union Station. To Railway World the machine represented "the latest improvements of the Union Switch & Signal Company".[17] Its levers controlled thirty-three switches and five movable frog points will semaphore signals placed on bridges over the tracks. The improvements reduced the travel time between New York and Washington by five minutes.[18]

Whether the Union Tunnel and other interlockings north of the station were also modernized in the 1890s is not known, but evidence suggests that they were not. The mechanical interlocking machines in use during this period could control only 1200 feet of track. There were five interlocking towers north of the station, and that many would not have been necessary if the interlockings had been powered.

The installation of powered interlockings north of the station may have been part of the upgrading program that included construction of a new station in 1911. At that time, Baltimore ranked as the seventh busiest rail center in the country. The PRR decided to build yet another new station to accommodate the traffic and to upgrade interlocking plants. Construction of the new and larger station with seven passenger tracks necessitated moving the existing Union Railroad Junction interlocking farther north (east) of the center of the station.[19] Union Junction interlocking was reconfigured and the current Union Junction tower was constructed.[20]

A US&S electro-pneumatic catalog from 1914 states that there were four interlocking plants and a total of 254 levers regulating the Baltimore terminal and its approaches.[21] All of the machines were electro-pneumatic. The four interlocking plants were B&P Junction, Fulton Junction (demolished in 1965 when this interlocking became remotely controlled from B&P Junction tower), Union Junction, and Biddle Street.[22]

Union Junction tower's essential design corresponds to the design of the other 47 manned interlocking towers on Amtrak's Northeast Corridor. The design is functional, providing only slightly more space than that required by the machinery. The bank of windows, sheltered from the sun and precipitation by wide overhanging eaves, maximizes track visibility. These features are characteristic of interlocking towers.

The tower is a two-story brick structure, approximately 45 feet by 30 feet, with the lower half stuccoed (Photos 1 and 2). The pilasters are painted metal perhaps copper, according to tower operator Ross Mullinger. The most distinguishing architectural feature is an ornate, flared, hipped tile roof that is accented by the addition of deep eaves and decorated brackets. A band of wide molding separates the first and second stories. A continuous line of windows makes up the second story of the structure, interrupted only by an oriel on one side. There is a bracketed, tiled shed roof over the main entrance and exterior metal stairway (Photo 3) from the first to the second story on the west side of the building. The first floor of the tower houses the relays, rectifiers, transformers, and cables that comprise the mechanical core of the system from which all controls originate and all indications are received. The second floor, where the operator sits, houses the interlocking machine and model board.

In September of 1924, the Broadway interlocking tower on the north (east) side of the Union Tunnels was closed and its functions transferred to the Union Junction tower. The PRR's electrification program in the 1930's caused a major reconfiguration of Union Junction interlocking. In 1929, the railroad negotiated with the City of Baltimore and won permission to proceed with a substantial improvement program that included a second double-tracked Union Tunnel parallel to the old tunnel and electrification from Baltimore to Washington, DC.[23] The new Union Tunnel was built to relieve the train congestion in Baltimore, which was described then (as it still is today) as a "bottleneck" to rail traffic along the eastern coast.[24] In connection with the electrification program, signal lines were moved to underground conduits to ensure greater reliability.[25] Bringing electrification wires through Baltimore required depressing the tracks by eighteen inches and the track configuration was altered as a result of the longer platforms required to accommodate the longer trains possible with electrification. Existing tracks were removed while the entire site area was regraded, and one track was removed from the old Union Tunnel. The new interlocking plants were modernized and simplified.[26]

The machine installed in the Union Junction interlocking tower in 1935 is the one currently in use (Photos 4 and 5). At that time, Union Junction tower took over the functions of two other towers north(east) of the Union Tunnels, the Hillen Junction and Biddle Street towers. These towers were closed as a result of the remote control capabilities of the new machine.

The machine is a US&S Model 14, one of the most popular powered interlocking machines of the time. According to a 1935 US&S pamphlet, all Model 14 interlocking machines were assembled at the factory to ensure proper fitting and operation of the machines moving parts, and then partially disassembled for

shipment.[27] This machine permits controlling opposing signals from the same lever, by moving the lever to the left and right, instead of using separate levers. Signals are operated electrically, switches pneumatically. Approximately twelve volts of electricity are required to operate the signals and valves. Ten compressors supply compressed air, the motive power for the switch machines. The usual pressure is 92 psi; a low air alarm rings if the pressure falls to 70 psi.[28] A model of the system, showing the interlocking layout and train movements by indicator lamps, is mounted above the machine (Photo 6).

The machine controls the signals and switches at the north end of Penn Station through the Union Tunnel to Biddle Street. These include all crossover switches at the north end of station, both Union Tunnels, and the crossovers at Biddle Street and Broadway Avenue. Station tracks 1-7 and 10, and freight tracks A, B and F between Union Junction and B&P Junction are controlled jointly by the two towers. In all, the 95 levers of the Union Junction tower's machine control 57 dwarf, pedestal, and high signals, all of the position-light type; 6 double slip switches; 3 movable-frogs; and 22 turnouts. A schematic drawing of the current track configuration in shown in figure 3.

Since the machine's installation, it has been altered as a result of fewer tracks, and the switches have been simplified for ease in maintenance. However, the appearance of the machine is essentially unchanged, since adaptations can be made to the interior of the machine without altering its external appearance.

As part of the Federal Railroad Administration's Northeast Corridor Improvement Project (NECIP), the Union Junction and B&P Junction interlockings will be reconfigured to improve trip times and system reliability. The project will require the removal of Union Junction tower because of the revised track configuration (Figure 3). With the installation of centralized traffic control as part of the NECIP, the tower functions will be transferred to Philadelphia. The interlocking machine and other items of historic interest will be salvaged and will become the property of the Baltimore Industrial Museum.

CONCLUSION

The history of Union Junction interlocking tower reflects a part of the history of railroad development in Baltimore. Union Junction tower (as well as B&P Junction tower) was listed on the National Register of Historic Places in 1975 as a non-contiguous structure related to Pennsylvania Station, which represents the peak of railroad development in Baltimore. The significance of the tower lies primarily in its function as a railroad facility. In addition to the tower's historical contribution to railroad operations in the Baltimore Station area, its design, construction, and associated machinery are representative of a period and type of railroad construction and technology. The tower's machine, common when it was installed, represents a type of interlocking machine which is now becoming rare.

NOTES

[1]American Railway Engineering Association, American Railway Engineering Association Manual, (Chicago: American Railway Engineering Association, 1921), p. 466.

[2]John A. Droege, Passenger Terminals and Trains, (New York: McGraw-Hill Book Company, 1916; reprint ed., Milwaukee: Kalmbach Publishing Co., 1969), p. 46.

[3]Association of American Railroads, Communication and Signal Section, American Railway Signaling Principles and Practices, Ch. XVI, "Interlocking," (New York: Association of American Railroads, 1953), p. 3.

[4]Association of American Railroads, Communication and Signal Section, American Railway Signaling Principles and Practices, Ch. XVII, "Mechanical and Electro-Mechanical Interlocking," (New York: Association of American Railroads, 1947), p. 3.

[5]American Railway Signaling Principles and Practices, Ch. XVI, p. 5.

[6]Union Switch & Signal Company, Electro-pneumatic Interlocking, (Swissvale, PA: Union Switch & Signal Company, 1914. Reprinted: 1928), p. 15.

[7]US&S, Electro-pneumatic, pp. 75-76.

[8]US&S, Electro-pneumatic, pp. 28-29, 84.

[9]John Pressley Coleman, "The Boston Southern Station: Track Facilities and Interlocking," The Railroad Gazette, May 12, 1899, pp. 331-332; Association of American Railroads, Communication and Signal Section, American Railway Signaling Principles and Practices, Ch. XVIII, "Electro-pneumatic Interlocking," (New York: Association of American Railroads, 1954), p. 24.

[10]Coleman, p. 332.

[11]US&S, Electro-pneumatic, p. 65.

[12]US&S, Electro-pneumatic, pp. 15 and 19; AAR, Electropneumatic, p. 4.

[13]Droege, p. 64.

[14]J. Elfreth Watkins, History of the Pennsylvania Railroad Company, 1846-1896, in its Relation to the Pennsylvania State Canals and Railroads and the Consolidated System East and West of Pittsburg, Part II, Vol. II, "The Baltimore Division," (Philadelphia: The Pennsylvania Railroad Company, 1896), p. 9.

[15]Interlocking is a relatively undocumented technology. A technical literature exists, but there is not the wealth of site-specific information that exists for other aspects of railroading. The information specific to the Union Junction interlocking presented here has been gathered from documentation of the station and nearby B&P Junction interlocking, maps, Union Switch & Signal catalogs, the model board of the machine, and discussions with Amtrak staff.

[16]Interview with Mr. Tony Kopecni, Train Dispatcher, Amtrak, Baltimore Penn Station, December 14, 1982.

[17]Quoted in Watkins, p. 9.

[18]Watkins, p. 9.

[19]Kopecni, Interview December 16, 1982.

[20]Ibid.

[21]US&S, Electro-pneumatic, p. 83.

[22]Kopecni, Interview December 16, 1982.

[23]William D. Middleton, When the Steam Railroads Electrified, (Milwaukee: Kalmback Publishing Co., 1974), p. 317.

[24]"The Pennsy Plans $22,500,000 Program Here," Baltimore Sun, February 24, 1935.

[25]P. Stewart MaCaulay, "Electric Horses through Baltimore," Baltimore Sun, February 10, 1935.

[26]Kopecni, Interview December 16, 1982.

[27]Union Switch & Signal Company, U-5046, Installation of the Model 14 Power Interlocking Machine, (Swissvale, PA: Union Switch & Signal Company July 1935), p. 3.

[28]Kopecni, Interview December 14, 1982.

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Union Switch & Signal Company. Instruction Pamphlet U-5046, Installation of the Model 14 Power Interlocking Machine. Swissvale, PA: The Company, 1935.

Watkins, J. Elfreth. History of the Pennsylvania Railroad Company, 1846-1896 in its Relation to the Pennsylvania State Canals and Railroads and the Consolidated System East and West of Pittsburg, Part II, Vol.II, "The Baltimore Division". Philadelphia: The Company, 1896.

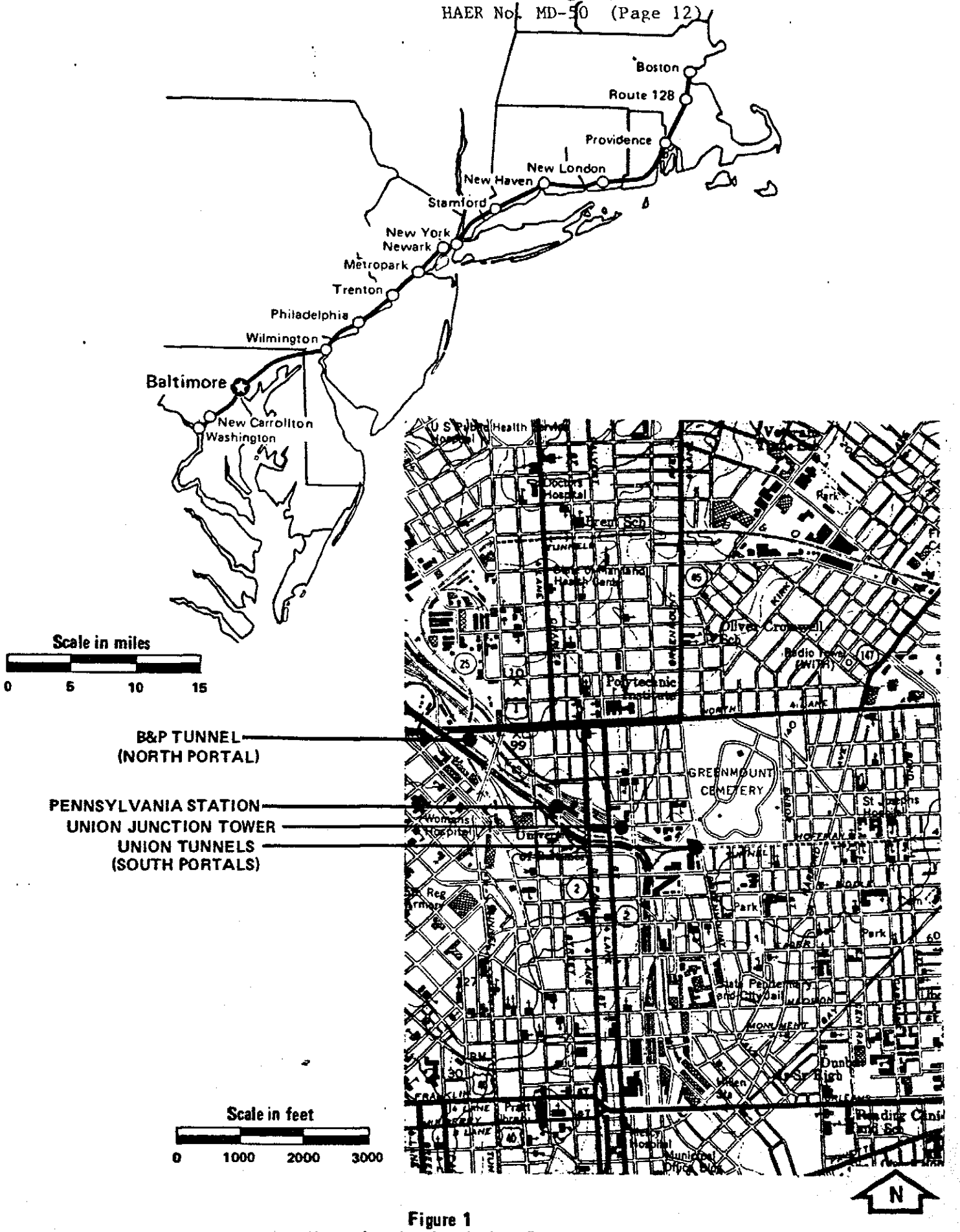


Figure 1
Union Junction Interlocking Tower

REGIONAL LOCATION

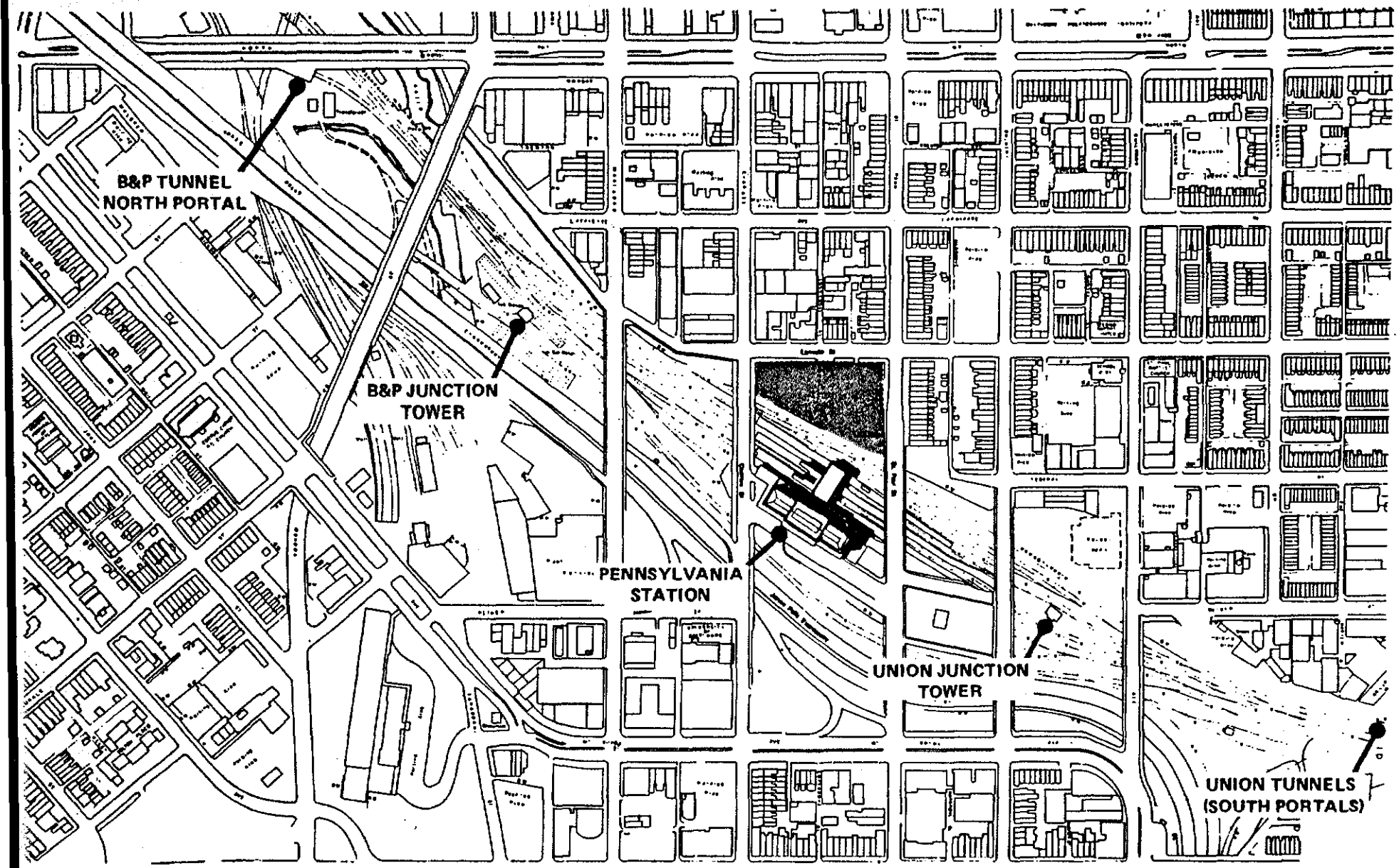
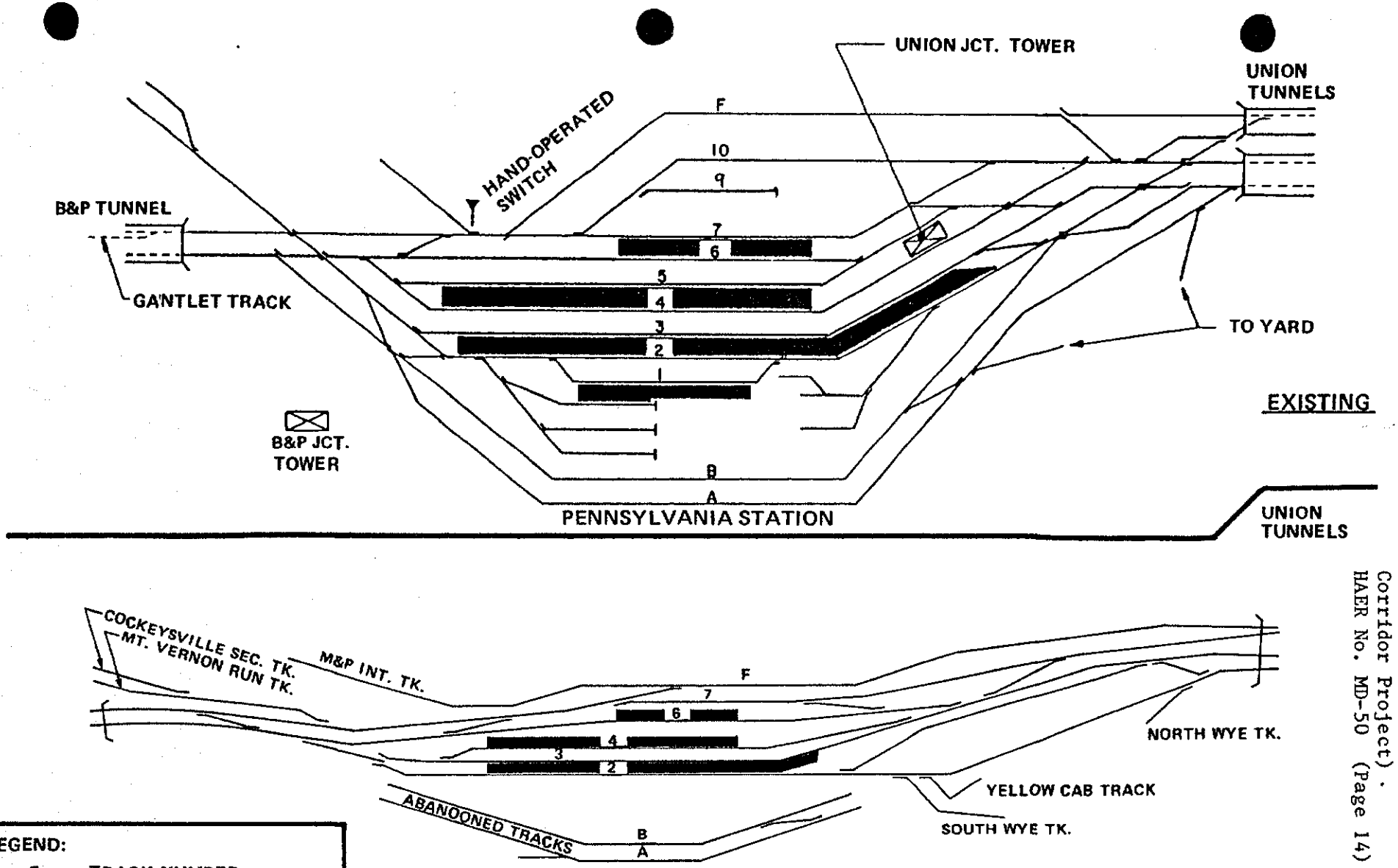


Figure 2
Union Junction Interlocking Tower

PROJECT LOCATION



SOURCE: BASELINE GENERAL TRACK CONFIGURATION PLANS INTERLOCKING CONFIGURATION, APRIL 1979: CSOW CHANGE NO. 21. JANUARY 1983

Figure 3
Union Junction Interlocking Tower

INTERLOCKING CONFIGURATION – UNION JUNCTION AND B&P JUNCTION

UNION JUNCTION INTERLOCKING (Northeast Corridor Project). HAER No. MD-50 (Page 14)