Appendix H

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Delaware River Port Authority (DRPA)

Port Authority Transit Corporation (PATCO)

Description and Contacts

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The Port Authority Transit Corporation (PATCO) rail transit line was built by the Delaware River Port Authority (DRPA) between Lindenwold, New Jersey and Center City Philadelphia, Pennsylvania, a distance of 14.5 miles. The line utilizes the former Camden – Philadelphia "Bridge Line", built by the Delaware River Joint Commission, predecessor of the DRPA. The Bridge Line opened in 1936, connecting 8th and Market Streets Station in Philadelphia with City Hall and Broadway Stations in Camden, via subways and a crossing of the Delaware River on the Benjamin Franklin Bridge. The Bridge is 140 feet above the water, and 1.5 miles in length.

The balance of the line in Philadelphia utilizes a City-owned subway, constructed in the 1930s but not opened until February 15, 1953. The balance of the line in New Jersey utilizes a former railroad corridor that first became operational on July 4, 1854.

Description of the Line

The double-tracked transit line operated by PATCO includes 2.3 miles in downtown subway, with seven stations (one of which, Franklin Square, is permanently closed), and 12.2 miles above ground, with seven stations (one of which, Haddonfield, is a deep open cut). Thus thirteen stations are spread over 14.5 miles of line. Supporting the two main tracks are fourteen interlockings, turn back tracks at three locations, tail or storage tracks at four locations, ten electrical substations for providing traction power, one electrical switching station, and a central control facility.

The substations supply direct current propulsion power at a nominal potential of 750 volts direct current from rectifier//transformer units. Alternating current to these substation s is obtained from three feeder lines from Public Service Energy Group in New Jersey at 26,400 volts. Two are identified as primary-use lines, and the third as an emergency backup. Additionally, two 13,200 volt alternating current lines of Philadelphia Electric Company provide additional backup.

Railroad lines operate within the PATCO right-of-way at two locations. In Camden, Conrail's line into South Jersey parallels PATCO's eastbound main track for a distance of about half a mile. Between the west end of Haddonfield and Lindenwold Station, New Jersey Transit's Atlantic City Line parallels PATCO's westbound man track, a distance about five and one half miles. The respective agencies, Conrail and New Jersey Transit, are responsible for the operation and maintenance of their rail facilities.

Primary maintenance facilities are located within the Lindenwold Shop Building. The area for maintaining transit cars consists of four shop tracks and a wash track. The Car Wash was expanded and upgraded as part of a major renovation that also included a major component part washing facility, blow-down building and electrical substation, all of which were accepted and put into service in 2005. Each of the tracks can accommodate four cars with the shop doors closed. Two of the four shop tracks are serviced by three overhead cranes, one of 5-ton capacity and two of 17-ton capacity. The other two tracks are over service pits. A two-car in-floor car-hoist system was installed in 1993, at the east end of No, 1 track. Just outside the east end of the shop are a blowing pit and an inspection pit. The balance of the car maintenance area consists of a welding shop, a machine shop, and electronics shop, administrative offices, and locker and washrooms. Adjacent to the offices is a storeroom, which supports PATCO maintenance activities. Outside storage of material is also provide near the Shop Building. Additional shop space was added in 2015 enclosing 3 tracks. Two tracks are over a maintenance pit with the second of these and a third track also served by a high-level platform. The building also provides additional bench, storage, and office spaces.

Also within the Shop Building, supporting the maintenance of all PATCO facilities and equipment except the transit cars and fare collection equipment, are a radio repair shop, and electronics and signal shop, plus administrative offices, locker and wash rooms, and the boiler room for the entire Shop Building.

Outside the man Shop Building is a storage and maintenance building for on-track work equipment.

Lindenwold Yard is located adjacent to the Shop Building. It consists of 17 storage and running tracks, an east end yard throat bypass track, plus a wye/test track and a three-track Way & Power storage yard, and is connected to the main line by an ascending, double-track loop at is east end. At its west end is a physical connection to a siding off the Atlantic City Rail Line, to enable delivery of carload freight and rail vehicles. A stub-ended portion of the siding connecting track also serves as a yard lead, facilitating placement of cars into the west end of the shop from the storage tracks.

Rail Vehicles

PATCO's transit car fleet consists of 120 fully compatible, multiple unit-type, high performance, electrically propelled vehicles. The married pairs have one operating compartment per car and

provide 80 seats. All of the cars in the fleet are 67 feet 6 inches over the anti-climbers, 10 feet wide, and 12 feet 4 inches high. PATCO operates 120 67-foot (20.42 m) cars. The unique whine of the motors and gear assemblies can lead many to mistake the cars for using thyristor drive or even a variable-frequency drive, but this is not the case. Bogies are of the Budd designed Pioneer III variety and while lightweight, provide for a very bouncy ride.

Operation

PATCO was one of the first transit systems to incorporate automatic train operation for regular service. The PATCO ATO is an analogue system that makes use of pulse code cab signaling supplied by Union Switch and Signal. The cab signals supply one of five different speeds (20 mph or 32 km/h, 30 mph or 48 km/h, 40 mph or 64 km/h, 65 mph or 105 km/h and 0 mph or 0 km/h) and the on-board ATO gear will supply maximum acceleration or maximum braking force to reach that target speed. The frequent use of such high acceleration and deceleration rates makes for a quick ride, yet one that can occasionally be perilous for non-seated passengers. Automatic station stops are handled by track mounted transponders and can be overridden by the operator for non-stopping trains.

Trains are normally operated in the semiautomatic ATO (Automatic Train Operation) mode. In this mode, the operator closed the doors (as is required in all modes) and pushes a :START: button. The train then accelerates, maintains speed, adheres to signal and speed commands, and stops at the next station automatically. The operator then opens the doors.

In the ATC (Automatic Train Control)-Manual mode, the train Operator controls the acceleration and braking rates and maintains speed by use of a master controller. Pulling the controller handle backward accelerates the train. Pushing the controller handle forward bakes the train. With the handle centered, the train coasts. The controller handle also incorporates a “deadman” feature. In the ATC-Manual mode, the ATC features prevent the Train Operator from violating signal or speed commands, and provide safe train separation, as is also the case in the ATO Mode.

The third and final mode of operation available to the Train Operator is the Manual Mode. In this mode the Train Operator is responsible for the safety of the train by operating in compliance with the rules and procedures and, if on the main line, the Dispatcher’s orders. It is the only mode of operation used in Lindenwold Yard.

The ATO Mode is the normal method of vehicle control for trains in revenue service. However, Train Operators are required to make at least one trip a day in the Manual-ATC Mode, and this mode is also the normal method of control when required in failure-recovery or other special operation situations.

The system suffers from problems handling slippery track conditions and human operators are required to take control in any sort of precipitation. Because of the ATO limitations, drivers must make one trip per day under manual operation to stay in practice and are not penalized for running their trains manually at any time of their choosing. In practice, most operators prefer automatic operation as not only is it less effort, but it also tends to result in faster trips.

The system was designed for one person train operation by exclusively utilizing island platforms and right-handed operation with operators sitting on the left side of the vehicle where they can open their window and monitor the boarding process. Where trains have to use the "wrong" side, door controls are provided next to a sliding window on the right side to give the operator a proper view. Operators are responsible for, opening and closing the doors, sounding the horn, starting the train from station stops and full manual operation of the train (when necessary).

Trains operate at a maximum of 65 mph (105 km/h) on the surface portion of the system and 40 mph (64 km/h) in the subway portion and over the bridge.

PATCO runs the majority of its trains in 2-, 4- or 6-car configurations. Single-unit trains were occasionally seen late at night (before of the Alstom rebuild),. All stations are capable of handling 7- or 8-car trains, but these lengths have never been run except for brief testing and for the annual holiday "Santa Train" special for children. In an effort to contain costs, PATCO actively manages its consist length as opposed to running trains in fixed sets. Train length is matched to the demand level for that particular time of day. In peak periods trains are 6 cars long, on "shoulder" periods they are 4 cars long, off peak they are 2 cars long.

Signaling

PATCO trains are governed by a pulse code cab signaling, which transmits signal codes to the trains via the running rails. Wayside signals are located only at interlockings and consist of two lamps on a single signal head, one lunar white and the other red. There are three typical signal indications, Red for "Stop", Lunar for "proceed under cab signals on main route" and flashing lunar for "proceed under cab signals on diverging route".

There are 5 cab signals, each corresponding to a speed. The cab signals are displayed to the operator via a series of 5 lamps above the speedometer, red for Stop, yellow/red for 20 mph, yellow for 30 mph, yellow/green for 40 mph and green for 65 mph. These lamps correspond to the same cab signals in use by various northeastern railroads. Even when the Automatic Train Operation System is not in use, the cab signal speed control function is still enabled and if an operator goes above the permitted speed, the power is cut and the brakes are applied until the speed is back within the limit.

The entire PATCO system is run from Center Tower, centrally located above a substation near the Broadway stations in Camden, NJ. Center Tower is staffed by two operators at peak periods and a

single operator otherwise. Wayside signals are marked with their corresponding lever in the old US&S fashion with R signals indicating a "right" lever motion and L signals indicating "left". Signals and switches are numbered in ascending order from west to east with 15th/16th Locust using levers 1-4 and Lindenwold using levers 73-76. The interlocking at Woodcrest, which was added in 1980, uses levers 87-98.

PATCO's Central Control Facility, Center Tower

Center Tower is the nerve center for all PATCO train and station operations. Built-in communications are designed to enhance both safety and operations. A hard-wired communications system links elevators in PATCO stations to a monitoring and control console. A telephone system includes direct lined to emergency response agencies in New Jersey and the 911 emergency network in Philadelphia. A digital trunked radio network provides communication with trains and Transit Services personnel, DRPA Transit Unit Police officers and vehicles, and maintenance personnel and vehicles.

Onboard the transit cars, the radio units provide the Train Operator with communications to Center Tower which provides redundancy to the radio carried by each Operator. This maintains communications capability with the Dispatcher in Center Tower during abnormalities. The microphone on the operating console has a public address mode, enabling the Train Operator to transmit routine and emergency messages and instructions throughout the train. Passenger emergency alarms in each car are audibly linked to the operating cab, with visual indicators outside the car where the alarm was actuated. The operating rules require the Train Operator to stop the train with an emergency brake application upon receipt of an emergency alarm, notify the Dispatcher in Center Tower, and then investigate.

Vehicle Safety Features

Additional built-in safety features on the transit care are extensive. Included area a "deadman" feature on the master controller, causing an emergency stop in a manual mode of operation should the Train Operator release the handle with brake cylinder pressure lower than 25 psi; sliding side door interlocks, preventing movement with a door open, and stopping the train should a door open while the train is moving; automatic emergency stopping in the event of automatic train control (ATC) or speed sensor failure; automatic enforcement of speed commands in both automatic train operation (ATO) and manual-ATC operating modes; and automatic emergency braking in the event of an uncoupling (pull-apart) or rupture of emergency pipes. The cab signal system provides for train operation at maximum scheduled speeds regardless of visibility. Operation without ATC protection is allowed only under the direction and supervision of the Dispatcher in Center Tower in compliance with the Rules.

Underground Safety Features

A number of safety capabilities have been built into or incorporated in various aspects of the PATCO line. The downtown subway segments in Philadelphia and Camden are relatively shallow and were built using the cut-and-cover technique. They are naturally ventilated through street/concourse level gratings. Side-wall emergency exits extend from track level to the sidewalk, with but three exceptions. The two exits under the Broad Street Subway of SEPTA, the lowest part

of the line at approximately minus 50 feet, lead to mezzanine-level concourses. At Franklin Square Station, the exit is in what was the former main entrance area.

Key underground stations have been identified for the installation of undercar deluge sprinkler system as well a smoke and fire detection and alarm system. The undercar deluge is a dry pipe system designed to be used by responding fire personnel in connection with a dry standpipe system also added to the underground station in 2004.

Portable fiberglass ladders, called “emergency ladders” are located at all the subway emergency exits and at or near both ends of all station platforms. Their purpose is to assist in evacuation of passengers from a train stalled or disabled between stations through the end doors to the right -of-way.

DRPA PATCO Contacts

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PATCO Minimum Standards for Safety

Minimum Standard	Document Description	Document Date	Document Version No	SSI
SSOPS	**NJDOT Fixed Guideway SSO Program Standard**	**10/2021**	**Version 2.0**	**FALSE**
ASP	Agency Safety Plan (ASP) – The ASP contains the requirements for the safety program and related activities at the RTA/RFGPTS.	6/2/2020	Version 1.0	FALSE
CMP	Configuration Management Plan (CMP) – the Configuration Management Committee and processes are a required element/function within the RTA/RFGPTS safety program, along with safety and security certification and system modifications.			TRUE
EOP	Emergency Operations Plan (EOP) – this document provides the coordination and preparedness activities inside and outside of the RTA/RFGPTS.		(2013) Operating Procedures App. 2: Dispatchers Standard and Emergency Operating Procedures	TRUE
I&M	Inspection and Maintenance (I&M) Manuals, SOPs, and Standards – these documents provide the requirements for inspection and maintenance of the rail system, including facilities, infrastructure, and related vehicles. These documents should have the custom		W&P Signal/Switch SOP/I&M (XX/XX/XXXX) W&P Track SOP/I&M (9/5/2008)	FALSE
Investigation Procedures	Investigation Procedures at the RTA/RFGPTS – this procedure includes a description of the types of events that need notification and investigation, who will perform those requirements, causal factor analysis, hazard analysis, and development of recommendation.	10/1/2010	SSPP App. 1: Accident Incident Investigation Manual	FALSE
RORB	Rail Operating Rule Book (RORB) – these are the rules that operators and others working around the rail system must follow.	6/2009	9/2018	FALSE
RWP	Right-of-Way or Roadway Worker Protection (RWP) Plan – this document is related to the RORB from the perspective of the protections and procedures for workers on the rail right of way.	3/13/2019	Right-of-way Safety Plan	FALSE

MINIMUM STANDARD	DOCUMENT DESCRIPTION	DOCUMENT DATE	DOCUMENT VERSION NO	SSI
SOPs - Command and Control	Command and Control/Train Control Standard Operating Procedures (SOPs) – these SOPs are used by the command and control staff/supervision to manage operations on the rail system for both usual and unusual operations, as well as managing maintenance and workers on the right of way. These SOPs should include troubleshooting information for frequent problems and managing emergencies on the rail system. These SOPs include the function of load control/management.	1/1/1969	Dispatcher's Procedure Book	FALSE
SOPs - Field Supervision	Field Supervision SOPs – these SOPs are for supervision out on the rail system for support of service delivery, responsiveness to passengers, and safety. The field supervisors will often be the first supervision to arrive at the scene of a safety event on the rail system and provide at least initial investigation of events on the rail system.	12/10/2003	Dispatcher's Procedure L.23 – Line Supervisor's Responsibility, 3/8/2013	FALSE
SOPs - Safety	Procedure requiring review of SOPs related to Safety – this procedure requires that the minimum safety standards at the RTA/RFGPTS are also required to be reviewed, agreed to, and approved by the Safety Department.			FALSE
SSCP	Safety and Security Certification Plan (SSCP) – this plan provides the required activities from the RTA/RFGPTS safety program for assuring that safety and security certification is completed for certain capital projects for new equipment/infrastructure or refurbishment of existing equipment/infrastructure. The main topics for safety and security certification are related design criteria, participation of the Safety Department, and a process of the RTA/RFGPTS assuring that all safety and security design criteria exist, were comprehensive, and were properly addressed including integrated testing of the final products.	7/12/2013	PATCO Safety and Security Certification Plan	FALSE

MINIMUM STANDARD	DOCUMENT DESCRIPTION	DOCUMENT DATE	DOCUMENT VERSION NO	SSI
SSP/SEPP	System Security Plan (SSP)/Security and Emergency Preparedness Plan (SEPP) – this security program document describes the requirements for system security and emergency preparedness at the RTA/RFGPTS. Note that the new SSO Rule no longer defines the content of the SSP/SEPP and its processes and procedures. However, the NJDOT SSO program will now consider this security program document as a minimum safety standard in terms of its overlap with the safety program at the RTA/RFGPTS (risk assessment and management, and emergency preparedness). The NJDOT SSO program no longer has requirements for the content of the SSP/SEPP, but does require that the RTA/RFGPTS develop an appropriate security program document and the NJDOT SSO program will provide oversight of that document and the processes that it represents, but only from the safety program (all-hazards) perspective.	7/12/2013	SEPP	TRUE
TAM	Transit Asset Management (TAM) Plan – this is a new plan now required for RTAs/RTSs and it is related to the CMP, but with a larger context.	10/1/2018	PATCO Transit Asset Management Plan	FALSE

Updates:

- March 5, 2018 – initial release
- July 6, 2020 – updates and edits from PATCO, update of minimum standards for safety
- September 22, 2020 – minor updates from the RFGPTS and NJDOT
- May 26, 2021 – minimum standards updates
- October 1, 2021 –NJDOT SSOPS date updated to 10/2021.