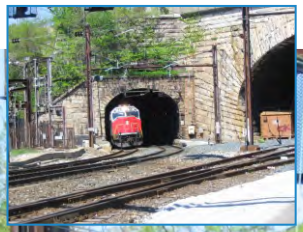
B&P TUNNEL PROJECT

B&P Tunnel Project
Baltimore, Maryland

NOISE & AIR QUALITY TECHNICAL MEMORANDUM FOR VENTILATION PLANTS

November 2015



U.S. Department of Transportation
Federal Railroad Administration

Maryland Department of Transportation

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I. INTRODUCTION

The purpose of this Technical Memorandum is to supplement the Air Quality and Noise Technical Reports[1,2] submitted in September 2015 with information on the proposed air ventilation system associated with the planned Baltimore and Potomac (B&P) Tunnel Project. This material has been assembled in support of the noise and air quality sections of the Draft Environmental Impact Statement (DEIS)[3] being prepared for this project by the Federal Railroad Administration (FRA)[4], in coordination with the Maryland Department of Transportation (MDOT)[5]. Importantly, this information is not intended to be treated, nor interpreted, as the final selection and design of the ventilation system for the B&P Tunnel Project. Additional studies and details are expected to be provided as the environmental review and design processes advance. Rather, this information is intended for disclosure purposes under the National Environmental Policy Act (NEPA) reported upon in the DEIS.

II. OVERVIEW OF VENTILATION SYSTEM

This section is divided into three sub-sections pertaining to relevant topics associated with train tunnel ventilation systems: (A) purpose of ventilation systems, (B) ventilation process overview, and (C) air filtration systems.

A. Purpose of Ventilation Systems

The purpose of the tunnel ventilation system is multifaceted: (i) to furnish outside air into the underground space(s); (ii) to remove air emissions and heat from inside the tunnel; and (iii) to provide a means for evacuating smoke and other by-products in the event of a fire or other emergency. Various proven ventilation design concepts are still under evaluation for this application on the B&P Tunnel Project, however, the current preference is to have a "passive" tunnel ventilation system during normal operations. With passive ventilation, air circulation and exchange results from a combination of train movement through the tunnel (i.e., the "piston effect") and natural air flow as winds blow through the tunnel. During this process, warmer air rises out of the tunnel and cooler air sinks into the tunnel. Under this system, tunnel air may exit at an intermediate vent shaft and/or at either end of the tunnel.

To maintain air quality conditions inside the tunnel that are within safe limits for workers, system sensors automatically activate mechanical fans, which aide in exhausting and diluting air emissions. The pollutant of greatest potential concern is nitrogen dioxide (NO_2) associated with diesel engine exhaust from train

[1] *B&P Tunnel Project Air Quality Technical Report,* prepared by KB Environmental Sciences, September 21, 2015.
[2] *B&P Tunnel Project Noise Technical Report,* prepared by KB Environmental Sciences, September 9, 2015.
[3] The EIS and associated technical reports are being conducted in compliance with the National Environmental Policy Act of 1969 (42 United States Code [USC] 4321 et seq.), the Council of Environmental Quality NEPA Regulations (40 CFR 1500-1508), the FRA Procedures for Considering Environmental Impacts (64 FR 28545, May 26, 1999), and FRA's Update to NEPA Implementing Procedures (78 FR 2713, January 14, 2013).
[4] FRA is serving as the lead Federal agency for the B&P Tunnel Project.
[5] MDOT is the funding grantee for the B&P Tunnel Project. MDOT oversees six modal state agencies, including the Maryland Transit Administration (MTA).

locomotives (notably, electric trains generate significantly less exhaust emissions).[6] For the B&P Tunnel Project, the proposed ventilation system would be activated when NO_2 levels in the tunnel exceed thresholds established by the federal Occupational Safety and Health Administration (OSHA). Additional potential pollutants of concern are discussed in **Section III.A, Air Quality,** of this memorandum.

B. Process Overview

Train tunnel ventilation systems are typically designed to address various operating and emergency conditions. For example, when trains move through the tunnels unimpeded, the system is intended to aid in the removal of train-generated heat and emissions in combination with the longitudinal airflows associated with the piston effect (described above). Under more congested operational conditions, when trains idle or move slowly, the system similarly is designed to help to ensure that train equipment temperatures do not reach levels above their operational limits. During periods of tunnel maintenance, the system aids in the removal/dilution of diesel exhaust emissions associated with the trains and the construction vehicles and equipment.

Under emergency conditions, such as a fire, the system is designed to remove smoke and other combustion gases to help maintain visibility and keep emergency routes smoke-free – facilitating the evacuation of passengers and crew members and the passage of firefighting personnel, if required. For this application, the emergency ventilation mechanical and size demands are to be developed in accordance with the latest edition of the National Fire Protection Association (NFPA) 130, *Standard for Fixed Guideway Transit and Passenger Rail Systems*.

Emergency ventilation systems for passenger rail and transit tunnels are usually composed of a series of ventilation shafts equipped with reversible fans. During a fire, the fans are operated in either exhaust or supply mode in a "push-pull" arrangement to direct outside air towards evacuating passengers and exhaust smoke in the direction opposite the evacuation.

The ventilation system must provide sufficient longitudinal air velocity past the fire, known as the "critical velocity," to prevent "back-layering," which is the movement of heated air and smoke in the opposite direction of the forced ventilation. The critical velocity is a function of tunnel and train geometry, tunnel grade, and the peak fire heat release rate. By delivering the critical velocity to the fire site, a "push-pull" emergency ventilation system enables passengers to evacuate towards a cross-passageway or an exit and allows firefighting personnel to approach the fire from the supply air side.

[6] Although NO_2 is the most prevalent pollutant, other pollutants also occur including carbon monoxide (CO), sulfur oxides (SO_x), hydrocarbons (HC) and particulate matter (PM). The same ventilation process that supports the removal of NO_2 will also aid in the removal of these pollutants (see also Section III.A).

Three example ventilation systems associated with New York City tunnels used by Amtrak's NEC commuter trains include the following: (a) the Weehawken system in Weehawken, New Jersey, which serves the two existing North (Hudson) River tunnels; (b) the First Avenue system in Manhattan which serves the four East River tunnels; and (c) the Long Island City system in Long Island City, Queens, which also serves the East River tunnels. Amtrak has recently rehabilitated all three facilities, which are currently equipped with code-compliant mechanical systems, conveyance equipment, ventilation shafts and containment buildings.

Amtrak has also constructed a tunnel ventilation complex for the Empire Line (North Access) tunnel, comprising of a ventilation system and containment building at West 33rd Street and Eleventh Avenue in Manhattan.

Figure 1: Tunnel Ventilation Fans at Amtrak Weehawken Shaft
Source: Amtrak 2015

C. Air Filtration Systems

Particle filtration systems installed on the ventilation systems U.S. transportation tunnels (e.g., road, subway, rail, etc.) are uncommon. Worldwide, these filtration systems are not used in rail tunnels. However, they are used, albeit rarely, in motor vehicle road tunnels to help remove diesel truck exhaust.

Given the current technologies used nationally and globally to ventilate transportation tunnels, the use of filters could cause the following potentially undesirable effects:

- In the event of a fire, a filter system would block the rapid flow of smoke and other pollutants out of the tunnel, leaving higher pollutant concentrations that threaten the safety of passengers or crew members.
- To overcome the retarding effect of filters on air flow, the use of a filtration system would require significantly enlarged fans, higher operating pressures, and potentially cause higher noise levels.
- The space required to house large air filtration and NO_2 treatment equipment could cause the ventilation structures to be larger.

As such, these installations are not considered to be an appropriate application for the B&P Tunnel.[7]

[7] Excerpted from: BP Tunnel PE JV Review of Air Filtration Question for Vent Plants R2 7-07-15.docx.

III. ENVIRONMENTAL CONSEQUENCES

This section presents an assessment of the potential air quality and noise effects of the proposed vent plant facilities, based upon the information available at the DEIS stage of the project.

A. Air Quality

The principal air quality considerations given to train tunnels are the conditions inside of the tunnel (discussed above) and the exhaust air from the tunnel portals and the ventilation systems. For the exhaust air, the aim is directed towards the quality of the air emitted to the outside environment during normal operations. In this case, the concern is associated with the compounds contained within the diesel train exhaust and other potential contaminants generated by trains operating over rails and the underlying track foundations. With respect to the emissions from diesel train engines, the contaminants-of-concern primarily include the following by-products from the burning of diesel fuel: carbon monoxide (CO), nitrogen oxides (NO_x), sulfur oxides (SO_x), unburnt and partially burnt hydrocarbons (HC), and particulate matter (PM) which is commonly referred to as soot. Volatile organic compounds (VOC), which are a subset of hydrocarbons, are released by mobile sources and from the evaporation of gasoline, solvents and other hydrocarbon-based compounds. Of note, NO_x and VOC emissions are precursors to ozone formation. Also of note, PM characterized as "fugitive dust" may arise from the mechanical breakdown of metal and earthen materials by the passage of both diesel- and electric-powered trains. Within a tunnel environment, the above pollutants are emitted to the above-ground environment either through the tunnel portals or the ventilation system, while a portion remains inside the tunnel.

The B&P Tunnel project is located in Baltimore City, Maryland, which is presently designated by the United States Environmental Protection Agency (U.S. EPA) as a moderate nonattainment area for the 8-hour ozone standard and a maintenance area for CO and PM equal to or less than 2.5 micrometers in diameter (fine particulates or PM2.5). Insofar as the proposed project is funded by, and would require input and/or approval by, the FRA, the General Conformity requirements of the Clean Air Act (CAA) are applicable.

As a means of assessing the potential ambient (i.e., outside) air quality effects associated with tunnel train traffic, an emissions inventory was prepared for the B&P Tunnel project. Air quality dispersion modeling for assessing ambient air quality effects associated with the vent plants will be conducted during the preparation of the Final EIS (FEIS), once the Preferred Alternative is identified and the necessary modeling information is available. Currently, the U.S. Department of Transportation is considering potential locations for the vent plants, and preliminary engineering designs are under development. Final vent plant locations and designs will be developed as part of the FEIS, which will include the following data necessary for dispersion modeling: (i) building positions and heights, (ii) location and size of exhaust vents/louvers on the building façade(s), (iii) local terrain (i.e., topography) near the selected locations, and (iv) locations of nearby receptors (i.e., residential units, parks and recreation facilities, schools, hospitals, etc.).

The emissions inventory was accomplished by computing emissions based on the types and number of trains passing through the tunnel combined with appropriate emission factors (see the *DEIS Air Quality*

Technical Report dated September 21, 2015 for additional information). Of note, the 2040 No-Build scenario includes the existing two-track tunnel and existing ventilation openings and portals, whereas the 2040 Build scenario includes the proposed four-track tunnel with vent plants near each portal and at an intermediate location.

The results were then compared to numeric thresholds as an indication of their potential effect on the outside environment. For this assessment two sets of thresholds were used. The "de-minimis" thresholds are established by the U.S. EPA under the General Conformity Rule of the CAA. These values are applied to "mobile" sources of emissions (e.g., motor vehicles, trains, etc.) and represent levels considered low enough so as not to cause or substantially contribute to a violation of the National Ambient Air Quality Standards (NAAQS). For the project area, these apply to the pollutants NO_x, VOC, and PM. The Prevention of Significant Deterioration (PSD) thresholds, also established by the U.S. EPA, are applied to stationary sources of emissions (e.g., stacks, vents, etc.) and again represent levels protective of the NAAQS.

The outcomes of the B&P Tunnel emissions inventory are presented in **Table 1** below in units of tons per year, listed by pollutant and project alternative under future-year conditions. For ease of comparison, the de-minimis and PSD thresholds are also shown.

Table 1. B&P Tunnel Operational Emissions Estimates (tons per year)

Pollutant	2040 No-Build	2040 Build	Net Change	De-Minimis Threshold	PSD Threshold
CO	8.6	19.4	10.9	N/A	N/A
NO_x	6.7	15.2	8.5	100	40
VOC	0.3	0.6	0.3	50	N/A
PM	0.1	0.2	0.1	100	N/A

Notes:
- All values rounded to the nearest 0.1 tons. Values of "Net Change" represent Build minus No-Build and are subject to rounding.
- Emission estimates are for Build Alternative 3C (the longest tunnel out of the six alternatives). It has the highest potential to affect air quality due to the greatest tunnel length.
- De-Minimis thresholds are established by the U.S. EPA for emissions associated with mobile sources (e.g., motor vehicles, trains, etc.). PSD thresholds are Prevention of Significant Deterioration thresholds established by the U.S. EPA for stationary sources of emissions.

As shown, the largest change (i.e., increase) in emissions associated with the B&P Tunnel Project is with CO, followed by NO_x, VOC, and PM. Compared to the applicable General Conformity thresholds, these expected increases are well within the prescribed values. With a focus on NO_x, the pollutant of most concern, the net change in emissions is also well within the applicable PSD threshold. Based upon these results, operational emissions associated with the project will not cause, nor substantially contribute to, a violation of the NAAQS.

Furthermore, the proposed tunnel ventilation system would be designed such that ventilated air will meet Federal air quality standards without the use of a filtration system (see also **Section III**). The

ventilation system would be designed to dilute and disperse pollutant levels, so that air quality standards would be met at any location where people may be exposed.[8]

B. Noise

The vent plant facilities would be located near each portal and near the intersection of Whitelock Street and Brookfield Avenue in Reservoir Hill.[9] The portal vent plants would be constructed near the portal openings as part of the cut-and-cover structures. The "intermediate" plant would be constructed above the tunnel at one location and would require openings connecting the interior of each tunnel bore to the ground surface level.

The existing conditions for ambient noise were measured at the "worst-case" location, which is the proposed intermediate vent plant adjacent to residential properties located along Whitelock Street and Brookfield Avenue. The noise measurements were conducted for 24 consecutive hours on October 8-9, 2015 along Whitelock Street across the street from the proposed vent plant site (see **Figure 2**). Noise levels were measured in terms of A-weighted decibels (abbreviated "dBA") which is used to describe the overall noise level and closely matches the human ear's response to audible frequencies. The following noise metrics were computed from the measurements:

- L_{dn} – The 24-hour day-night average sound level, an average sound level which includes a 10-decibel penalty added between 10:00 pm and 7:00 am to account for greater nighttime sensitivity to noise.
- L_{max} – The maximum noise level that occurs during an event (such as a train passby).

At this location, ambient sound levels were due primarily to motor vehicle traffic on Whitelock Street and the measured L_{dn} was 65.8 dBA. Of note, noise levels from 5:00pm to 6:00pm on October 8 were atypically high (i.e., L_{max} 92 dBA) and may have been due to sources other than motor vehicle traffic.

[8] Excerpted from: BP Tunnel PE JV Review of Air Filtration Question for Vent Plants R2 7-07-15.docx.
[9] The FRA is considering other potential locations for the intermediate vent plant.

Figure 2. Noise Measurement Location
Source: RK&K 2015

1. Construction Noise

During the Draft EIS and development phase of a project, construction details are typically limited. Therefore, the Federal Transit Administration (FTA) noise assessment guidelines[10] suggest evaluating possible construction scenarios against local ordinances (if applicable criteria are available). The FTA design guidelines, for example, are evaluated against noise levels from the two loudest pieces of equipment that, under worst case conditions, are assumed to operate continuously for one hour during both the daytime (7:00 am to 10:00 pm) and nighttime (10:00 pm to 7:00 am) periods.

In Baltimore City, the local noise ordinance identified for the project study corridor exempts construction activities from noise restrictions.[11] Since the local noise ordinance does not provide quantitative noise limits on construction activities, the noise policy from the Maryland Department of the Environment (MDE) was reviewed to assess temporary construction activities.[12] The MDE has established the following noise guidelines for construction activities (these sound levels are described as "maximum allowable sound pressure levels" and are therefore assumed to be L_{max} levels; see the *DEIS Noise Technical Report* dated September 21, 2015 for additional information):

- 90 dBA – daytime (7 am to 10 pm) – residences;
- 55 dBA – nighttime (10 pm to 7 am) – residences;

[10] Federal Transit Administration, *Transit Noise and Vibration Impact Assessment*, Washington, DC, May 2006
[11] Health Code of Baltimore City, § 9-103.b Noise Regulation, 2015.
[12] Maryland Department of the Environment 26.02.03, Control of Noise Pollution, 2012.

- Blasting during construction is exempt from the MDE noise ordinance during the daytime (7 am to 10 pm);
- Pile driving during construction is exempt from the MDE noise ordinance constraints from 8 am to 5 pm; and
- Construction activities on public property are exempt (per MDE 26.02.03.02.C.2.l).

2. Operational Noise

Noise levels in the immediate vicinity of the vent plant buildings would be caused by the continual operation of the vent fans within each facility. The horizontal fans would operate periodically and would generate sound that would propagate through the louvers on the side and top of the vent plant buildings. As discussed previously, fans would operate periodically when NO_2 levels in the tunnel exceed a set threshold or in emergencies when smoke is present in the tunnel. NO_2 levels are likely to be highest when the level of diesel locomotive operations are highest, or when congestion causes trains to operate slowly or to idle in the tunnel. However, there is not enough information currently available to determine how many hours per day, on average, the fans would run and whether or not they would run during the night.[13]

The Alternative 3 tunnel designs include three vent plants: one near each portal and an intermediate facility located above the tunnel. The north portal location for Alternatives 3A, 3B, and 3C would be identical, located in the vicinity of the existing tunnel's north portal. The proposed north portal would be approximately 700 feet from the nearest residential zone and 900 feet from the nearest institutional zone. The south portal locations for the three alternatives are similar to one another and are in the vicinity of the P. Flanigan & Sons asphalt plant on North Monroe Street. The south portal, depending on the Alternative, would range from approximately 100-800 feet from the nearest residential zone and 500-1,300 feet from the nearest institutional zone. The intermediate facility would be located at the intersection of Whitelock Street and Brookfield Avenue in Reservoir Hill. The intermediate vent plant would be located adjacent to residential zones and approximately 170 feet from the nearest institutional zone.

The three vent plant facilities would be subject to the operational noise level standards included in the Noise Regulation of the Health Code of Baltimore City.[14] This regulation provides the noise limits for manufacturing, commercial, and residential zones in Baltimore City – depending on the source of noise and the types of adjacent land uses. For noise generated within residential zones, there is a limit of 55 dBA at any point on the property line of the use (the noise limit is described as a measured maximum sound level; although not specifically stated, it is assumed to be in terms of L_{max}). Between 9:00pm and 7:00am, the limit is 5 dBA lower for any uses within a residential zone (that is, 50 dBA). Although the Health Code allows for different noise limits for "short, durational deviations", for the purposes of this

[13] Via email from the Preliminary Engineering Team, September 22, 2015.
[14] Health Code of Baltimore City, § 9-206 Noise Regulation, 2015.

report it is assumed that the noise limit for the vent plants is L_{max} 50 dBA at the property boundary of each vent plant facility.

The vent plants would be designed to meet the L_{max} 50 dBA noise limit for the worst-case location, which is the intermediate facility adjacent to residential properties located along Brookfield Avenue south of the facility. The design standard for the vent plants would limit the outdoor noise level, when the fans are in operation, to L_{max} 50 dBA at the facility property lines.

To achieve the required reduction in noise level, cylindrical or rectangular sound attenuators would be mounted directly to each fan or to the ductwork within the system. In addition, the building itself would partially shield noise from the interior of the vent plant, which would further reduce noise levels outside of the building (with the exception of the louvers on one side of the building and the top of the building). The final design of the building will also take into account building orientation and the location of the louvers in order to reduce noise levels in the communities near each vent plant. The Preliminary Engineering Team has stated that the vent plant facilities, with attenuators installed, will emit noise at 45 dBA.[15] This would meet the design standard of L_{max} 50 dBA at the facility property lines (i.e., the noise level generated would be less than the design standard). By comparison, the measured L_{max} at the site ranged from 47 dBA to 92 dBA, and the average of all measured L_{max} values was 72 dBA.[16]

IV. CONCLUSION

The purpose of the B&P Tunnel ventilation system is multifaceted: (i) to furnish outside air into the underground space(s); (ii) to remove air emissions and heat from inside the tunnel; and (iii) to provide a means for evacuating smoke and other by-products in the event of a fire or other emergency. Under normal operating conditions, the removal/dilution of air emissions is aimed primarily at the combustion products from the burning of diesel fuel. The pollutants of concern include NO_x, CO, VOC, and PM.

The principal air quality considerations given to ventilation of train tunnels are the interior conditions, and the exhaust air from the tunnel portals and the ventilation plants. For the exhaust air, the aim is directed towards the quality of the air emitted to the outside environment during normal operations. Compared to the applicable General Conformity thresholds, the expected increases in emissions with the project are well within the prescribed values. With a focus on NO_x, the pollutant of most concern, the net change in emissions is also well within the applicable stationary source PSD threshold. Based upon these results, emissions associated with the ventilation plants for the project will not cause, nor substantially contribute to, a violation of the NAAQS. The vent plant facilities would be designed in order to meet Federal air quality standards without the use of a filtration system.

Noise exposure due to the ventilation of the proposed B&P Tunnel was assessed in terms of the construction and operation of the vent plant facilities. The applicable noise ordinances and guidelines were assessed relative to the land uses surrounding each portal and the intermediate location. The vent

[15] Via email from RK&K, October 10, 2015.

[16] L_{max} was calculated once every five minutes during the 24-hour measurement period.

plant facilities would be designed in order to meet the Baltimore Health Code noise regulations. This would ensure that, during operation of the vent plants, the resulting noise levels in the adjacent communities would meet the applicable standards.

This information is not intended to be treated, nor interpreted, as the final selection and design of the ventilation system for the B&P Tunnel Project. Additional studies and details are expected to be provided as the environmental review and design processes advance.