SOUND IMPACT EVALUATION AND ASSESSMENT

Brooklyn Avenue New Substation Project
Hamlet of Massapequa, Town of Oyster Bay
Nassau County, New York

Prepared for:

PSEG Long Island
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October 2021

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TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

PSEG Long Island LLC (PSEG Long Island) requested that PS&S Engineering, PC (PS&S) perform a Sound Impact Evaluation and Assessment ("the Assessment") for the Proposed Brooklyn Avenue Substation, located at 48 Brooklyn Avenue, in the Hamlet of Massapequa, Town of Oyster Bay, Nassau County, New York to assess the potential sound-level impacts at the nearest boundaries of the Proposed Substation property. PS&S completed the requested Assessment in accordance with accepted noise level evaluation standards, procedures, requirements, and guidelines.

The existing total daytime sound levels measured/observed around the Proposed Substation property varied between 54 A-weighted decibels (dBA) and 66 dBA, and existing total nighttime sound levels varied between 51 dBA and 63 dBA. Sound level measurements were taken at the property lines of the Proposed Substation property closest to potential receptors. Ambient sound levels measured at these locations were influenced by the local traffic, particularly along Hicksville Road and Sunrise Highway, as well as overhead air traffic and activity along the Long Island Railroad (LIRR) right-of-way to the south.

Sound propagation modeling of the area was performed using SoundPLAN Essential 5.0 to identify and incorporate all known sound sources around the Proposed Substation property, after completion of Proposed Substation. The sound propagation modeling results indicate that sound levels at the Proposed Substation property after the completion of the Proposed Substation would not raise sound levels more than 1 dBA above existing total sound levels.

1.0 INTRODUCTION

PSEG Long Island LLC (PSEG Long Island) is proposing the construction of a new 69/13 kV substation. The site will encompass 0.76-acres (Section 52, Block 265, Lot Nos. 2551 through 2567 as identified on Nassau County Department of Assessment Land and Tax Maps) located at 48 Brooklyn Avenue, hamlet of Massapequa, Town of Oyster Bay, Nassau County, New York and owned by Long Island Power Authority (LIPA) ("Proposed Substation Property"). The Proposed Substation will include three transformer banks, three switchgear enclosures, and a battery enclosure. The purpose of the Proposed Substation is to improve electric service reliability and capacity to the surrounding service area.

New noise generating equipment includes three (3) new 33 MVA 33/16.8kV transformers, and four (4) 12,000 BTU, 5 kW Packaged Terminal Air Conditioner (PTAC) units - one associated with each of the four enclosures.

PS&S Engineering, PC (PS&S) performed a Sound Impact Evaluation and Assessment ("Assessment") for the Proposed Substation to assess potential sound-level impacts at receptors in the vicinity of the Proposed Substation property. PS&S completed the Assessment in accordance with accepted noise level evaluation standards, procedures, requirements, and guidelines. The Assessment included the following:

- Measurement of existing ambient total daytime and nighttime sound levels at the property boundaries of the Proposed Substation property, and identification and characterization of noise source influences in the area;
- Sound propagation modeling of anticipated sound-level contributions from the Proposed Substation using the nationally recognized SoundPLAN Essential (V. 5.0) three-dimensional acoustic propagation model software; and
- Comparison of the results of the sound propagation modeling to the applicable New York State Department of Environmental Conservation (NYSDEC) Noise Policy Guidelines.

2.0 PROJECT LOCATION & SOUND LEVEL STANDARDS

2.1 Site Location

The site will encompass 0.76-acres (Section 52, Block 265, Lot Nos. 2551 through 2567 as identified on Nassau County Department of Assessment Land and Tax Maps) located at 48 Brooklyn Avenue, hamlet of Massapequa, Town of Oyster Bay, Nassau County, New York ("Proposed Substation Property"). The Site is currently vacant, with the exception of perimeter fencing and a dolomite surface. Properties adjacent to the Proposed Substation property are either commercial properties, roadways, or parking lots, which are all paved. Trees and other vegetation are present further to the north and south of the Proposed Substation property, along New York Avenue and the LIRR right-of-way.

The nearest residential property lines, along New York Avenue (Location 5), are approximately 150 feet north of the substation fencing and are separated by commercial and municipal properties.

2.2 Noise/Sound-Level Standards & Criteria

NYSDEC Noise Policy Guidelines are detailed in the Program Policy Memorandum/Noise Policy Guidelines titled *Assessing and Mitigating Noise Impacts* (NYSDEC, October 6, 2000, Revised February 2, 2001). The NYSDEC Noise Policy Guidelines (included as **Appendix A)** provide guidance on when sound-levels resulting from proposed projects have the potential for adverse noise impacts and details when projects may require review and possible mitigation measures. This guidance document states that sound pressure levels be measured on the A-weighted decibel scale dB(A) which is weighted towards those portions of the frequency spectrum, between 20 and 20,000 Hertz, to which the human ear is most sensitive. NYSDEC Guidance states that the goal for any new operation should ideally not exceed existing ambient noise levels by more than 6 dBA at the receptor. A Sound Pressure Level (SPL) increase of 10 dBA, which results in a perceived doubling of loudness, "deserves consideration of avoidance and/or mitigation measures in most cases."

The guidance also states that SPL increases ranging from 0 to 3 dBA should have no appreciable effect on receptors. Furthermore, the addition of any new noise generating equipment in a non-industrial (e.g., residential) setting should not raise the ambient noise level above a maximum of 65 dBA, which is the level that allows for undisturbed speech at a distance of approximately three feet.

3.0 EXISTING SOUND MONITORING SURVEY

3.1 Sound-Level Monitoring

Existing sound levels were measured at six locations in the vicinity of the Proposed Substation on August 11, 2021 during both daytime (7 AM – 10 PM) and nighttime (10 PM – 7 AM) periods. Existing sound sources potentially influencing the area and observed during sound monitoring activities were also noted.

The sound level measurements were obtained with a certified and calibrated Quest SoundPro DL-1-1/3 Sound Level Meter set to the "A-weighting" scale and "slow" measurement speed. A wind screen was used on the sound level meter during all readings. The wind speed and temperature were recorded at the beginning and end of each measurement period to ensure changing weather conditions did not impact sound level measurements. The noise-level meter was calibrated at hourly intervals as well as at the beginning and end of the sound level monitoring during the survey.

3.2 Sound Monitoring Locations

The sound monitoring locations are shown in **Figure 3-1**. These sound monitoring locations were selected to document the existing ambient total sound levels at the nearest property boundaries of the Site, as well as existing total sound levels along Sunrise Highway to the southeast of the Proposed Substation.

3.3 Sound-level Measurements (A-weighted)

A summary of the sound monitoring data is presented in **Table 3-1** below. This table lists the range of total sound levels at each of the six monitoring locations during the daytime and nighttime periods. The observed daytime total sound levels varied from 54 dBA to 66 dBA, and the nighttime sound levels varied from 51 dBA to 63 dBA. Reported total sound levels are the highest regularly occurring sound levels observed from sound sources in the area.

The major sound-level influences in the vicinity of the Proposed Substation property were from local vehicular roadway traffic, particularly along Hicksville Road and Sunrise Highway, as well as minor contributions from non-anthropogenic sources such as insects and wind rustling leaves. Overhead air traffic also contributed to the noise environment for several monitoring locations. Vehicular traffic on Brooklyn Avenue, and train traffic along the Long Island Railroad also provided irregular, significant increases in noise levels which were excluded from total sound results.

TABLE 3-1
SOUND-LEVEL MEASUREMENT DATA SUMMARY

MONITORING LOCATION ID	MONITORING LOCATION DESCRIPTION	DAYTIME MEASURED TOTAL SOUND LEVELS (dBA)	NIGHTTIME MEASURED TOTAL SOUND LEVELS (dBA)
1	Adjacent to 49 Brooklyn Avenue (Northern Perimeter of the Site)	62	53
2	Adjacent to 44 Brooklyn Avenue (Northwest corner of the Site	55	51
3	Adjacent to 50 Brooklyn Avenue (Eastern Perimeter of the Site)	56	53
4	Adjacent to 501 Hicksville Road	62	60
5	Adjacent to 55 New York Avenue	54	51
6	Town of Oyster Bay Parking Lot at intersection of Hicksville Road and Sunrise Highway	66	63

NOTES:
Sound-level measurement data was collected on 08/11/2021.
Reported data are the highest regularly occurring sound levels. Highest regularly occurring sound is defined as the highest reading in a range of non-extraneous sounds collected at each location.

Legend

Noise Monitoring Location

Proposed Substation Boundary

Sources:
Esri, StreetMap USA, 2012
Esri, World Imagery, 2020

PS&S
3 MOUNTAINVIEW ROAD
WARREN, NEW JERSEY 07059
PHONE: (732) 560-9700

NOISE MONITORING LOCATION MAP
PSEG Long Island
Brooklyn Avenue Substation Project
Massapequa, Nassau County, New York

Drawn By: ML	Scale: 1" = 150'	Project No. 01315.0833
Chk'd By: ES	Date: 9/1/2021	Figure No. 3-1

Path: P:\01315\0833\DWGs\Y-GIS\Maps\Fig03-1_NoiseMonitoring_20210830_00.mxd

4.0 SOUND MODELING

4.1 Proposed Equipment

The new sound-generation substation equipment consists of three (3) 33 MVA 33/16.8kV transformer banks (Banks #1, #2, and #3), three proposed switchgear enclosures, each equipped with one 12,000 BTU, 5 kW Packaged Terminal Air Conditioner (PTAC unit), and one (1) proposed battery enclosure equipped with one 12,000 BTU, 5 kW PTAC unit.

The proposed layout of the Site after completion of the Proposed Substation is included as **Appendix B.**

4.2 Sound Sources – Assumptions and Model Inputs

The sound propagation modeling performed for this assessment conservatively assumes that:

- All of the above-specified equipment is installed;
- The noise-generating equipment will be operating at full load with all fans in operation.

Transformers

The proposed transformer banks for the Proposed Substation are Pennsylvania Transformer Technology, Inc. LTC Transformers, which are rated for 33MVA, 33/16.8 kV.

Based on manufacturer specifications, each transformer will produce sound levels of 47 dBA at a distance of 50 feet from the source. Manufacturer specifications for the proposed transformer banks are included in **Appendix C**.

All transformers are modeled as operating under “full load” conditions with all cooling fans in operation. Full load conditions are expected to occur only occasionally, during the hot summer season.

PTAC Units

The proposed PTAC Units for the switchgear enclosures and battery enclosure are Trane Model PTEF 1201HAA PTAC Air Conditioner and Heat-pump units, which are rated for 12,000 BTU, 5kW.

Based on manufacturer specifications each PTAC Unit will produce sound levels of 44 dBA at a distance of 50 feet from the source. Manufacturer specifications for the proposed PTAC Units are included in **Appendix C**.

Existing Total Sound Levels

The locations of the proposed transformer banks, substation structures equipped with the PTAC units, the existing off-site structures, and the sound monitoring locations used in the computer sound propagation modeling, are depicted on **Figure 4-1**.

Existing total sound levels were measured around the Proposed Substation property, as reported in Section 3. Existing sound sources can have an additive effect on total sound levels, following completion of the Proposed Substation.

4.3 Sound Impact Modeling

Sound-level contributions from the equipment were predicted using SoundPLAN Essential (V. 5.0) three-dimensional acoustic propagation model software (Braunstein and Berndt, GmbH/SoundPLAN LLC, 2019). The SoundPLAN industrial noise type option was used for the sound modeling calculations.

The SoundPLAN software allows for calculation of sound from multiple sound sources at multiple receivers while accounting for specific Proposed Substation property sound radiation patterns and propagation effects of structures. The sound sources are identified in the propagation modeling with x and y coordinates and a relative height above terrain. The Proposed Substation equipment identified in this assessment was modeled as point sources and digitized in a geo-referenced coordinate system based on Proposed Substation property plan dimensions. The model receptors are also identified with three-dimensional x, y, and z coordinates. Model receptors were located along the nearest property boundaries at an average ear level height of 1.5 meters above ground level in accordance with applicable modeling guidance. The projected sound-level changes were then compared to NYSDEC Noise Policy Guidelines.

In addition to the proposed noise sources, existing noise sources, specific site conditions, and equipment layout can influence sound propagation, as described below.

Elevation

SoundPLAN software uses a digital ground model (based on elevation contours). Existing ground elevations for the immediately surrounding properties for the Proposed Substation property were used in the modeling, based on data incorporated from Google Earth. No change in the existing ground elevations were assumed under the build condition for the modeling.

Buildings

Existing buildings were digitized from Google Earth, while PSEG Long Island-provided Site plans and proposed dimensions that were included in the model calculations (i.e., calculation of diffraction around buildings).

Structure Reflections

Structures may modify the noise radiation patterns of equipment. The SoundPLAN software includes calculations to account for potential sound amplification from reverberation/reflection off the exterior surfaces of the existing and proposed structures based on the structure's facade. A reflection loss coefficient is assigned to each building or structure based on the material of the facade. All structures were conservatively modeled as "minimally absorbent" (default reflection loss of 1 dB).

4.4 Modeling Results (Projected A-weighted Sound Pressure Levels)

A summary of the projected (modeled) cumulative equipment sound levels at the modeling locations is presented in **Table 4-1** below. Modeled sound levels include the effects of both existing (ambient) total sound levels and sound sources from the Proposed Substation.

The full load sound level around the Proposed Substation was modeled to be no greater than 54 dBA at the nearest residential property lines, and no greater than 62 dBA at the property line closest to the Proposed Substation.

TABLE 4-1 SUMMARY OF MODELED FULL LOAD FUTURE SOUND-LEVELS GENERATED BY PROPOSED SUBSTATION AT SELECTED PROPERTY BOUNDARIES					
RECEPTOR NO.	**RECEPTOR LOCATION**	**DAYTIME TOTAL SOUND LEVELS WITH ALL EQUIPMENT OPERATING AT FULL LOAD (dBA)**	**DAYTIME MEASURED AMBIENT TOTAL SOUND LEVELS (dBA)**	**NIGHTTIME TOTAL SOUND LEVELS WITH ALL EQUIPMENT OPERATING AT FULL LOAD (dBA)**	**NIGHTTIME MEASURED AMBIENT TOTAL SOUND LEVELS (dBA)**
1	Adjacent to 49 Brooklyn Avenue (Northern Perimeter of the Site)	62	62	53	53
2	Adjacent to 44 Brooklyn Avenue (Northwest corner of the Site	55	55	51	51
3	Adjacent to 50 Brooklyn Avenue (Eastern Perimeter of the Site)	56	56	54	53
4	Adjacent to 501 Hicksville Road	62	62	60	60
5	Adjacent to 55 New York Avenue	54	54	51	51
6	Town of Oyster Bay Parking Lot at intersection of Hicksville Road and Sunrise Highway	66	66	63	63

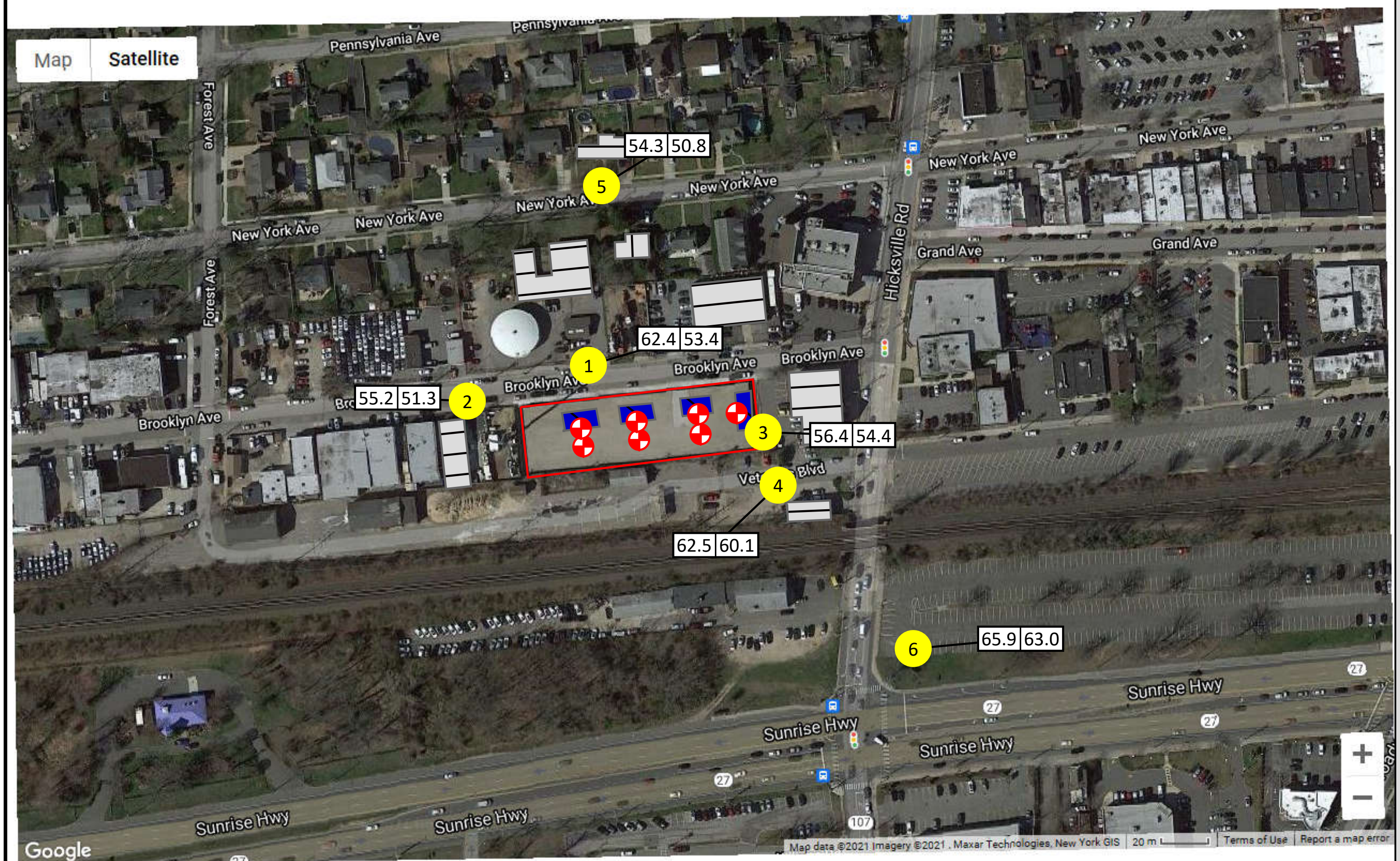


Figure 4-1

PSEG Long Island
Brooklyn Ave Substation

MODELED FULL LOAD FUTURE SOUND LEVELS WITH ALL NEW SUBSTATION NOISE GENERATING EQUIPMENT OPERATING AT MAXIMUM CAPACITY

The Substation was modeled based on the Plot Plan and Equipment Specs provided by PSEGLI.

Substation Sound Sources:
-Three (3) 33 MVA 33/16.8kV Transformers at 47.0 dB each; and
-Four (4) PTAC Units at 44.0 dB, each

Signs and symbols

Property Boundary
New Substation Building
Existing Building
Receiver
Point source

Level tables

Modeled Sound Levels (Day/Night)

1 : 2985

0 15 30 60 90 120 m

5.0 SUMMARY AND CONCLUSIONS

The sound propagation modeling results indicate that the projected noise levels will be no greater than 54 dBA at the nearest residential property lines (Location 5), and no greater than 62 dBA at the property lines closest to the Proposed Substation (Locations 1 and 4).

As the modeling demonstrates, total sound levels at the subject property lines following the completion of the Proposed Substation would not increase more than 1 dB beyond existing total sound levels. The net increases in total sound levels above ambient sound levels are depicted on **Figure 5-1.** NYSDEC Noise Policy Guidelines state that increases ranging from 0-3 dB should have no appreciable effect on receptors.

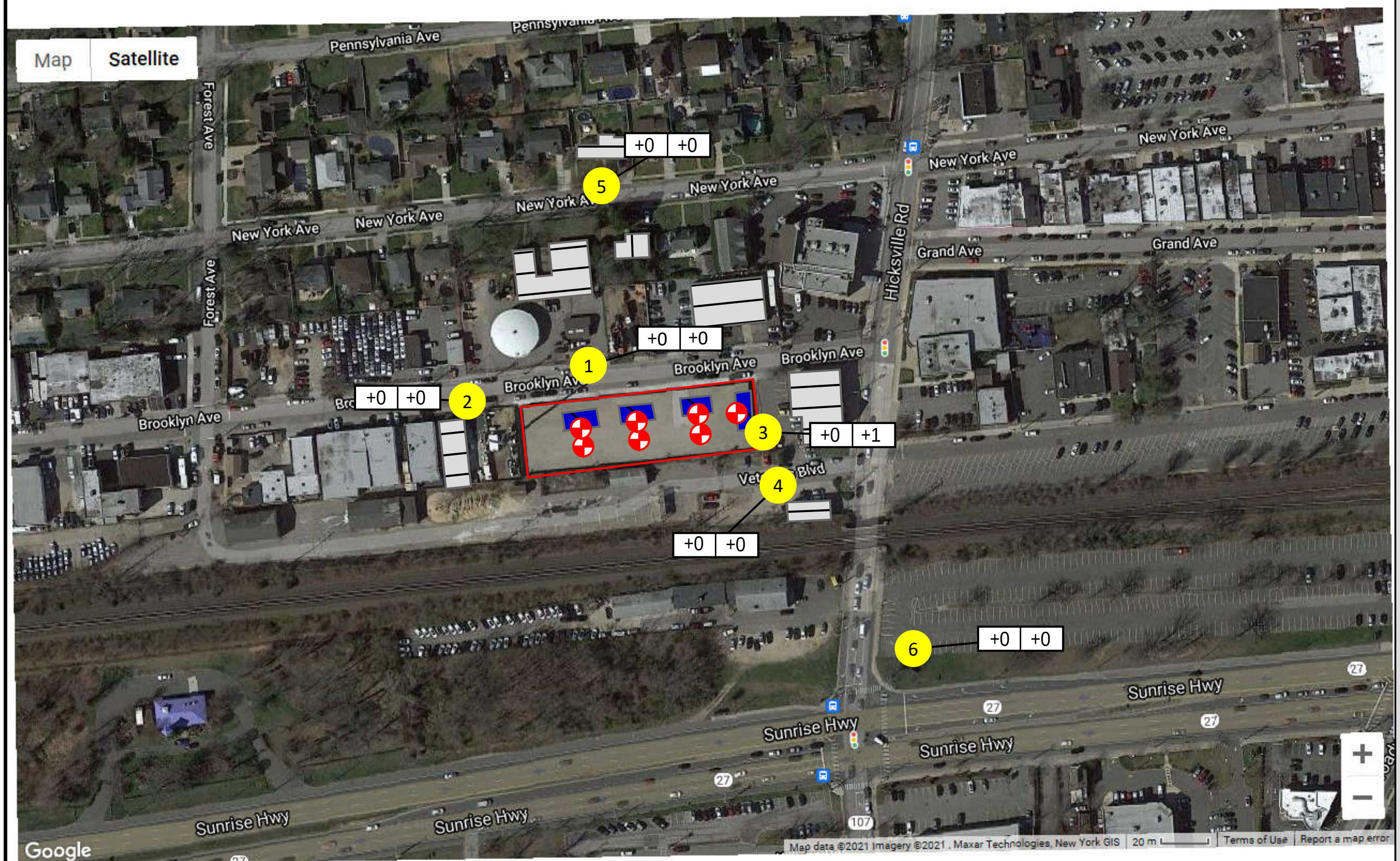


Figure 5-1

PSEG Long Island
Brooklyn Ave Substation

NET INCREASE FROM AMBIENT SOUND LEVELS WITH ALL NEW SUBSTATION NOISE GENERATING EQUIPMENT OPERATING AT MAXIMUM CAPACITY

The Substation was modeled based on the Plot Plan and Equipment Specs provided by PSEGLI.

Substation Sound Sources:
-Three (3) 33 MVA 33/16.8kV Transformers at 47.0 dB each; and
-Four (4) PTAC Units at 44.0 dB, each

Signs and symbols

Property Boundary
New Substation Building
Existing Building
Receiver
Point source

Level tables

Net dBA Increase from Ambient Levels (Day/Night)

1 : 2985

0 15 30 60 90 120 m

PS&S

6.0 REFERENCES

Braunstein and Berndt. SoundPLAN Essential Version 5.0. Braunstein and Berndt GmbH/ SoundPLAN LLC, May 2019.

New York State Department of Environmental Conservation (NYSDEC). Assessing and Mitigating Noise Impacts. Department ID: DEP-00-1. Office of Environmental Permits. October 6, 2000, Revised February 2, 2001.

APPENDIX A

NYSDEC Noise Policy Guidance

Assessing and Mitigating Noise Impacts

New York State
Department of Environmental Conservation

PROGRAM POLICY	**Department ID: DEP-00-1**	**Program ID: n/a**
Issuing Authority: Environmental Conservation Law Articles 3, 8, 23, 27 Name: Jeffrey Sama Title: Director Signature: /S/ Date: 10/6/00	**Originating Unit: Division of Environmental Permits** Office/Division: Environmental Permits Unit: Phone: (518) 402-9167	
Issuance Date: October 6, 2000 Revised: February 2, 2001	Latest Review Date (Office Use):	

Abstract: Facility operations regulated by the Department of Environmental Conservation located in close proximity to other land uses can produce sound that creates significant noise impacts for proximal sound receptors. This policy and guidance presents noise impact assessment methods, examines the circumstances under which sound creates significant noise impacts, and identifies avoidance and mitigative measures to reduce or eliminate noise impacts.

Related References: See references pages 27 and 28.

I. PURPOSE[1]

This policy is intended to provide direction to the staff of the Department of Environmental Conservation for the evaluation of sound levels and characteristics (such as pitch and duration) generated from proposed or existing facilities. This guidance also serves to identify when noise levels may cause a significant environmental impact and gives methods for noise impact assessment, avoidance, and reduction measures. These methods can serve as a reference to applicants preparing environmental assessments in support of an application for a permit. Additionally, this guidance explains the Department's regulatory authority for undertaking noise evaluations and for imposing conditions for noise mitigation measures in the agency's approval

[1] A Program Policy Memorandum is designed to provide guidance and clarify program issues for Division staff to ensure compliance with statutory and regulatory requirements. It provides assistance to New York State Department of Environmental Conservation (DEC) staff and the regulated community in interpreting and applying regulations and statutes to assure that program uniformity is attained throughout the State. Nothing set forth in a Program Policy Memorandum prevents DEC staff from varying from that guidance as specific circumstances may dictate, provided the staff's actions comply with applicable statutory and regulatory requirements. As this guidance document is not a fixed rule, it does not create any enforceable right by any party using the Program Policy Memorandum.

of permits for various types of facilities pursuant to regulatory program regulations and the State Environmental Quality Review Act (SEQR).

II. BACKGROUND

Noise is defined as any loud, discordant or disagreeable sound or sounds. More commonly, in an environmental context, noise is defined simply as unwanted sound. Certain activities inherently produce sound levels or sound characteristics that have the potential to create noise. The sound generated by proposed or existing facilities may become noise due to land use surrounding the facility. When lands adjoining an existing or proposed facility contain residential, commercial, institutional or recreational uses that are proximal to the facility, noise is likely to be a matter of concern to residents or users of adjacent lands.

A. Sources of Noise Generation

The three major categories of noise sources associated with facilities are (1) fixed equipment or process operations; (2) mobile equipment or process operations; and (3) transport movements of products, raw material or waste. The fixed plant may include a very wide range of equipment including: generators; pumps; compressors; crushers of plastics, stone or metal; grinders; screens; conveyers; storage bins; or electrical equipment. Mobile operations may include: drilling; haulage; pug mills; mobile treatment units; and service operations. Transport movements may include truck traffic within the operation, loading and unloading trucks and movement in and out of the facility. Any or all of these activities may be in operation at any one time. Singular or multiple effects of sound generation from these operations may constitute a potential source of noise.

B. Potential for Adverse Impacts

Numerous environmental factors determine the level or perceptibility of sound at a given point of reception. These factors include: distance from the source of sound to receptor; surrounding terrain; ambient sound level; time of day; wind direction; temperature gradient; and relative humidity. The characteristics of a sound are also important determining factors for considering it as noise. The amplitude (loudness), frequency (pitch), impulse patterns and duration of sound all affect the potential for a sound to be a noise. The combination of sound characteristics, environmental factors and the physical and mental sensitivity of a receptor to a sound determine whether or not a sound will be perceived as a noise. This guidance uses these factors in assessing the presence of noise and the significance of its impacts. It relies upon qualitative and quantitative sound evaluation techniques and sound pressure level impact modeling presented in accepted references on the subject.

C. Mitigation

Mitigation refers to actions that will be taken to reduce the effects of noise or the noise levels on a receptor. Adverse noise effects generated by a facility can be avoided or reduced at the point of generation thereby diminishing the effects of the noise at the point of reception. This guidance identifies various mitigation techniques and their proper application either at the source of noise generation or on a facility's property. Alternative construction or operational methods, equipment maintenance, selection of alternative equipment, physical barriers, siting of activities, set backs, and established hours of construction or operation, are among the techniques that can successfully avoid or reduce adverse noise effects.

D. Decision Making

When an assessment of the potential for adverse noise impacts indicates the need for noise mitigation, it is preferred that specifications for such measures be incorporated in a noise analysis and in the applicant's work or operational plan necessary for a complete application. Presenting a plan that incorporates effective noise mitigation provisions facilitates the Department's technical and environmental review and minimizes or negates the imposition of permit conditions by the Department. Adherence to these plans becomes a condition of a permit.

Noise avoidance and mitigation measures may also be imposed directly as conditions of permit issuance. This guidance will review the statutory authority under which the Department can require the mitigation of noise effects.

III. POLICY

In the review of an application for a permit, the Department of Environmental Conservation is to evaluate the potential for adverse impacts of sound generated and emanating to receptors outside of the facility or property. When a sound level evaluation indicates that receptors may experience sound levels or characteristics that produce significant noise impacts or impairment of property use, the Department is to require the permittee or applicant to employ reasonable and necessary measures to either eliminate or mitigate adverse noise effects. Options to be used to fulfill this guidance should be implemented within the existing regulatory and environmental review framework of the agency.

Regulatory authority for assessing and controlling noise effects are contained in both SEQR and specific Department program regulations. Specific regulatory references are as follows:

Section 3-0301(1)(i) of the Environmental Conservation Law (ECL) states that the commissioner shall have the power to: "i. Provide for prevention and abatement of all water, land and air pollution including but not limited to that related to particulates, gases, dust, vapors, noise, radiation, odor, nutrients and heated liquids."

To comply with Article 8 of the ECL and 6 NYCRR Part 617, State Environmental Quality Review Act, consideration of all relevant environmental issues must be undertaken in making a determination of environmental significance. Noise impact potential is one of many potential issues for consideration in a SEQR review.

Environmental Conservation Law (ECL) Article 23, Title 27, Mined Land Reclamation Law (MLRL), requires applicants for permits to prepare and submit a mined land use plan to the Department for approval. The plan must describe, "the applicant's mining method and measures to be taken to minimize adverse environmental impacts resulting from the mining operation." The provisions to be incorporated in a Mined Land Use Plan, as specified in 6 NYCRR Section 422.2, include the control of noise as a component of the plan.

The solid waste regulations at 6 NYCRR Subdivision 360-1.14(p), establish A-weighted decibel levels that are not to be exceeded at the property line of a facility.

The Division of Air Resources has regulations in 6 NYCRR Parts 450 through 454 that regulate the allowable sound level limits on certain motor vehicles. The statutory authority for these regulations is found in the New York State Vehicle and Traffic Law, Article 10, Section 386.

This guidance does not supercede any local noise ordinances or regulations.

IV. RESPONSIBILITY

The environmental analyst, acting as project manager for the review of applications for permits or permit modifications and working in concert with the program specialist, is responsible for ensuring that sound generation and noise emanating from proposed or existing facilities are properly evaluated. For new permits or significantly modified permits, there should be a determination as to the potential for noise impacts, and establishment of the requirements for noise impact assessment to be included in the application for permit. Where the Department is lead agency, the analyst is responsible for making a determination of significance pursuant to SEQR with respect to potential noise impacts and include documentation for such determination.

Where impacts are to be avoided or reduced through mitigation measures, the analyst, or where there are program requirements to address noise, the program specialist, should determine the effectiveness and feasibility of those measures and ensure that the permit conditions contain specific details for such measures. It should also be determined if additional measures to control noise are to be imposed as a condition of permitting. Appropriate permit language for the permit conditions should be developed by the program specialist and the analyst. The results of noise impact evaluations and the effectiveness of mitigation measures shall be incorporated into SEQR documents and, where necessary, permit conditions shall be placed in final permits to ensure effective noise control.

When it is determined that potential noise effects, as well as other issues, warrant evaluation of impacts and mitigation measures in a Draft Environmental Impact Statement (EIS) prepared pursuant to SEQR, the environmental analyst with the Division of Environmental Permits assumes responsibility for determining the level of evaluation needed to assess sound level generation, noise effects, and mitigation needs and feasibility.

For existing facilities, the program specialist will determine the need for additional mitigation measures to control noise effects either in response to complaints or other changes in circumstances such as new noise from existing facilities or a change in land-use proximal to the facility.

The applicant or their agent, in preparing an application for a permit and supporting documentation, is responsible for assessing the potential noise impacts on area receptors. When potential adverse noise impacts are identified, the applicant should incorporate noise avoidance and reduction measures in the construction or operating plans. The applicant's submittal should also assess the effectiveness of proposed mitigation measures in eliminating adverse noise reception. Where noise effects are determined to be a reason in support of a SEQR positive declaration, the applicant shall assess noise impacts, avoidance, and mitigation measures in a Draft EIS using methodologies acceptable to this Department.

V. PROCEDURE

The intent of this section is to: introduce terms related to noise analyses; describe some of the various methods used to determine the impacts of sound pressure levels on receptors; identify some of the various attenuators of noise; and list some of the mitigative techniques that can be used to reduce the effects of noise on a receptor. At the end of the section three levels of analysis are described. The first level determines the potential for adverse noise impacts based on noise characteristics and sound pressure increases solely on noise attenuation over distance between the source and receptor of the noise. The second level factors other considerations such as topography and noise abatement measures in determining if adverse noise impacts will occur. The third level evaluates noise abatement alternatives and their effectiveness in avoiding or reducing noise impacts.

The environmental effects of sound and human perceptions of sound can be described in terms of four characteristics:

1. Sound Pressure Level (SPL may also be designated by the symbol L_p) or perceived loudness is expressed in decibels (dB) or A-weighted decibel scale dB(A) which is weighted towards those portions of the frequency spectrum, between 20 and 20,000 Hertz, to which the human ear is most sensitive. Both measure sound pressure in the atmosphere.
2. Frequency (perceived as pitch), the rate at which a sound source vibrates or makes the air vibrate.
3. Duration i.e., recurring fluctuation in sound pressure or tone at an interval; sharp or startling noise at recurring interval; the temporal nature (continuous vs. intermittent) of sound.
4. Pure tone which is comprised of a single frequency. Pure tones are relatively rare in nature but, if they do occur, they can be extremely annoying.

Another term, related to the average of the sound energy over time, is the Equivalent Sound Level or $L_{eq.}$ The L_{eq} integrates fluctuating sound levels over a period of time to express them as a steady state sound level. As an example, if two sounds are measured and one sound has twice the energy but lasts half as long, the two sounds would be characterized as having the same equivalent sound level. Equivalent Sound Level is considered to be directly related to the effects of sound on people since it expresses the equivalent magnitude of the sound as a function of frequency of occurrence and time. By its derivation L_{eq} does not express the maximum nor minimum SPLs that may occur in a given time period. These maximum and minimum SPLs should be given in the noise analysis. The time interval over which the L_{eq} is measured should always be given. It is generally shown as a parenthetic; $L_{eq\ (8)}$ would indicate that the sound had been measured for a period of eight hours.

Equivalent Sound Level (L_{eq}) correlates well and can be combined with other types of noise analyses such as Composite Noise Rating, Community Noise Equivalent Level and day-night noise levels characterized by L_{dn} where an $L_{eq(24)}$ is measured and 10 dBA is added to all noise levels measured between 10 pm and 7 am. These different types of noise analyses basically combine noise measurements into measures of cumulative noise exposure and may weight noise occurring at different times by adding decibels to the actual decibel level. Some of these analyses require more complex noise analysis than is mentioned in this guidance. They may be used in a noise analyses prepared for projects.

Designations for sound levels may also be shown as $L_{(10)}$ or $L_{(90)}$ in a noise analysis. These designations refer to the sound pressure level (SPL) that is exceeded for 10% of the time over which the sound is measured, in the case of $L_{(10)}$, and 90% of the time, in the case of $L_{(90)}$. For example, an $L_{(90)}$ of 70 dB(A) means that 70 dB(A) is exceeded for 90% the time for which the measurement was taken.

A. Environmental Setting and Effects on Noise Levels

1. Sound Level Reduction Over Distance - It is important to have an understanding of the way noise decreases with distance. The decrease in sound level from any single noise source normally follows the “inverse square law.” That is, SPL changes in inverse proportion to the square of the distance from the sound source. At distances greater than 50 feet from a sound source, every doubling of the distance produces a 6 dB reduction in the sound. Therefore, a sound level of 70 dB at 50 feet would have a sound level of approximately 64 dB at 100 feet. At 200 feet sound from the same source would be perceived at a level of approximately 58 dB.

2. Additive Effects of Multiple Sound Sources - The total sound pressure created by multiple sound sources does not create a mathematical additive effect. Below Table A is given to assist you in calculating combined noise sources. For instance, two proximal noise sources that are 70 dBA each do not have a combined noise level of 140 dBA. In this case the combined noise level is 73 dBA. Since the difference between the two sound levels is 0 dB, Table A tells us to add 3 dB to the sound level to compensate for the additive effects of the sound. To find the cumulative SPL assess the SPLs starting with the two lowest readings and work up to the difference between the two highest readings. For several pieces of equipment, operating at one

time, calculate the difference first between the two lowest SPLs, check Table A and add the appropriate number of decibels to the higher of the two sound levels. Next, take the sound level that was calculated using Table A and subtract the next lowest sound level to be considered for the operation. Consult Table A again for the additive effect and add this to the higher of the two sound levels. Follow this process until all the sound levels are accounted for. As an example, let us say that an area for a new facility is being cleared. The equipment to be used is: two chainsaws, one operating at 57 dBA and one at 60 dBA; a front end loader at 80 dBA; and a truck at 78 dBA. Start with the two lowest sound levels: 60 dBA - 57 dBA = 3 dBA difference. Consulting the chart add 2 dBA to the higher sound level. The cumulative SPL of the two chainsaws is 62 dBA. Next, subtract 62 dBA from 78 dBA. 78 dBA - 62 dBA = 16 dBA. In this case, 0 dBA is added to the higher level so we end up with 78 dBA. Lastly, subtract 78 dBA from the 80 dBA. 80 dBA - 78 dBA = 2 dBA a difference of 2 dBA adds 2 dBA to the higher SPL or 82 dBA. The SPL from these four pieces of equipment operating simultaneously is 82 dBA.

Table A

Approximate Addition of Sound Levels

Difference Between Two Sound Levels	Add to the Higher of the Two Sound Levels
1 dB or less	3 dB
2 to 3 dB	2 dB
4 to 9 dB	1 dB
10 dB or more	0 dB

(USEPA, Protective Noise Levels, 1978)

3. Temperature and Humidity - Sound energy is absorbed in the air as a function of temperature, humidity and the frequency of the sound. This attenuation can be up to 2 dB over 1,000 feet. Such attenuation is short term and, since it occurs over a great distance, should not be considered in calculations. Higher temperatures tend to increase sound velocity but does

not have an effect on the SPL. Sound waves bend towards cooler temperatures. Temperature inversions may cause temporary problems when cooler air is next to the earth allowing for more distant propagation of sound. Similarly, sound waves will bend towards water when it is cooler than the air and bounce along the highly reflective surface. Consequently large water bodies between the sound source and the receptor may affect noise attenuation over distance.

4. Time of Year - Summer time noises have the greatest potential for causing annoyance because of open windows, outside activities, etc. During the winter people tend to spend more time indoors and have the windows closed. In general, building walls and windows that are closed provide a 15 dB reduction in noise levels. Building walls with the windows open allow for only a 5 dB reduction in SPL.

5. Wind - Wind can further reduce the sound heard at a distance if the receptor is upwind of the sound. The action of the wind disperses the sound waves reducing the SPLs upwind. While it is true that sound levels upwind of a noise source will be reduced, receptors downwind of a noise source will not realize an increase in sound level over that experienced at the same distance without a wind. This dispels the common belief that sound levels are increased downwind due to wind carrying noise.

6. Land forms and structures - In certain circumstances, sound levels can be accentuated or focused by certain features to cause adverse noise impacts at specified locations. At a hard rock mine, curved quarry walls may have the potential to cause an amphitheater effect while straight cliffs and quarry walls may cause an echo. Buildings that line streets in cities can cause a canyon effect where sound can be reflected from the building surfaces similar to what might happen in a canyon. Consideration of noise impacts associated with these types of conditions may require specialized expertise to evaluate impact potential and to formulate suitable mitigation techniques.

Consideration of existing noise sources and sound receptors in proximity to a proposed activity can be important considerations even when the activity under review is not a noise source. Topography, vegetation, structures and the relative location of noise receptors and sources to these features are all aspects of the environmental setting that can influence noise impact potential. As such, land alteration may also indirectly create an adverse noise impact where natural land features or manmade features serve as a noise barrier or provide noise attenuation for existing sources of noise, i.e. highway, railroads, manufacturing activity. Removal of these features, i.e. hills, vegetation, large structures or walls, can expose receptors to increased sound pressure levels causing noise problems where none had previously existed.

B. Impact Assessment

1. Factors to Consider

Factors to consider in determining the impact of noise on humans, are as follows:

a. Evaluation of Sound Characteristics

(1) Ambient noise level - A noise can only intrude if it differs in character or SPL from the normal ambient sound. Most objective attempts to assess nuisance noise adopt the technique of comparing the noise with actual ambient sound levels or with some derived criterion.

(2) Future noise level - The ambient noise level plus the noise level from the new or proposed source.

(3) Increase In Sound Pressure Level - A significant factor in determining the annoyance of a noise is Sound Pressure Level (SPL). SPLs are measured in decibels.

(4) Sharp and Startling Noise - These high frequency and high intensity noises can be extremely annoying. When initially evaluating the effects

of noise from an operation, pay particular attention to noises that can be particularly annoying. One such noise is the back-up beepers required to be used on machinery. They definitely catch one's attention as they were meant to do. Continual beeping by machinery can be mitigated (see Section V.C. Mitigation - Best Management Practices). Another impulse noise source that can be very annoying is the exhaust from compressed air machinery. This exhaust is usually released in loud bursts. Compressed air exhaust can also be mitigated if it causes a noise problem by using readily available mufflers or specifically designed enclosures.

(5) Frequency and Tone - Frequency is the rate at which a sound source vibrates or makes the air vibrate. Frequency is measured in Hertz (Hz). Frequency can also be classified as high ("sharp"), low ("dull"), and moderate. Pure tones are rare in nature. Tonal sounds usually consist of pure tones at several frequencies. Pure tones and tonal sounds are discerned more readily by the human ear. Pure tones and tonal sounds are compensated for in sound studies by adding a calculated number of dB(A) to the measured sound pressure.

(6) Percentile of Sound Levels - Fluctuations of SPLs can be expressed as a percentile level designated as $L_{(n)}$ where a given decibel level is exceeded *n* % of the time. A designation of $L_{(10)}$ = 70 dBA means the measured SPLs exceeded 70 dBA 10% of the time. A designation of $L_{(90)}$ = 70 dBA means the measured SPLs were exceeded 90% of the time. $L_{(90)}$ is often used to designate the background noise level.

(7) Expression of Overall Sound - Part of the overall assessment of sound is the *Equivalent Sound Level* (L_{eq}) which assigns a single value of sound level for a period of time in which varying levels of sound are experienced over that time period. The L_{eq} value provides an indication of the effects of sound on people. It is also useful in establishing the ambient sound levels at a potential noise source.

In order to evaluate the above factors in the appropriate context, one must identify the following: 1) appropriate receptor locations for sound level calculation or measurement; 2) ambient sound levels and characteristics at these receptor locations; and 3) the sound pressure increase and characteristics of the sound that represents a significant noise effect at a receptor location.

b. Receptor Locations

Appropriate receptor locations may be either at the property line of the parcel on which the facility is located or at the location of use or inhabitance on adjacent property. The solid waste regulations require the measurements of sound levels be at the property line. The most conservative approach utilizes the property line. The property line should be the point of reference when adjacent land use is proximal to the property line. Reference points at other locations on adjacent properties can be chosen after determining that existing property usage between the property line and the reference point would not be impaired by noise, i.e., property uses are relatively remote from the property line. The location of the facility should be shown on a map in relation to each potential receptor. Any future expansion should be described in a narrative as well as depicted on a map. The map and narrative should also include the distance of the operation to each point of reception including the distance at the point in time when an expanding operation will be closest to the receptors.

c. Thresholds for Significant Sound Pressure Level (SPL) Increase

The goal for any permitted operation should be to minimize increases in sound pressure level above ambient levels at the chosen point of sound reception. Increases ranging from 0-3 dB should have no appreciable effect on receptors. Increases from 3-6 dB may have potential for adverse noise impact only in cases where the most sensitive of receptors are present. Sound pressure increases of more than 6 dB may require a closer analysis of impact potential depending on existing SPLs and the character of surrounding land use and receptors. SPL increases approaching 10 dB result in a perceived doubling of SPL. The perceived doubling of the SPL results from the fact that SPLs are measured on a logarithmic scale. An increase of 10 dB(A) deserves consideration of avoidance and mitigation measures in most cases. The above thresholds as indicators of impact potential should be viewed as guidelines subject to adjustment as appropriate for the specific circumstances one encounters.

Establishing a maximum SPL at the point of reception can be an appropriate approach to addressing potential adverse noise impacts. Noise thresholds are established for solid waste management facilities in the Department's Solid Waste regulations, 6 NYCRR Part 360. Most humans find a sound level of 60 - 70 dB(A) as beginning to create a condition of significant noise effect (EPA 550/9-79-100, November 1978). In general, the EPA's "Protective Noise Levels" guidance found that ambient noise levels # 55 dBA $L_{(dn)}$ was sufficient to protect public health and welfare and, in most cases, did not create an annoyance (EPA 550/9-79-100, November 1978). In non-industrial settings the SPL should probably not exceed ambient noise by more than 6 dB(A) at the receptor. An increase of 6 dB(A) may cause complaints. There may be occasions where an increase in SPLs of greater than 6 dB(A) might be acceptable. The addition of any noise source, in a non-industrial setting, should not raise the ambient noise level above a maximum of 65 dB(A). This would be considered the "upper end" limit since 65 dB(A) allows for undisturbed speech at a distance of approximately three feet. Some outdoor activities can be conducted at a SPL of 65 dB(A). Still lower ambient noise levels may be necessary if there are sensitive receptors nearby. These goals can be attained by using the mitigative techniques outlined in this guidance.

Ambient noise SPLs in industrial or commercial areas may exceed 65 dB(A) with a high end of approximately 79 dB(A) (EPA 550/9-79-100, November 1979). In these instances mitigative measures utilizing best management practices should be used in an effort to ensure that a facility's generated sound levels are at a minimum. The goal in an industrial/commercial area, where ambient SPLs are already at a high level, should be not to exceed the ambient SPL. Remember, if a new source operates at the same noise level as the ambient, then 3 dB(A) must be added to the existing ambient noise level to obtain the future noise level. If the goal is not to raise the future noise levels the new facility would have to operate at 10 dB(A) or more lower than the ambient.(see Table A)

Table B

HUMAN REACTION TO INCREASES IN SOUND PRESSURE LEVEL

Increase in Sound Pressure (dB)	**Human Reaction**
Under 5	Unnoticed to tolerable
5 - 10	Intrusive
10 - 15	Very noticeable
15 - 20	Objectionable
Over 20	Very objectionable to intolerable

(Down and Stocks - 1978)

Impact assessment will vary for specific project reviews, but must consist of certain basic components for all assessments. Additional examination of sound generation and noise reception are necessary, where circumstances warrant. Sound impact evaluation is an incremental process, with four potential outcomes:

- exemption criteria are met and no noise evaluation is required;
- noise impacts are determined to be non-significant (after first-level evaluation);
- noise impacts are identified as a potential issue but can be readily mitigated (after second level evaluation); or
- noise impacts are identified as a significant issue requiring analysis of alternatives as well as mitigation (third level evaluation).

All levels of evaluation may require preparation of a noise analysis. The required scope of noise impact analysis can be rudimentary to rather sophisticated, depending on circumstances and the results obtained from initial levels of evaluation. Recommendations for each level of evaluation are presented below.

2. Situations in Which No Noise Evaluation is Necessary

When certain criteria are satisfied, the need for undertaking a noise impact analysis at any level is eliminated. These criteria are as follows:

a. The site is contained within an area in which local zoning provides for the intended use as a “right of use”. It does not apply to activities that are permissible only after an applicant is granted a special use permit by the local government; and

b. The applicant’s operational plan incorporates appropriate best management practices (BMPs [see Section V.C. Mitigation - Best Management Practices]) for noise control for all facets of the operation.

Where activities may be undertaken as a “right of use”, it is presumed that noise has been addressed in establishing the zoning. Any residual noise that is present following BMP implementation should be considered an inherent component of the activity that has been found acceptable in consideration of the zoning designation of the site.

3. First Level Noise Impact Evaluation

The initial evaluation for most facilities should determine the maximum amount of sound created at a single point in time by multiple activities for the proposed project. All facets of the construction and operation that produce noise should be included such as land clearing activities (chain saw and equipment operation), drilling, equipment operation for excavating, hauling or conveying materials, pile driving, steel work, material processing, product storage and removal. Land clearing and construction may be only temporary noise at the site whereas the ongoing operation of a facility would be considered permanent noise. An analysis may be required for various phases of the construction and operation of the project to assure that adverse noise effects do not occur at any phase.

To calculate the sound generated by equipment operation, one can consult the manufacturers' specifications for sound generation, available for various types of equipment. Another option for calculating the sound to be generated by equipment is to make actual measurements of sound generated by existing similar equipment, elsewhere.

Tables C and D summarize noise measurements from some common equipment used in construction and mining. Table E summarizes the noise level, in decibels (dB[A]), from some common sources. This information can be used to assist Department staff in relating potential noise impacts to sound levels produced by commercial and industrial activities. Use of these tables in the first level of analysis will help determine whether or not noise will be an issue and whether actual measurements should be made to confirm noise levels.

Table C

PROJECTED NOISE LEVELS

Noise Source	Measurements	1,000 feet	2,000 feet	3,000 feet
Primary and secondary crusher	89 dB(A) at 100 ft	69.0 dB(A)	63.0 dB(A)	59.5 dB(A)
Hitachi 501 shovel loading	92 dB(A) at 50 ft	66.0 dB(A)	60.0 dB(A)	56.5 dB(A)
Euclid R-50 pit truck loaded	90 dB(A) at 50 ft	64.0 dB(A)	58.0 dB(A)	54.4 dB(A)
Caterpillar 988 loader	80 dB(A) at 300 ft	69.5 dB(A)	63.5 dB(A)	60.0 dB(A)

(The Aggregate Handbook, 1991)

Table D
Common Equipment Sound Levels

EQUIPMENT	**DECIBEL LEVEL**	**DISTANCE** in feet
Augered earth drill	80	50
Backhoe	83-86	50
Cement mixer	63-71	50
Chain saw cutting trees	75-81	50
Compressor	67	50
Garbage Truck	71-83	50
Jackhammer	82	50
Paving breaker	82	50
Wood Chipper	89	50
Bulldozer	80	50
Grader	85	50
Truck	91	50
Generator	78	50
Rock drill	98	50

(excerpt and derived from Cowan, 1994)

Table E

Sound Source	dB(A)°	Response Criteria
	150	
Carrier Deck Jet Operation	140	
	130	Painfully Loud Limit Amplified Speech
Jet Takeoff (200 feet)	120	
Discotheque Auto Horn (3 feet) Riveting Machine	110	Maximum Vocal Effort
Jet Takeoff (2000 feet) Shout (0.5 feet)	100	
N.Y. Subway Station Heavy Truck (50 feet)	90	Very Annoying Hearing Damage (8 hours, continuous exposure)
Pneumatic Drill (50 feet)	80	Annoying
Freight Train (50 feet) Freeway Traffic (50 feet)	70	Telephone Use Difficult Intrusive
Air Conditioning Unit (20 feet)	60	
Light Auto Traffic (50 feet)	50	Quiet
Living Room Bedroom	40	
Library Soft Whisper (15 feet)	30	Very Quiet
Broadcasting Studio	20	
	10	Just Audible
	0	Threshold of Hearing

(The Aggregate Handbook, 1991)

The sound level at receptor locations should be calculated using the inverse square rule whereby sound is attenuated over distance. Again, each doubling of the distance from the source of a noise decreases the SPL by 6 dB(A) at distances greater than 50 feet. This calculation should first consider the straight line distance between the point of noise generation and the point of noise reception with the presumption that no natural or manmade features exist along the transect between the two points that would further attenuate sound level. Calculations should be performed for each point of reception in all directions being careful to evaluate the worst case noise impact potential by considering activities at the point where they would be closest to a receptor. The sound level calculated for the point of reception should be related to ambient sound levels. Ambient sound levels can be either measured or assumed based on established references for the environmental setting and land use at the point of reception. For estimation purposes, ambient SPLs will vary from approximately 35 dB(A) in a wilderness area to approximately 87 dB(A) in a highly industrial setting. A quiet seemingly serene setting such as rural farm land will be at the lower end of the scale at about 45 dB(A), whereas an urban industrial area will be at the high end of this scale at around 79 dB(A) (EPA 550/9-79-100, November 1978). If there is any concern that levels based on reference values do not accurately reflect ambient SPL, field measurements should be undertaken to determine ambient SPLs.

Where this evaluation indicates that sound levels at the point of reception will not be perceptible, similar to or only slightly elevated as compared to ambient conditions, no further evaluation is required. When there is an indication from this initial analysis that marginal or significant noise impact may occur, further evaluation is required. In determining the potential for an adverse noise impact, consider not only ambient noise levels, but also the existing land use, and whether or not an increased noise level or the introduction of a discernable sound, that is out of character with existing sounds, will be considered annoying or obtrusive. (see B.1.a Evaluation of Sound Characteristics)

4. Second Level Noise Impact Evaluation

Further refine the evaluation of noise impact potential by factoring in any additional noise attenuation that will be provided by existing natural topography, fabricated structures such as buildings, walls or berms or vegetation located between the point of noise generation and noise reception. This analysis may require consideration of future conditions and the loss of natural noise buffers over time.

Dense vegetation that is at least 100 feet in depth will reduce the sound levels by 3 to 7 dB(A). Evergreens provide a better vegetative screen than deciduous trees. Keep in mind that if a vegetative screen does not currently exist, planting a vegetative screen may require 15 or more years of growth before it becomes effective.

The degree to which topography attenuates noise depends on how close the feature is located to the source or the receptor of the noise. Topography can act as a natural screen. The closer a hill or other barrier is to the noise source or the receptor, the larger the sound shadow will be on the side opposite the noise source. Certain operations such as mining and landfills may be able to use topography to maintain a screen between the operation and receptors as they progress. Mining operations may be able to create screens by opening a mine in the center of the site using and maintaining the pit walls as barriers against sound (Aggregate Handbook, 1991).

If after taking into account all the attenuating features the potential still exists for adverse noise impact, other types of noise analyses or modeling should be used to characterize the source. An Equivalent Sound Level (L_{eq}) analysis or a related type of noise analysis may better define activities or sources that require more mitigation or isolation so that noise emanating from these sources will not cause an adverse impact.

Where it is demonstrated that noise absorbing or deflecting features further attenuate sound reception to a level of no significant increase, no further analysis is necessary. Where it is determined that noise level or the character of the noise may have a significant adverse effect on receptors, other noise mitigation measures should be evaluated in an expanded noise analysis.

5. Third Level - Mitigation Measures

When the above analyses indicate significant noise effects may or will occur, the applicant should evaluate options for implementation of mitigation measures that avoid, or diminish significant noise effects to acceptable levels (see Section V.C. Mitigation - Best Management Practices). Adequate details concerning mitigation measures and an evaluation of the effectiveness of the mitigative measures through additional sound level calculations should be provided in a noise analysis. These calculations are to factor in the noise reduction or avoidance capabilities of the mitigation measures. In circumstances where noise effects cannot readily be reduced to a level of no significance by project design or operational features in the application, the applicant must evaluate alternatives and mitigation measures in an environmental impact statement to avoid or reduce impacts to the maximum extent practicable per the requirements of the State Environmental Quality Review Act (SEQR).

The noise analysis should be part of the application or a supplement to it, and will be part of the SEQR environmental assessment by reference. Duplicative noise analysis information is not required for the permit application and the assessment of impacts under SEQR. A proper analysis can satisfy information needs for both purposes.

C. <u>Mitigation - Best Management Practices (BMP) for Reducing Noise</u>

Various noise abatement techniques are available for reducing frequency of sound, duration of sound or SPLs at receptor locations. The mitigation techniques given below are listed according to what sound characteristic they mitigate.

1. Reduce noise frequency and impulse noise at the source of generation by:

   a. Replacing back-up beepers on machinery with strobe lights (subject to other requirements, e.g., OSHA and Mine Safety and Health Administration, as applicable). This eliminates the most annoying impulse beeping;

   b. Using appropriate mufflers to reduce the frequency of sound on machinery that pulses, such as diesel engines and compressed air machinery;

   c. Changing equipment: using electric motors instead of compressed air driven machinery; using low speed fans in place of high speed fans;

   d. Modifying machinery to reduce noise by using plastic liners, flexible noise control covers, and dampening plates and pads on large sheet metal surfaces; and

2. Reduce noise duration by:

   a. Limiting the number of days of operation, restricting the hours of operation and specifying the time of day and hours of access and egress can abate noise impacts.

   b. Limiting noisier operations to normal work day hours may reduce or eliminate complaints.

   Limiting hours of construction or operation can be an effective tool in reducing potential adverse impacts of noise. The impacts of noise on receptors can be significantly reduced by effectively managing the hours at which the loudest of the operations can take place.

Implementation of hours of operation does not reduce the SPL emanating from a facility. Determining whether or not hours of operation will be effective, mitigation requires consideration of: public safety, for example road construction at night may reduce traffic concerns and facilitate work; duration of the activity, is it a one time event necessary to meet a short term goal or will the activity become an ongoing operation; and surrounding land use, consider what type(s) of land use is proximal to the activity and at what time(s) might a reduction of noise levels be necessary. There may be other factors to consider due to the uniqueness of a given activity or the type of land use adjacent to the activity. Hours of operation should also consider weekend activities and legal holidays that may change the types of land use adjacent to the permitted activity or increase traffic levels in an area.

The best results from using hours of operation as a mitigative measure will be obtained if the hours are negotiated with the owner or operator of the facility. The less noisy aspects of an operation may not have to be subject to the requirements of hours of operation such as preparing, greasing and maintaining machinery for the upcoming day's operation. The more noisy operations can be scheduled to begin when people in the receptor area are less likely to be adversely effected. Hours of operation should be included in the operation plans for a facility that becomes part of the permit, or in the event that there is no operation plan, can be included as a permit condition.

3. Reduce Noise sound pressure levels by:

   a. Increasing the setback distance.
   b. Moving processing equipment during operation further from receptors.
   c. Substituting quieter equipment (<u>example</u> - replacing compressed air fan with an electric fan could result in a 20 dB reduction of noise level).

d. Using mufflers selected to match the type of equipment and air or gas flow on mechanical equipment.
e. Ensuring that equipment is regularly maintained.
f. Enclosing processing equipment in buildings (example - enclosing noisy equipment could result in an 8-10 dB noise level reduction, a 9 inch brick wall can reduce SPL by 45-50 dB).
g. Erecting sound barriers such as screens or berms around the noise generating equipment or near the point of reception. The angle of deflection also increases as the height of a screen or barrier increases. Screens or barriers should be located as close to the noise source or the receptor as possible. The closer the barrier is located to the source or the receptor, the greater the angle of deflection of the sound waves will be creating a larger "sound shadow" on the side opposite the barrier. Stockpiles of raw material or finished product can be an effective sound barrier if strategically placed.
h. phasing operations to preserve natural barriers as long as possible.
i. altering the direction, size, proximity of expanding operations.
j. Designing enclosed facilities to prevent or minimize an SPL increases above ambient levels. This would require a noise analysis and building designed by a qualified engineer that includes adequate ventilation with noise abatement systems on the ventilation system.

Public notification of upcoming loud events can also be used as a form of mitigation although it doesn't fit easily into the categories above. People are less likely to get upset if they know of an upcoming event and know that it will be temporary.

The applicant should demonstrate that the specific mitigation measures proposed will be effective in preventing adverse noise effects on receptors.

D. Decision Making - Conditioning Permits to Limit Noise Impacts

Preferably, the mitigation measures as outlined in the construction and operational plans should be relied upon to mitigate the effects of noise on receptors. The permit should state that the activity will be conducted in accordance with the approved plan. Otherwise, mitigation measures and BMP's can be imposed within specific permit conditions.

It is not the intention of this guidance to require decibel limits to be established for operations where such limits are not required by regulation. There are, however, instances when a decibel limit may be established for an operation to ensure activities do not create unacceptable noise effects, as follows:

1. The review of a draft and final environmental impact statement demonstrates the need for imposition of a decibel limit;
2. A decibel limit is established by the Commissioner's findings after a public hearing has been held on an application;
3. The applicant asks to have a decibel limit to demonstrate the ability to comply; or
4. A program division seeks to establish a decibel limit as a permit condition, when necessary to demonstrate avoidance of unacceptable noise impact.

Ultimately, the final decision must incorporate appropriate measures to minimize or avoid significant noise impacts, as required under SEQR. Any unavoidable adverse effects must be weighed along with other social and economic considerations in deciding whether to approve or deny a permit.

REFERENCES

1) Cowan, James P., Handbook of Environmental Acoustics, Van Nostrand Reinhold, 1994.

2) Down, C.G. and Stocks, J.; Environmental Impact of Mining. Applied Science Publishers Ltd., ISBN 0853347166, 1978.

3) U.S. Dept of Transportation - Federal Highway Administration Office of Research and Development; Highway Noise-A Manual for Highway Noise and Land Use, Nov. 1974.

4) New York State Motor Vehicle Law, Chapter IV, Subchapter E, 450.2, Part 450, "Noise From Heavy Motor Vehicles," 200.701 CN, February 28, 1997.

5) Beranek, L.A. ed., Noise and Vibration Control. Cambridge, MA: Institute of Noise Control Engineering, 1971, pp. 164-174 and 182-191.

6) Barksdale, R.D., editor, 1991. The Aggregate Handbook: National Stone Association (Washington, DC), 1.V.

7) Norman, David K., Wampler , Peter J., Throop, Allen H., Schnitzer, E. Frank, and Roloff, J., 1996. "Best Management Practices for Reclaiming Surface Mines in Washington and Oregon." Oregon Dept. of Geology and Mineral Industries, Open File Report 0-96-2.

8) United States Environmental Protection Agency, Protective Noise Levels, Condensed Version of EPA Levels document, EPA 550/9-79-100, November 1978, Office of Noise Abatement & Control, Washington, D.C.

9) United States Environmental Protection Agency, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, EPA 550/9-74-004, March 1974, Office of Noise Abatement and Control, Washington, D.C.

10) City of Davis General Plan, Appendix E Background Information on Environmental Acoustics, November 1996.

11) The Australian National University, “Physics and Psychophysics of Music”, ACAT 1003, David Worrall, http://www.anu.edu.au/ITA/ACAT/drw/PPofM/Intensity2.html, 1998.

12) Danish Wind Turbine Manufacturers Association, Measuring and Calculating Sound Levels, November 18, 1997.

Additional Reading

a. Beranek, Leo L. and Istavan L. Ver, Noise and Vibration Control Engineering, John Wiley & Sons, Inc. New York, 1992.

b. Beranek, Leo L., Noise and Vibration Control, Institute of Noise Control Engineering, Revised Edition, Washington, C.C., 1988.

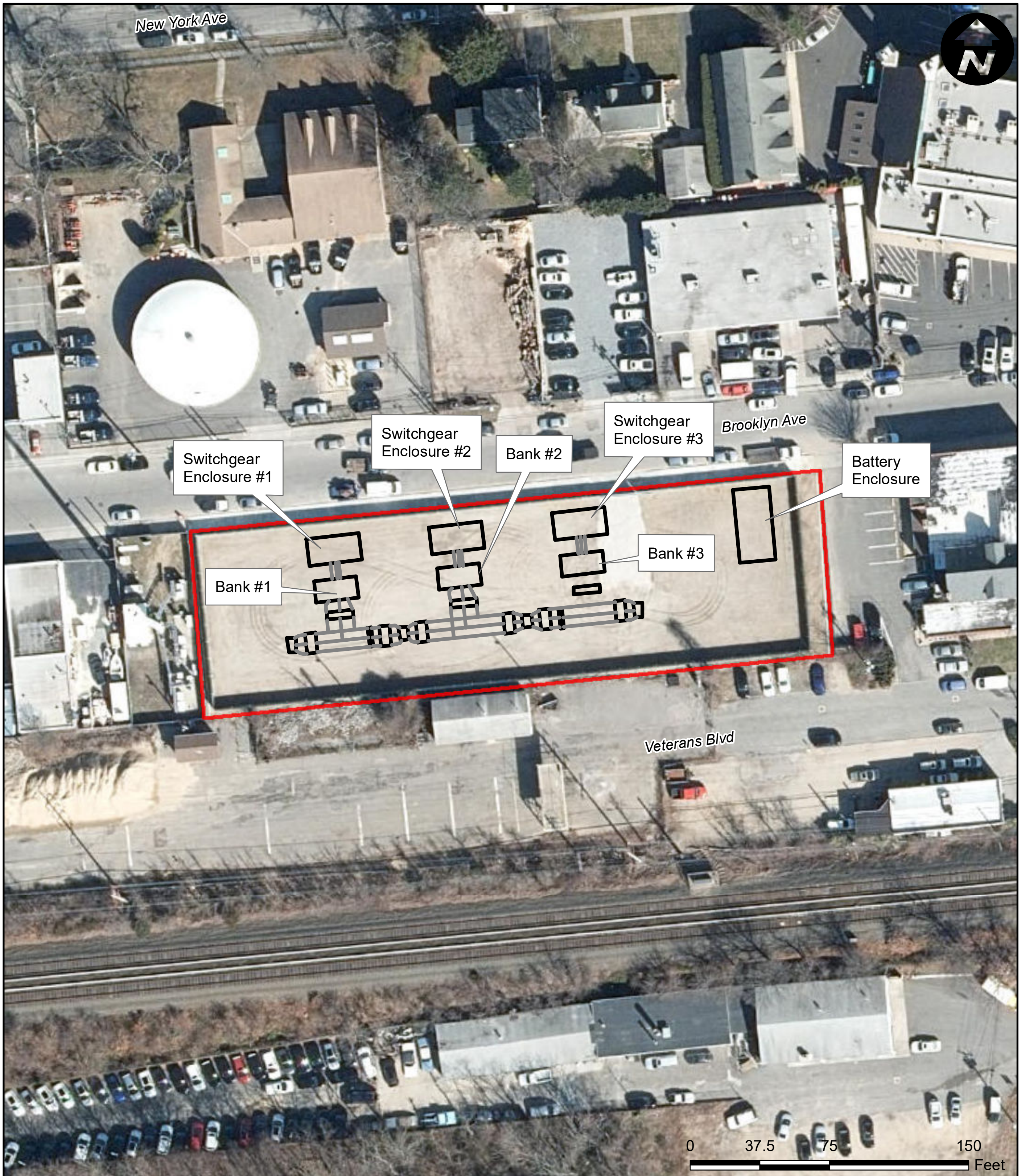
c. Diehl, George, M., Machinery Acoustics, John Wiley & Sons, New York, 1973.

d. Erwin, J.D., Graf, E. R., Industrial Noise and Vibration Control, Prentice Hall, Englewood Cliffs, New Jersey, 1979.

e. Jensen, Paul, et al, Industrial Noise Control Manual, U.S. Department of Health, Education and Welfare, Public Health Service, Cincinnati, 1978.

APPENDIX B

Proposed Site Layout



Legend

Proposed Site Limits

3 MOUNTAINVIEW ROAD
WARREN, NEW JERSEY 07059
PHONE: (732) 560-9700

PROPOSED SITE LAYOUT MAP

PSEG Long Island
Brooklyn Avenue Substation Project
Massapequa, Nassau County, New York

Sources:
Site Features extracted from PSE&G LI, Proposed Layout, Received July 15, 2021
Esri, StreetMap USA, 2012
Esri, World Imagery, 2020

Drawn By: DM	Scale: 1" = 75'	Project No. 01315.0833
Chk'd By: ES	Date: 10/8/2021	Figure No. 1

Path: P:\01315\0833\DWGs\Y-GIS\Maps\Fig01_ProposedSiteLayout_20211008_00.mxd

APPENDIX C

Manufacturer Specifications

PENNSYLVANIA TRANSFORMER TECHNOLOGY, INC.
30 Curry Ave., Box 440
Canonsburg, PA 15317

TRANSFORMER TEST REPORT

P.T.T.I. Spec: 20386 P.T.T.I. Order: C-09286-5

Customer: PSE&G LONG ISLAND Customer Order: 5000022911

SERIAL No. C-09286-5-4

% IMPEDANCE AND LOAD LOSS (WATTS)

Base MVA Results @ 85°C

Transformer connection (V)	Tap Pos.	MVA	% Impedance	Guar.	Watts	Guar.
70950 - 15180 Volts	A-16R	16.8	9.24		63824	
67650 - 15180 Volts	C-16R	16.8	9.41		66667	
64350 - 12420 Volts	E-16R	16.8	9.74		71274	
70950 - 13800 Volts	A-N	16.8	8.96		66563	
69300 - 13800 Volts	B-N	16.8	9.02		67464	
67650 - 13800 Volts	C-N	16.8	9.10	9.0	68088	76000
66000 - 13800 Volts	D-N	16.8	9.25		70527	
64350 - 13800 Volts	E-N	16.8	9.41		73008	
70950 - 12420 Volts	A-16L	15.12	8.04		62228	
67650 - 12420 Volts	C-16L	15.12	8.12		64457	
64350 - 12420 Volts	E-16L	15.12	8.32		66793	
64350 - 13713 Volts	E-1L	16.69	8.53		61193	
64350 - 13110 Volts	E-8L	15.96	8.91		70754	
64350 - 12592 Volts	E-14L	15.33	9.15		78929	
64350 - 12506 Volts	E-15L	15.22	9.19		80205	
64350 - 14490 Volts	E-8R	16.8	9.60		72077	

Top MVA Results @ 85°C

Transformer connection (V)	Tap Pos.	MVA	% Impedance	Guar.	Watts	Guar.
70950 - 15180 Volts	A-16R	33	18.15		245831	
67650 - 15180 Volts	C-16R	33	18.48		256806	
64350 - 12420 Volts	E-16R	33	19.12		274580	
70950 - 13800 Volts	A-N	33	17.60		256368	
69300 - 13800 Volts	B-N	33	17.71		259837	
67650 - 13800 Volts	C-N	33	17.88		262235	
66000 - 13800 Volts	D-N	33	18.16		271665	
64350 - 13800 Volts	E-N	33	18.48		281223	
70950 - 12420 Volts	A-16L	29.7	15.78		239676	
67650 - 12420 Volts	C-16L	29.7	15.93		247278	
64350 - 12420 Volts	E-16L	29.7	16.35		257256	
64350 - 13713 Volts	E-1L	32.79	16.74		235593	
64350 - 13110 Volts	E-8L	31.35	17.49		272529	
64350 - 12592 Volts	E-14L	30.11	17.97		304041	
64350 - 12506 Volts	E-15L	29.9	18.05		308842	
64350 - 14490 Volts	E-8R	33	18.85		277638	

PENNSYLVANIA TRANSFORMER TECHNOLOGY, INC.
30 Curry Ave., Box 440
Canonsburg, PA 15317

TRANSFORMER TEST REPORT

P.T.T.I. Spec:	20386	P.T.T.I. Order:	C-09286-5
Customer:	PSE&G LONG ISLAND	Customer Order:	5000022911

SERIAL No. C-09286-5-4

1 2 / 2 $ ' / 2 6 6 : $ 7 7 6 $ 1 ' (; & , 7 , 1 * & 8 5 5 (1 7 # U &

	BEFORE IMPULSE			AFTER IMPULSE		GUARANTEES	
Tap	% Excitation	% Exciting Current	WATTS	% Exciting	WATTS	% Exciting Current	WATTS
C-N	90	0.054	8084	0.052	8037		
C-N	100	0.074	10108	0.073	10256	0.50	10600
C-N	110	0.12	12548	0.12	12864	0.00	---
C-1R	100	1.19	13774	1.20	14173		

For transformer capacitance and power factor, see attached Doble Report.

% ZERO SEQUENCE IMPEDANCE @ 85°C

Transformer connection (V)	MVA	% Impedance
67650 - 15180 Volts	16.8	0.902+10.37j
67650 - 13800 Volts	16.8	0.976+10.85j
67650 - 12420 Volts	15.12	1.12+11.846j

RESISTANCE @ 85°C

Total resistance of three phases in series.

H.V. Winding

H.V. Tap	Resistance
A	1.6724
B	1.6337
C	1.5949
D	1.5555
E	1.5166

L.V. Winding

LTC Pos.	Resistance	LTC Pos.	Resistance
16R	0.06183	1L	0.05761
15R	0.06108	2L	0.05948
14R	0.06152	3L	0.05916
13R	0.06086	4L	0.05984
12R	0.06121	5L	0.05950
11R	0.06054	6L	0.06017
10R	0.06088	7L	0.05976
9R	0.06020	8L	0.06053
8R	0.06054	9L	0.06018
7R	0.05976	10L	0.06086
6R	0.06022	11L	0.06052
5R	0.05957	12L	0.06121
4R	0.05992	13L	0.06085
3R	0.05921	14L	0.06154
2R	0.05954	15L	0.06110
1R	0.05751	16L	0.06184
N	0.05713		

WINDING INSULATION RESISTANCE IN GIGAOHMS @ 22 °C

H.V. to Ground; Guard on L.V	43.7
L.V. to Ground; Guard on H.V	7.49
H.V. & L.V. ; Guard to Ground.	8.36

(Measured with a 2500 volt Megger Test Set)

PENNSYLVANIA TRANSFORMER TECHNOLOGY, INC.
30 Curry Ave., Box 440
Canonsburg, PA 15317

TRANSFORMER TEST REPORT

P.T.T.I. Spec: 20386 P.T.T.I. Order: C-09286-5

Customer: PSE&G LONG ISLAND Customer Order: 5000022911

SERIAL No. C-09286-5-4

CORE INSULATION RESISTANCE IN GIGAOHMS

	HV	Center	LV	PA
$IWHU WDQN	9.16	12.27	395	1880
$IWHU SRZHU	7.55	9.2	952	2000
-XVW 3ULRU WR				

(Measured with a 1000 volt Megger Test Set)

ADDITIONAL TEMPERATURE TEST DATA IN DEGREES "C"

Transformer Connection: 65550 - 12506 Volts (Position "E - 15L")

33 MVA Results

	H1-H0	H2-H0	H3-H0	X1-X0	X2-X0	X3-X0	Guarantee
Winding Gradient:	15.6	14.7	15.3	19.6	21.4	21.9	
Average Oil Rise:	39.1	39.1	39.1	39.1	39.1	39.1	
Winding Rise:	54.7	53.8	54.4	58.7	60.5	61.0	65
Top Oil Rise:	56.1						
Bottom Oil Rise:	22.1						
Hot Spot Rise:	75.3	74.2	74.9	77.1	79.0	79.5	80

The top MVA temperature rise test was conducted on C-09286-5-4.

16.8 MVA Result

	H1-H2	H2-H0	H3-H0	X1-X0	X2-X0	X3-X0	Guarantee
Winding Gradient:	7.0	7.8	7.2	11.2	10	8.6	
Average Oil Rise:	33.4	33.4	33.4	33.4	33.4	33.4	
Winding Rise:	40.4	41.2	40.6	44.6	43.4	42.0	65
Top Oil Rise:	42.6						
Bottom Oil Rise:	24.2						
Hot Spot Rise:	51.2	52.2	51.5	54.6	53.3	51.8	80

The base MVA temperature rise test was conducted on 9286-5-4

PENNSYLVANIA TRANSFORMER TECHNOLOGY, INC.
30 Curry Ave., Box 440
Canonsburg, PA 15317

TRANSFORMER TEST REPORT

P.T.T.I. Spec:	20386	P.T.T.I. Order:	C-09286-5
Customer:	PSE&G LONG ISLAND	Customer Order:	5000022911

SERIAL No. C-09286-5-4

AUXILIARY LOSSES

	Tested	Guarantee
Cooling equipment loss in watts @ ONAN/ONAF rating:	2355	4000
Cooling equipment loss in watts @ ONAN/ONAF/ONAF rating:	4660	8000

Power consumption with all fans, heaters, LTC drive motor, lamps, and all other devices operated from the fan control circuit: 5 Watts.

SOUND LEVEL

	Test	Guarantee
Audible core noise level at 105% rated voltage in Decibels @ 16.8 MVA (Fans Off):	49.9	62
Audible core noise level at 105% rated voltage in Decibels @ 33 MVA (Fans Off):	49.9	65
Audible load noise level in Decibels @ 16.8 MVA Rating:	59.8	
Audible load noise level in Decibels @ 33 MVA Rating:	60.3	
Combine core & load noise level in Decibels @ 16.8 MVA ratii	60.3	
Combine core & load noise level in Decibels @ 33 MVA rating	60.6	

The audible noise level was tested on tap E-1R on P.T.T.I Serial No. C-09286-5-4, Customer Purchase Order 5000022911

TRANSFORMER FACTORY
CERTIFIED TEST REPORT

PSE&G LONG ISLAND
BROOKLYN AVE # 2

PURCHASE ORDER # 50000 22901
UNIT SER. # E5120

November 02, 2020

3550 MAYFLOWER DRIVE
LYNCHBURG, VA 24501
(434) 845-0921*(800) 368-3017
FAX (434) 845-7089

PSE&G LONG ISLAND
BROOKLYN AVE # 2
Project # NP # 972
Purchase Order # 50000 22901
UNIT SER. # E5120
November 2, 2020

Part I - Executive Summary

General and Rating Data

Date	November 02, 2020		
Customer	**PSE&G LONG ISLAND BROOKLYN AVE # 2**		
Project #	NP # 972		
Purchase Order #	50000 22901		
Delta Star Inc. Factory Serial #	E5120		
Transformer Type	Load Tap Changing Transformer		
Type of Construction	Core Form		
Cooling Class	ONAN/ONAF/ONAF/ONAF		
Number of Phases	3		
Frequency [Hz]	60		
Insulating Medium	Mineral Oil		
Temperature Rise [ºC]	65		
Type of Fluid Flow	Non-Directed		
Polarity (For Single-Phase Only)	N/A		
Winding Ratings			
Connection	**HV**	**LV**	**TV**
	WYE	WYE	DELTA
Voltage [kV]	67.7Y	13.8GrdY/7.97	11.7
Power [MVA @ ºC]	16.8/22.4/28/33 @ 65 ºC	16.8/22.4/28/33 @ 65 ºC	5.6/7.5/9.3/11 @ 65 ℃
Line BIL [kV]	350	150	110
Neutral BIL [kV]	---	110	-

PSE&G LONG ISLAND
BROOKLYN AVE # 2
Project # NP # 972
Purchase Order # 50000 22901
UNIT SER. # E5120
November 2, 2020

DELTA STAR INCORPORATED

Guaranteed and Reported data

Total, Load, No-load Losses, Impedance and Exciting Current Tests

No Load Loss and Exciting Current					
Reference Temp.	Exciting Current as % of Rated Current at ONAN MVA		No Load Loss @ 100% of Rated Voltage [kW]		-
	Guaranteed	Reported	Guaranteed	Reported	-
20 °C	0.400	0.093	15.00	13.73	-

Load Loss and Impedance												
Reference Temp.	67.65 to 13.80 kV @ 16.8 MVA				70.95 to 13.80 kV @ 16.8 MVA				64.35 to 13.80 kV @ 16.8 MVA			
	Guaranteed		Reported		Guaranteed		Reported		Guaranteed		Reported	
	Load Losses [kW]	Imp. [%]	Load Losses [kW]	Imp. [%]	Load Losses [kW]	Imp. [%]	Load Losses [kW]	Imp. [%]	Load Losses [kW]	Imp. [%]	Load Losses [kW]	Imp. [%]
85 °C	58.70	9.00	58.44	8.73	-	-	57.05	8.63	-	-	59.84	8.95

Cooling Equipment Losses [kW] (losses in control equipment not included)		Total losses @ ONAN MVA [kW] (cooling and other control equipment not included)	
Guaranteed	Reported	Guaranteed	Reported
2.50	2.507	73.70	72.17

Efficiency and Regulation

MVA	Winding Connection	% Regulation @ Lagging PF [%]					% Efficiency @ Load [%]			
			100	90	80	70	100	75	50	25
16.8	67.65 to 13.80 kV	Guaranteed	0.75	4.53	5.90	-	99.56	99.62	99.64	99.55
		Calculated	0.73	4.40	5.73	6.63	99.57	99.63	99.66	99.59

PSE&G LONG ISLAND
BROOKLYN AVE # 2
Project # NP # 972
Purchase Order # 50000 22901
UNIT SER. # E5120
November 2, 2020

Temperature Rise Test

All temperature rises measurements are presented in degrees Celsius (ºC) with average winding rise being corrected to the instance of shutdown and the windings loaded until constant temperature rise had been reached. Maximum (hottest-spot) winding rises above ambient were determined per sub clause 5.11.1.1c of IEEE C57.12.00-2015. Thermal images were recorded prior to the highest MVA heat run shutdown; electronic data provided upon request.

MVA	kV			Amps			Taps		Total Losses	Type of Cooling	Quantity	
	HV	LV	TV	HV	LV	TV	DETC	LTC			Fans	Rads
16.8	64.4	12.5	11.7	151	775	832	5	15L	83.8	ONAN	0	7
33.0	64.4	12.5	11.7	296	1523	1634	5	15L	278.7	ONAF	4	7
24.8	64.4	12.5	11.7	222	1142	1226	5	15L		ONAF	4	7
41.3	64.4	12.5	11.7	370	1904	2043	5	15L		ONAF	4	7

MVA	Winding and Oil Guarantee	Phase	Reported Fluid Rise		Average Winding Rise by Resistance			Ambient	Winding Hottest Spot Rise by Calculation		
			Top	Bottom	HV	LV	TV		HV	LV	TV
16.8	65	A	-	-	-	-	-	-	-	-	-
		B	-	-	-	-	-	-	-	-	-
		C	34.3	18.2	31.5	33.0	-	27.9	39.8	42.1	-
33.0	65	A	50.2	24.0	52.3	57.3	-	27.3	65.8	73.7	-
		B	50.2	24.0	52.7	57.0	-	27.3	66.3	73.2	-
		C	50.2	24.0	53.0	58.4	-	27.3	66.6	74.9	-
24.8	65	C	33.0	11.0	35.0	40.0	-	30.0	46.0	54.0	-
41.3		C	72.0	36.0	74.0	85.0	-	32.0	93.0	108.0	-

*Note: Thermal Data for 75%FA & 125%FA is from duplicate unit N2195.
All reported temperatures are for 1000/3300 [m/ft] elevation.

Oil Time Constant (Hours)		Wndg Time Const. (Mins)			M Exponent			N Exponent
Cool Down	Heat Up	HV	LV	TV	HV	LV	TV	
-	1.7	5.7	7.4	-	0.68	0.69	-	0.81

Sound Pressure Test

Cooling Class	kV		A - Weighted Sound Pressure/Intensity Level [dB]		Type of Instrument
	HV	LV	Guaranteed	Reported	
ONAN	67.7	12.51	62	55.2	Bruel and Kjaer 2250
ONAF	67.7	12.51	-	55.8	
ONAF/ONAF	67.7	12.5	-	57.3	
ONAF/ONAF/ONAF	67.7	12.51	65	58.3	

Part II - Additional Reported Data and Confirmation of Tests Performed

Turns Ratio

Ratio, polarity and phase rotation measurements were performed as per *IEEE C57.12.00* requirements on all taps, with ratio results within +/- 0.5% of indicated nameplate voltage ratios, correct phase and polarity. Recorded data provided in Attachments.

DELTA STAR INCORPORATED

DC Winding Resistance Test: Sum of Three Phases

Refer. Temp. [°C]	Tap Position	Resistance [Ω]		
		HV	LV	TV
85	1	1.4321		
85	2	1.3983		
85	3	1.3671		
85	4	1.3328		
85	5	1.2989		
85	N		0.04437	
85	16R		0.04897	
85	16L		0.04897	

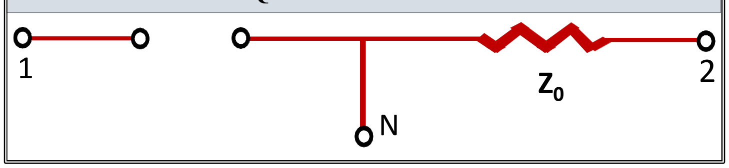
Additional data is provided in Attachments.

No Load Loss and Exciting Current

Refer. Temp. [°C]	Rated Voltage [%]	Taps		Exciting current [%]		No load loss [kW]	
		DETC	LTC	Before Dielectrics	After Dielectrics	Before Dielectrics	After Dielectrics
20	100	3	N	0.096	0.093	13.75	13.73
20	90	3	N	0.081	0.079	10.80	10.75
20	110	3	N	0.122	0.122	17.28	17.31
20	100	3	15L	1.293	-	16.69	-
20	100	3	16L	0.095	-	13.71	-
20	100	3	15R	1.287	-	16.38	-
20	100	3	16R	0.094	-	13.59	-

Zero-phase Sequence Impedance Test

"T" EQUIVALENT NETWORK



DETC	LTC	MVA	Z_0 [%]	Z_0 (R + jX) [%]
1	N	16.8	7.330	0.921+7.274j
3	N	16.8	7.330	0.918+7.276j
5	N	16.8	7.340	0.918+7.280j
1	16R	16.8	6.820	0.901+6.759j
3	16R	16.8	6.820	0.894+6.759j
5	16R	16.8	6.810	0.898+6.754j
1	16L	16.8	8.210	0.987+8.149j
3	1L	16.8	8.210	0.982+8.149j
5	16L	16.8	8.200	0.983+8.138j

PSE&G LONG ISLAND
BROOKLYN AVE # 2
Project # NP # 972
Purchase Order # 50000 22901
UNIT SER. # E5120
November 2, 2020

DELTA STAR INCORPORATED

Load Losses and Impedance

Refer. Temp. [°C]	LTC Tap	MVA	HV 71.0 kV		HV 69.3 kV		HV 67.7 kV		HV 66.0 kV		HV 64.4 kV	
			Load Losses [kW]	Imp. R + Xj [%]	Load Losses [kW]	Imp. R + Xj [%]	Load Losses [kW]	Imp. R + Xj [%]	Load Losses [kW]	Imp. R + Xj [%]	Load Losses [kW]	Imp. R + Xj [%]
85	N	16.8	57.05	0.34 + 8.62j	56.99	0.34 + 8.63j	58.44	0.35 + 8.72j	58.84	0.35 + 8.82j	59.84	0.36 + 8.94j
85	16R	16.8	55.59	0.33 + 8.93j	-	-	56.82	0.34 + 9.06j	-	-	58.59	0.35 + 9.32j
85	16L	16.8	65.03	0.39 + 8.38j	-	-	65.68	0.39 + 8.47j	-	-	67.36	0.40 + 8.67j
85	1L	16.8	-	-	-	-	-	-	-	-	60.12	0.36 + 8.94j
85	8L	16.8	-	-	-	-	-	-	-	-	63.68	0.38 + 8.88j
85	14L	16.8	-	-	-	-	-	-	-	-	66.33	0.39 + 8.76j
85	15L	16.8	-	-	-	-	-	-	-	-	67.12	0.40 + 8.71j
85	N	33.0	220.32	0.67 + 16.94j	220.08	0.67 + 16.96j	226.47	0.69 + 17.12j	227.22	0.69 + 17.32j	231.07	0.70 + 17.56j
85	16R	33.0	214.64	0.65 + 17.53j	-	-	219.39	0.66 + 17.79j	-	-	226.23	0.69 + 18.30j
85	16L	33.0	251.70	0.76 + 16.47j	-	-	255.17	0.77 + 16.64j	-	-	261.23	0.79 + 17.03j
85	1L	33.0	-	-	-	-	-	-	-	-	232.17	0.70 + 17.56j
85	8L	33.0	-	-	-	-	-	-	-	-	245.92	0.75 + 17.44j
85	14L	33.0	-	-	-	-	-	-	-	-	256.17	0.78 + 17.20j
85	15L	24.8	-	-	-	-	-	-	-	-	146.69	0.59 + 12.83j
85	15L	33.0	-	-	-	-	-	-	-	-	261.96	0.79 + 17.10j
85	15L	41.3	-	-	-	-	-	-	-	-	412.24	1.00 + 21.37j

Lightning Impulse

Lightning Impulse tests were performed on all line and neutral terminals as follows:

HV Line	350	kV BIL
HV Neutral	---	kV BIL
LV Line	150	kV BIL
LV Neutral	--	kV BIL

Recorded oscillograms and the summary of key parameters are provided in Attachments.

DELTA STAR INCORPORATED

Applied Voltage Test

AC voltage was applied to each winding, with all other windings, tank and core grounded, as follows:

Winding rating [kV]	Voltage applied [kV rms]	Duration [sec]
67.7Y	140	60
13.8GrdY/7.97	34	
11.7	0	

Induced Voltage Test

An induced voltage test for 7200 cycles was performed at enhancement level with 124.71 kV applied across full HV winding.

Partial Discharge Test

The 7200 cycle enhancement level test was followed by a 1 hour partial discharge test. Highest partial discharge and radio-influence voltage readings were less than 300 pC and 50 µV respectively. Recorded data is provided in Attachments.

Overall Insulation Power Factor and Capacitance Test (Before Dielectrics)

Insulation	Power factor corrected to 20ºC [%]	Capacitance [pF]
$C_H + C_{HL}$	0.164	9942.595
C_H	0.216	2014.640
C_{HL}	0.148	7927.305
$C_L + C_{LH}$	0.167	19023.449
C_L	0.178	11094.950
C_{LH}	0.148	7927.550

The detailed data for overall and bushing tests is included in electronic files available upon request.

Overall Insulation Power Factor and Capacitance Test (After Dielectrics)

Insulation	Power factor corrected to 20ºC [%]	Capacitance [pF]
$C_H + C_{HL}$	0.164	9942.595
C_H	0.216	2014.640
C_{HL}	0.148	7927.305
$C_L + C_{LH}$	0.167	19023.449
C_L	0.178	11094.950
C_{LH}	0.148	7927.550

The detailed data for overall and bushing tests is included in electronic files available upon request.

PSE&G LONG ISLAND
BROOKLYN AVE # 2
Project # NP # 972
Purchase Order # 50000 22901
UNIT SER. # E5120
November 2, 2020

Single-Phase Exciting Current Test

DETC	LTC	Voltage [kV]	Exiting current [mA]		
			H1-H2	H2-H3	H3-H1
3	16L	10	12.418	14.473	26.757
3	15L	10	159.825	161.966	174.739
3	14L	10	12.442	14.482	26.771
3	13L	10	47.921	50.243	61.919
3	12L	10	12.454	14.487	26.770
3	11L	10	47.940	50.244	61.928
3	10L	10	12.461	14.488	26.773
3	9L	10	160.275	162.365	175.130
3	8L	10	12.470	14.496	26.775
3	7L	10	47.968	50.279	61.941
3	6L	10	12.473	14.501	26.782
3	5L	10	47.994	50.283	61.946
3	4L	10	12.479	14.504	26.778
3	3L	10	160.328	162.412	175.137
3	2L	10	12.486	14.511	26.786
3	1L	10	47.983	50.270	61.925
1	N	10	11.522	13.403	24.683
2	N	10	12.008	13.959	25.737
3	N	10	12.481	14.495	26.772
4	N	10	13.019	15.137	27.958
5	N	10	13.603	15.803	29.250
3	1R	10	47.952	50.228	61.898
3	2R	10	12.489	14.502	26.782
3	3R	10	159.931	161.956	174.767
3	4R	10	12.494	14.509	26.790
3	5R	10	47.991	50.275	61.939
3	6R	10	12.496	14.512	26.789
3	7R	10	47.982	50.272	61.953
3	8R	10	12.499	14.519	26.795
3	9R	10	160.296	162.407	175.125
3	10R	10	12.506	14.523	26.798
3	11R	10	48.023	50.299	61.983
3	12R	10	12.511	14.526	26.804
3	13R	10	48.045	50.312	61.996
3	14R	10	12.514	14.528	26.806
3	15R	10	160.376	162.356	175.170
3	16R	10	12.521	14.535	26.810

Insulation Resistance Test (Corrected to 20 °C)

Insulation	Insulation Resistance at 2.5 kV DC for 1 Min. Duration [MΩ]
HV-LV & GND	1130
LV-HV & GND	603
HV-GND (LV Guarded)	7300
LV-GND (HV Guarded)	1268

Insulation	Insulation Resistance at 1 kV DC for 1 Min. Duration [MΩ]
Main Core to Ground	1245
Main Frame to Main Core	1305
Main Frame to Ground	1258
PA Core to Ground	8475

No Load Sound Test @ 100%

Measuring Position	ONAN Sound dB(A)		ONAF Sound dB(A)		NA2 Sound dB(A)	
	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height
1	60.2	61.0	59.3	58.5		
2	59.3	60.0	59.1	59.2		
3	57.8	57.8	59.5	58.8		
4	58.0	58.5	58.7	59.1		
5	59.9	59.5	60.6	61.4		
6	59.3	57.6	60.3	60.9		
7	59.3	58.2	60.4	60.3		
8	59.2	58.9	60.2	60.4		
9	60.2	58.4	60.8	62.1		
10	57.8	58.2	60.8	61.2		
11	59.1	58.3	62.3	61.2		
12	59.0	58.4	60.9	59.1		
13	59.8	59.0	59.8	59.1		
14	61.2	61.7	59.5	60.3		
15	59.7	59.2	59.9	60.3		
16	60.0	59.0	59.3	59.7		
17	61.2	59.5	60.5	61.1		
18	62.1	59.9	58.7	60.0		
19	58.5	59.6	58.8	59.2		
20	59.1	60.2	60.5	61.1		
21	59.3	60.3	58.9	60.5		
22			58.0	58.6		
23			59.6	59.0		
24			59.6	60.2		
25			59.5	58.4		
26			56.7	57.2		
27			57.2	57.8		
28			57.7	58.2		
29			57.3	58.6		
30			58.3	58.4		
31			59.1	58.8		
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
Subtotal	59.7	59.3	59.6	59.8		
Average	59.5		59.7		#NUM!	
Amb. Correction	1.6		1.6		#NUM!	
Wall Correction	1.7		2.3		2.3	
Field Correction	1.0		0.0		0.0	

MR	5120
A or C Test	A
VOLTAGE %	100
TESTED BY	ct
DATE	10/30/2020
CELL NUMBER	
NLTC POS.	3
LTC POS.	15L
VOLTAGE (V)	12510
CURRENT (A)	10.03

Measuring Position	**Ambient Sound Level**	
	1/3 Height	2/3 Height
BEFORE TEST		
5	56.9	56.5
11	56.9	56.9
16	57.0	57.3
21	56.7	56.5
Subtotal	56.9	56.8
Average	56.8	
AFTER TEST		
5	56.7	56.4
11	56.8	57.1
16	57.2	57.2
21	56.7	56.6
Subtotal	56.9	56.8
Average	56.8	
Total Avg	56.8	

Wall Sound Reflection Correction	
A (meters)	679.3
α	0.2
S_V (meters)	3396.5
ONAN Contour	
S (meters)	79.1
h (inchs)	118.7
l_m (meters)	21
K	**1.7**
ONAF Contour	
S (meters)	116.8
h (inchs)	118.7
l_m (meters)	31
K	**2.3**

A WEIGHTED NO LOAD SOUND LEVEL		
Cooling Method	Measured Sound Level dB(A)	Guaranteed Sound Level dB(A)
ONAN	55.2	62
ONAF	55.8	64
NA2	#NUM!	65

A WEIGHTED NO LOAD SOUND POWER	
Cooling Method	Sound Power Calc. dB(A)
ONAN	74.2
ONAF	74.8
NA2	#NUM!

No Load Sound Test @ 100%

Measuring Position	ONAN Sound dB(A)		ONAF Sound dB(A)		NA2 Sound dB(A)	
	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height
1	60.9	60.0	61.7	60.6		
2	59.4	59.1	61.6	60.1		
3	57.8	57.7	60.2	60.2		
4	59.4	58.2	61.8	61.7		
5	60.6	60.0	62.8	63.2		
6	60.8	60.5	63.2	64.0		
7	60.8	60.7	63.7	63.9		
8	62.4	61.7	63.0	63.0		
9	62.4	61.3	63.2	63.9		
10	63.2	62.0	64.1	64.0		
11	62.4	60.9	64.3	63.9		
12	61.7	61.0	63.4	63.6		
13	62.0	61.8	62.6	62.3		
14	63.1	63.4	63.2	62.2		
15	63.2	62.1	63.5	62.3		
16	63.7	61.9	63.4	63.7		
17	61.1	60.3	62.7	62.6		
18	63.7	61.2	61.9	60.7		
19	62.3	61.8	60.1	59.4		
20	62.4	62.0	60.8	60.8		
21	63.6	61.4	61.9	60.6		
22	62.3	60.9	60.9	58.8		
23	61.2	59.5	61.3	58.7		
24	61.0	60.2	60.8	60.2		
25	60.5	60.3	61.0	60.2		
26	60.2	59.2	61.2	59.1		
27	58.8	58.3	58.3	58.6		
28	59.9	58.6	60.3	58.3		
29	58.3	58.9	58.4	58.7		
30	60.6	59.7	60.5	59.6		
31	59.5	59.5	60.2	58.7		
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
Subtotal	61.6	60.7	62.1	61.6		
Average	61.2		61.9		#NUM!	
Amb. Correction	1.6		1.3		#NUM!	
Wall Correction	2.3		2.3		2.3	
Field Correction	0.0		0.0		0.0	

MR	5120
A or C Test	A
VOLTAGE %	100
TESTED BY	ct
DATE	10/30/2020
CELL NUMBER	
NLTC POS.	3
LTC POS.	N
VOLTAGE (V)	13800
CURRENT (A)	0.67

Measuring Position	Ambient Sound Level	
	1/3 Height	2/3 Height
BEFORE TEST		
8	56.9	56.5
16	56.9	56.9
23	57.0	57.3
31	56.7	56.5
Subtotal	56.9	56.8
Average	56.8	
AFTER TEST		
8	56.7	56.4
16	56.8	57.1
23	57.2	57.2
31	56.7	56.6
Subtotal	56.9	56.8
Average	56.8	
Total Avg	56.8	

Wall Sound Reflection Correction	
A (meters)	679.3
α	0.2
S_V (meters)	3396.5
ONAN Contour	
S (meters)	116.8
h (inchs)	118.7
l_m (meters)	31
K	**2.3**
ONAF Contour	
S (meters)	116.8
h (inchs)	118.7
l_m (meters)	31
K	**2.3**

A WEIGHTED NO LOAD SOUND LEVEL		
Cooling Method	Measured Sound Level dB(A)	Guaranteed Sound Level dB(A)
ONAN	57.3	0
ONAF	58.3	65
NA2	#NUM!	0

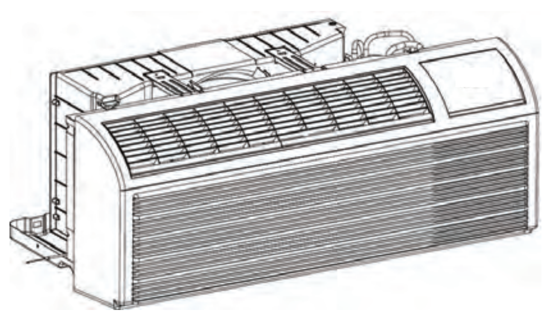
A WEIGHTED NO LOAD SOUND POWER	
Cooling Method	Sound Power Calc. dB(A)
ONAN	#NUM!
ONAF	#NUM!
NA2	#NUM!

TRANE

Service Manual

ProSpace™
Packaged Terminal Air Conditioner (PTAC)
for 208/230 V and 265V Units with R410A Refrigerant

208/230 Volts:	**265 Volts:**
PTEF0701GAA	PTEF0702GAA
PTHF0701GAA	PTHF0702GAA
PTEF0901HAA	PTEF0902HAA
PTHF0901HAA	PTHF0902HAA
PTEF1201HAA	PTEF1202HAA
PTHF1201HAA	PTHF1202HAA
PTEF1501HAA	PTEF1502HAA
PTHF1501HAA	PTHF1502HAA



⚠ SAFETY WARNING

Only qualified personnel should install and service the equipment. The installation, starting up, and servicing of heating, ventilating, and air-conditioning equipment can be hazardous and requires specific knowledge and training. Improperly installed, adjusted or altered equipment by an unqualified person could result in death or serious injury. When working on the equipment, observe all precautions in the literature and on the tags, stickers, and labels that are attached to the equipment.

October 2017 PTAC-SVM001B-EN

Ingersoll Rand

Introduction

The ProSpace™ Packaged Terminal Air Conditioners and heat pumps provide a high standard of quality in performance, workmanship, durability and appearance as they heat and cool the occupied air space year round.

This manual provides information for ease of installation, operation and maintenance. All models are designed for through–the–wall installation. Separate installation instructions are included with all accessory components.

General Information

Read this manual completely and carefully before starting any work. Write down the model and serial number on the space provided on the product registration card. The model and serial number can be located on the serial number plate attached to the unit. These numbers are required for any service work.

Important: *Ensure that this manual is left with the owner for future reference. Observe all local codes and ordinances.*

Warnings, Cautions, and Notices

Safety advisories appear throughout this manual as required. Your personal safety and the proper operation of this machine depend upon the strict observance of these precautions.

The three types of advisories are defined as follows:

⚠WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠CAUTION	Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury. It could also be used to alert against unsafe practices.
NOTICE	Indicates a situation that could result in equipment or property-damage only accidents.

Important Environmental Concerns

Scientific research has shown that certain man-made chemicals can affect the earth's naturally occurring stratospheric ozone layer when released to the atmosphere. In particular, several of the identified chemicals that may affect the ozone layer are refrigerants that contain Chlorine, Fluorine and Carbon (CFCs) and those containing Hydrogen, Chlorine, Fluorine and Carbon (HCFCs). Not all refrigerants containing these compounds have the same potential impact to the environment. Trane advocates the responsible handling of all refrigerants-including industry replacements for CFCs and HCFCs such as saturated or unsaturated HFCs and HCFCs.

Important Responsible Refrigerant Practices

Trane believes that responsible refrigerant practices are important to the environment, our customers, and the air conditioning industry. All technicians who handle refrigerants must be certified according to local rules. For the USA, the Federal Clean Air Act (Section 608) sets forth the requirements for handling, reclaiming, recovering and recycling of certain refrigerants and the equipment that is used in these service procedures. In addition, some states or municipalities may have additional requirements that must also be adhered to for responsible management of refrigerants. Know the applicable laws and follow them.

⚠ WARNING

Proper Field Wiring and Grounding Required!

Failure to follow code could result in death or serious injury.

All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state/national electrical codes.

⚠ WARNING

Personal Protective Equipment (PPE) Required!

Failure to wear proper PPE for the job being undertaken could result in death or serious injury. Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, MUST follow precautions in this manual and on the tags, stickers, and labels, as well as the instructions below:

- **Before installing/servicing this unit, technicians MUST put on all PPE required for the work being undertaken (Examples; cut resistant gloves/sleeves, butyl gloves, safety glasses, hard hat/bump cap, fall protection, electrical PPE and arc flash clothing). ALWAYS refer to appropriate Material Safety Data Sheets (MSDS)/Safety Data Sheets (SDS) and OSHA guidelines for proper PPE.**
- **When working with or around hazardous chemicals, ALWAYS refer to the appropriate MSDS/SDS and OSHA/GHS (Global Harmonized System of Classification and Labelling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection and handling instructions.**
- **If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other country-specific requirements for arc flash protection, PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASH CLOTHING. ENSURE ELECTRICAL METERS AND EQUIPMENT ARE PROPERLY RATED FOR INTENDED VOLTAGE.**

⚠ WARNING

Follow EHS Policies!

Failure to follow instructions below could result in death or serious injury.

- **All Ingersoll Rand personnel must follow Ingersoll Rand Environmental, Health and Safety (EHS) policies when performing work such as hot work, electrical, fall protection, lockout/tagout, refrigerant handling, etc. All policies can be found on the BOS site. Where local regulations are more stringent than these policies, those regulations supersede these policies.**
- **Non-Ingersoll Rand personnel should always follow local regulations.**

Copyright

Trademarks

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Important: *Ensure that this manual is left with the owner for future reference. Observe all local codes and ordinances.*

Table of Contents

Model Number Description

Use the following to determine the correct model number.

PT E F 070 2 G AA

Digit 1,2 Digit 3 Digit 4 Digit 5-7 Digit 8 Digit 9 Digit 10,11

- **Digit 1, 2; Product Family**
  - PT = Packaged Terminal Unit
- **Digit 3; Heating Methods**
  - E = Cooling with Electric Heat
  - H = Heat Pump with Electric Heat
- **Digit 4; Development Sequence**
  - F
- **Digit 5 through 7; Size and Cooling**
  - 070 = 7,000 Btu
  - 090 = 9,000 Btu
  - 120 = 12,000 Btu
  - 150 = 15,000 Btu
- Digit 8; Electrical Voltage
  - 1 = 208/230 Vac
  - 2 = 265 Vac
- **Digit 9; Electric Heat Size**
  - G = Maximum of 3.5 kW
  - H = Maximum of 5.0 kW
- **Digit 10, 11; Design Sequence**
  - AA = First
  - AB = Second

Air Conditioners with Electric Heat

Performance	Units	PTEF0701GAA	PTEF0702GAA	PTEF0901HAA	PTEF0902HAA	PTEF1201HAA	PTEF1202HAA	PTEF1501HAA	PTEF1502HAA
Trade Name:		ProSpace™	ProSpace™	ProSpace™	ProSpace™	ProSpace™	ProSpace™	ProSpace™	ProSpace™
Style/Function:		Cooling Only w/ Heaters	Cooling Only w/ Heaters	Cooling Only w/ Heaters	Cooling Only w/ Heaters	Cooling Only w/ Heaters	Cooling Only w/ Heaters	Cooling Only w/ Heaters	Cooling Only w/ Heaters
Cooling Capacity:	Btu/h	7,000/7,200	7,200	9,200/9,400	9,400	11,600/11,800	11,800	14,200/14,500	14,500
Electric Heat Power Input:	W	2,450/3,450	2,450/3,450	2,450/3,450/ 5,000	2,450/3,450/ 5,000	2,450/3,450/ 5,000	2,450/3,450/ 5,000	2,450/3,450/ 5,000	2,450/3,450/ 5,000
EER:	(Btu/h)/ W	13	13	12.1	12.1	11.6/11.6	11.6	10.4/10.4	10.4
Dehumidifying Vol:	Pint/h	1.69	1.69	2.11	2.11	2.75	2.75	3.17	3.17
Application Area:	ft2	108-172	108-172	129-194	129-194	172-258	172-258	226-334	226-334
Electrical									
Rated Voltage:	V~	208/230	265	208/230	265	208/230	265	208/230	265
Rated Frequency:	Hz	60	60	60	60	60	60	60	60
Phases:		1	1	1	1	1	1	1	1
Cooling Power Current:	A	2.9/2.7	2.4	3.9/3.7	3.3	5.1/4.9	4.2	6.7/6.2	5.4
Power Cord:		Refer to Table 1 and Table 2.	Refer to Table 1 and Table 2.	Refer to Table 1 and Table 2.	Refer to Table 1 and Table 2.	Refer to Table 1 and Table 2.	Refer to Table 1 and Table 2.	Refer to Table 1 and Table 2.	Refer to Table 1 and Table 2.
Features									
Sound Pressure Level (H/L):	dB (A)	50/48	50/48	52/50	52/50	53/50	53/50	54/51	54/51
Airflow Volume									
(H/L):	CFM	312/283	312/283	330/294	330/294	341/306	341/306	341/306	341/306
Warranty:		5-Year Parts/5-Year Sealed System Replacement	5-Year Parts/5-Year Sealed System Replacement	5-Year Parts/5-Year Sealed System Replacement	5-Year Parts/5-Year Sealed System Replacement	5-Year Parts/5-Year Sealed System Replacement	5-Year Parts/5-Year Sealed System Replacement	5-Year Parts/5-Year Sealed System Replacement	5-Year Parts/5-Year Sealed System Replacement
Specifications									
Dim of Package (L x W x H):	Inch	45 x 25 x 19	45 x 25 x 19	45 x 25 x 19	45 x 25 x 19	45 x 25 x 19	45 x 25 x 19	45 x 25 x 19	45 x 25 x 19
Net Weight:	lb	106	106	115	115	119	119	120	120
Refrigerant:		R410A	R410A	R410A	R410A	R410A	R410A	R410A	R410A
Refrigerant Charge:	lb	1.4	1.4	1.5	1.5	2.2	2.2	2.2	2.2

Heat Pumps with Electric Heaters

Performance	Units	PTHF0701GAA	PTHF0702GAA	PTHF0901HAA	PTHF0902HAA	PTHF1201HAA	PTHF1202HAA	PTHF1501HAA	PTHF1502HAA
Trade Name:		ProSpace™	ProSpace™	ProSpace™	ProSpace™	ProSpace™	ProSpace™	ProSpace™	ProSpace™
Style/Function:		Heat Pump w/ Heaters	Heat Pump w/ Heaters	Heat Pump w/ Heaters	Heat Pump w/ Heaters	Heat Pump w/ Heaters	Heat Pump w/ Heaters	Heat Pump w/ Heaters	Heat Pump w/ Heaters
Cooling Capacity:	Btu/h	7,000/7,200	7,200	9.200/9,400	9,400	11,600/11,800	11,800	14,200/14,500	14,500
Heating Capacity:	Btu/h	5,800/6,000	6,000	8,100/8,300	8,300	10,400/10,600	10,600	13,000/13,300	13,300
Electric Heat Power Input:	W	2,450/3,450	2,450/3,450	2,450/3,450/ 5,000	2,450/3,450/ 5,000	2,450/3,450/ 5,000	2,450/3,450/ 5,000	2,450/3,450/ 5,000	2,450/3,450/ 5,000
EER:	(Btu/h)/ W	13	13	12.1	12.1	11.6/11.6	11.6	10.4/10.4	10.4
Dehumidifying Vol:	Pint/h	1.69	1.69	2.11	2.11	2.75	2.75	3.17	3.17
Application Area:	ft2	108-172	108-172	129-194	129-194	172-258	172-258	226-334	226-334
Electrical									
Rated Voltage:	V~	208/230	265	208/230	265	208/230	265	208/230	265
Rated Frequency:	Hz	60	60	60	60	60	60	60	60
Phases:		1	1	1	1	1	1	1	1
Cooling Power Current:	A	2.9/2.7	2.4	3.9/3.7	3.3	5.1/4.9	4.2	6.7/6/2	5.4
Heating Power Current:	A	2.6/2.4	2.2	3.4/3.2	3.1	4.7/4.2	3.7	6.7/6.2	5
Power Cord:		Refer to Table 1 and Table 2.	Refer to Table 1 and Table 2.	Refer to Table 1 and Table 2.	Refer to Table 1 and Table 2.	Refer to Table 1 and Table 2.	Refer to Table 1 and Table 2.	Refer to Table 1 and Table 2.	Refer to Table 1 and Table 2.
Features									
Sound Pressure Level (H/L):	dB (A)	50/48	50/48	52/50	52/50	53/50	53/50	54/51	54/51
Airflow Volume (H/L):	CFM	312/283	312/283	330/294	330/294	341/306	341/306	341/306	341/306
Warranty:		5-Year Parts/5-Year Sealed System Replacement	5-Year Parts/5-Year Sealed System Replacement	5-Year Parts/5-Year Sealed System Replacement	5-Year Parts/5-Year Sealed System Replacement	5-Year Parts/5-Year Sealed System Replacement	5-Year Parts/5-Year Sealed System Replacement	5-Year Parts/5-Year Sealed System Replacement	5-Year Parts/5-Year Sealed System Replacement
Specifications									
Dim of Package (L x W x H):	Inch	45 x 25 x 19	45 x 25 x 19	45 x 25 x 19	45 x 25 x 19	45 x 25 x 19	45 x 25 x 19	45 x 25 x 19	45 x 25 x 19
Net Weight:	lb	112	112	119	119	121	121	123	123
Refrigerant:		R410A	R410A	R410A	R410A	R410A	R410A	R410A	R410A
Refrigerant Charge:	lb	2.1	2.1	2.1	2.1	2.2	2.2	2.4	2.4

Electrical

⚠ WARNING

Live Electrical Components!

Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

When it is necessary to work with live electrical components, have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks.

Power Connection Options

Appropriate power cord accessory kit is determined by the voltage and the amperage of the branch circuit, based on the unit amperage requirements (for example, electric heater size). The unit ships without a power cord.

Note: *Ensure the outlet matches the appropriate prong configuration on the plug. It should be within reach of the service cord. All wiring, including installation of the receptacle, must be in accordance with the NEC™ and all local codes, ordinances and regulations. National codes require the use of an arc fault or leakage current detection device on all 208/230V power cords. For 265V units, if power cord accessory option is selected, then the cord is only l8" long and must plug into the accessory electrical 265V sub-base.*

All Units

Important: *Follow NEC and local electrical codes when installing electrical supply wiring. The following is only shown as a sample.*

Use recommended wire size (Table 1) and install a single-branch circuit. All units are designed to operate off only one (1) single branch circuit.

Note: *Only use copper conductors. Branch circuit wire is single circuit from main box. AWG wire sizes are based on copper wire at a 140°F (60°C) temperature rating.*

Table 1. Common Branch Circuit Wire Sizes

Nameplate Amps	AWG Wire Size
7.0 to 12	14
12.1 to 16	12
16.1 to 24	10

Grounding

For safety and protection, the unit is grounded through the service cord plug or through separate ground wire provided on hard wired units. Ensure that the branch circuit or general purpose outlet is grounded.

Voltage Supply

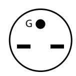
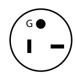
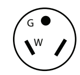
Check voltage supply at outlet. For satisfactory results, the voltage range must always be within the ranges specified on the data information plate. Power cord does not ship with the unit. The cord to order is determined by the unit voltage and the desired electric heat capacity.

Cord/Connected Units

The 250 Vac field supplied outlet must match the plug for standard 208/230V units and be within reach of the service cord.

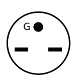
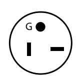
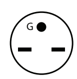
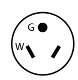
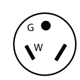
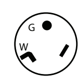
Note: *Do NOT use 30 amp cord with size 07 units.*

Table 2. Electric Heater and Cord Information, PTEF07xxx and PTHF07xxx

Voltage:	**230 Vac**[a]		**265 Vac**	
Amps:[b]	15	20	15	20
Heater Size:	2.5 kW	3.5 kW	2.5 kW	3.5 kW
Plug Layout:				
NEMA Plug:	6-15P	6-20P	7-15P	7-20P
Cord #:	PWR00286	PWR00288	PWR00287	PWR00289

(a) The 250 Vac field supplied outlet must match the plug for standard 208/230V units and be within reach of the service cord.
(b) Do Not use 30 amp cord with size 07 units.

Table 3. Electric Heater and Cord Information, PTEF and PTHF Size 09, 12, and 15

Voltage:	**230 Vac**			**265 Vac**		
Amps:	15	20	30	15	20	30
Heater Size:	2.5 kW	3.5 kW	5.0 kW	2.5 kW	3.5 kW	5.0 kW
Plug Layout:						
NEMA Plug:	6-15P	6-20P	6-30P	7-15P	7-20P	7-30P
Cord #:	PWR00286	PWR00288	PWR00290	PWR00287	PWR00289	PWR00291

Power Cord Protection

Note: *Power cord does not ship with the unit.*

The power cord for 230/208V units provide protection from fire. The unit power automatically disconnects when unsafe conditions are detected. Power to the unit can be restored by pressing the reset button on plug head. Upon completion of unit installation for 230/208V models, an operational check should be performed using the TEST/RESET buttons on the plug head.

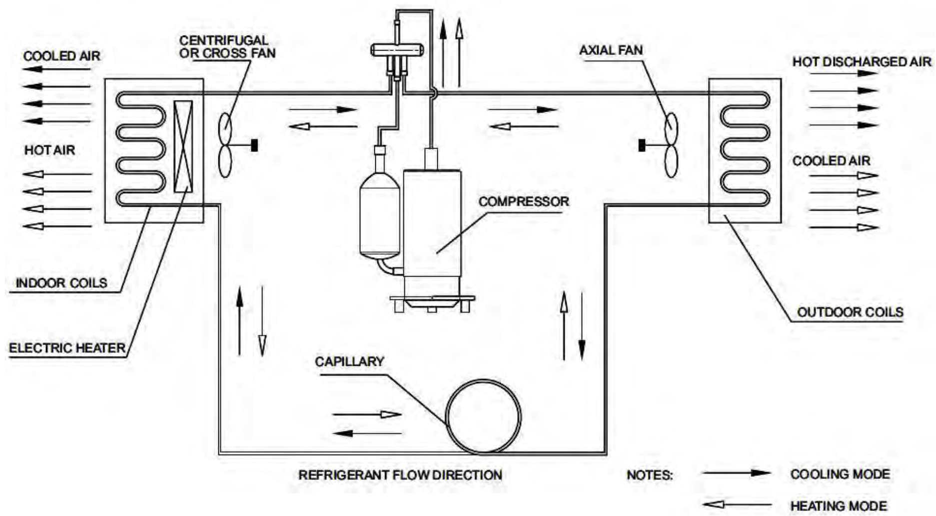
Note: *Models with 265V do not incorporate this feature because they require use of an electrical sub-base accessory. Connection to a wall socket is not permitted for 265V units. All 265V units must be hard wired using the hard wire kit or make use of the plug-in receptacle in the standard sub-base.*

Refrigerant System Diagrams

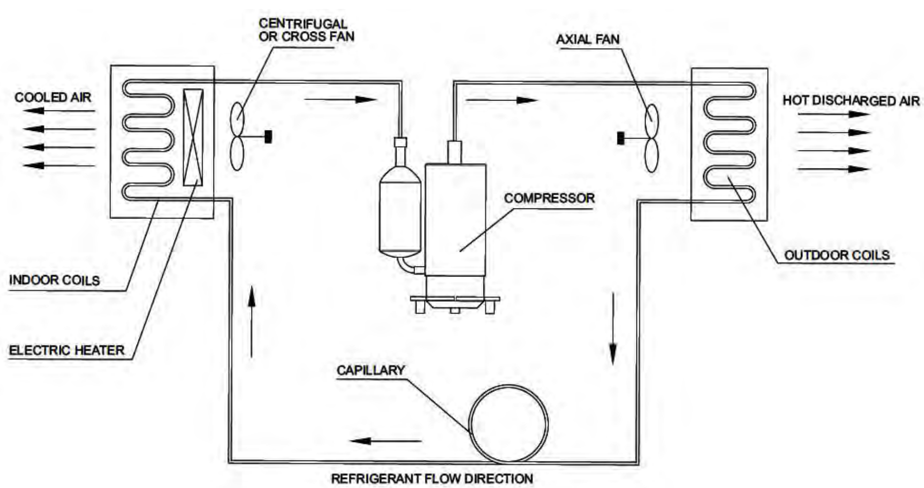
System Pressures and Temperature Ranges

- High side normal pressure should be approximately 435 psig.
- Low side normal pressure should be between 102 and 145 psig.
- High side normal temperature range is between 158°F and 194°F.
- Low side normal temp. range is between 50°F and 68°F.
- If the compressor amperage measures equal to or greater than 12 amps, the compressor will shutdown.

PTHF Cooling, Heat Pump, Auxiliary Electric Heat



PTEF Cooling and Electric Heat

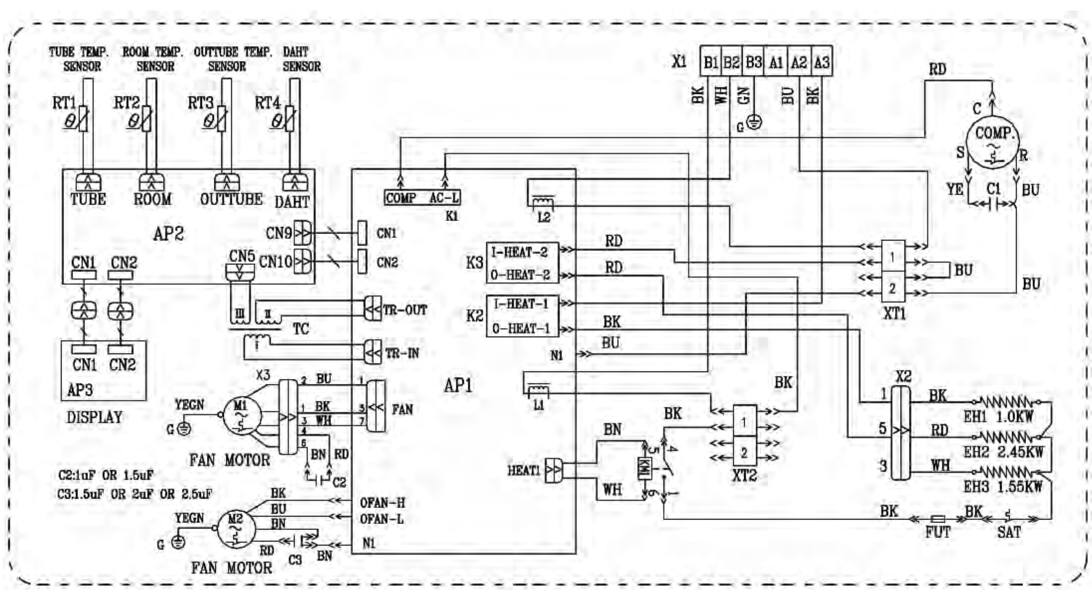


Electrical Wiring Diagrams

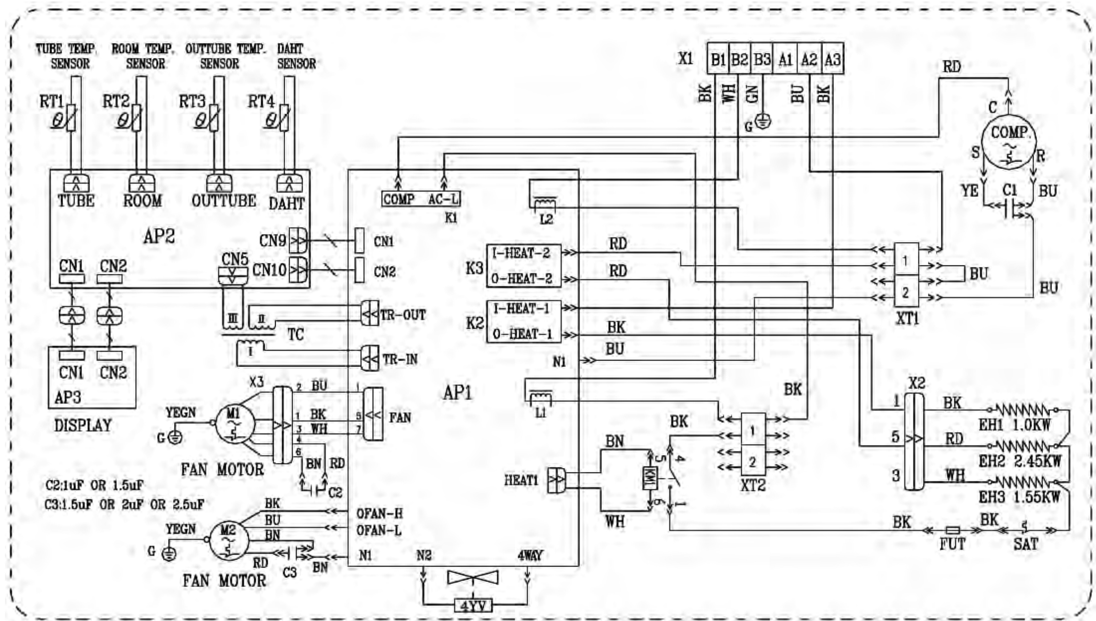
Symbol	Color
WH	White
YE	Yellow
RD	Red
YEGN	Yellow/Green
GN	Green
BM	Brown
BU	Blue
BK	Black
CAP	Capacitor
COMP	Compressor
	Grounding Wire
/	/

Electrical Wiring Diagrams for 208V/230V

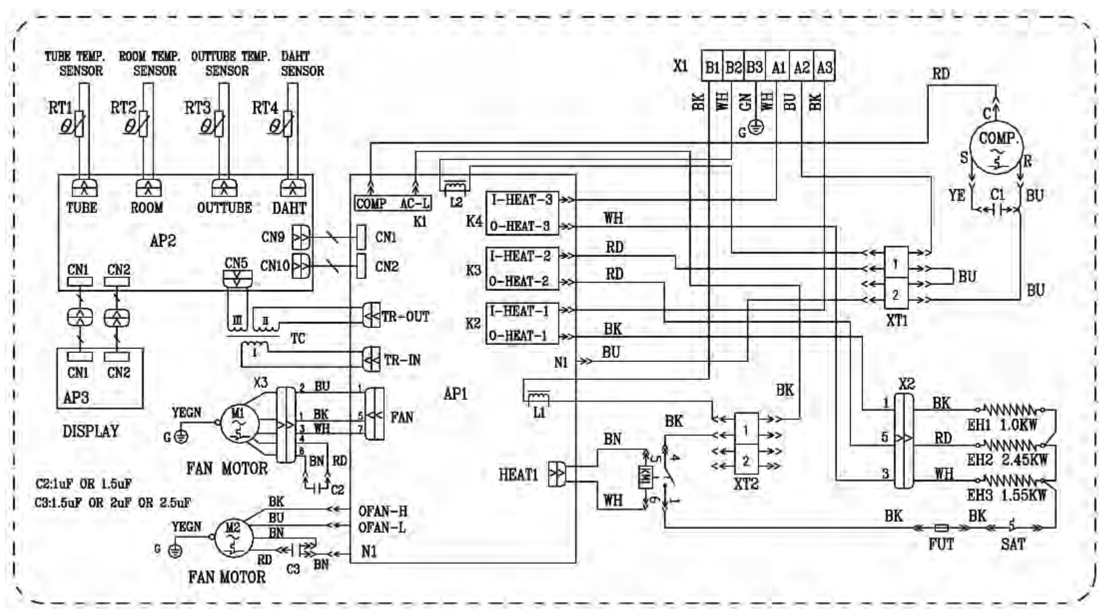
208V/230V PTEF0701) and 265V;(PTEF0702)



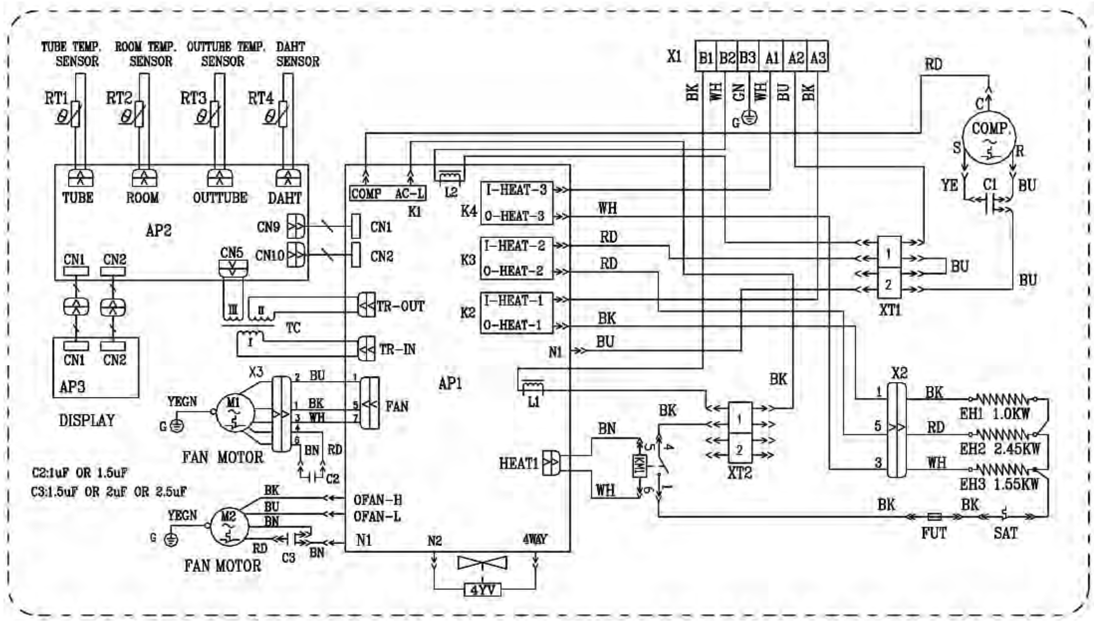
208V/230V PTHF0701) and 265V;(PTHF0702)



208V/230V PTEF0901, PTEF1201, PTEF1501) and 265V;(PTEF902, PTEF1202, PTEF1502)



208V/230V PTHF0901, PTHF1201, PTHF1501) and 265V;(PTHF902, PTHF1202, PTHF1502)



Control Panel Operation

Button Functions

- **Mode Button;** used to select specific mode. Each mode corresponds to the lit selection on the panel.
- **Timer;** used to set the protection for compressor and electric heater minimum stop time or the protection for compressor minimum operation time (protection time is reduced). Time is set by pressing the ▲ or ▼buttons.
- **Power Button (ON/OFF);** press the Power button to turn the unit on/off. If pressing ▲ or ▼ in the OFF mode, digital display turns on after displaying the indoor temperature for 15 seconds. If pressing the Mode button in OFF mode, the controller resumes to the corresponding operation status and the Power indicator is lit.
- **ON Status;** the Power Indicator is lit to show unit is ON.
- **Dry Mode (for Cooling/Heating Models);** When selecting dry mode, the unit operates at low fan speed. The fan speed cannot be adjusted.
- When selecting fan mode, air conditioner will operate in fan mode only. Then press FAN button to adjust fan speed. When selecting heat mode, air conditioner will operate under heat mode.
- **Cool Mode;** used to operate the unit in cooling. If the unit is turned off, the controller operates to the last cooling setpoint. Other functions operate according to the status before turning OFF the unit.
- Fan Speed; used to adjust the fan speed to high, low, or auto. Fan speed cannot be adjusted when in Dry Mode.
- **Heat Mode;** used to operate the unit in heating. If the unit is turned off, the controller operates to the last heating setpoint. Other functions operate according to the status before turning the OFF the unit.
- **Constant Fan Mode;** the fan operates continuously when the Constant Fan mode is set to ON. If Constant Fan Mode is OFF, the fan stops as the load stops. The fan speed is controlled by the Fan Speed button (High, Low, or Auto) If a wired controller is connected, the fan speed follows the command of wired controller. The controller operates whether the is operating or not.
- **▲ or ▼ Buttons (Warmer or Cooler);** used to increase/decrease temperature in increments of 1°F. Press and hold either button for 2 seconds to increment the temperature range rapidly. Range is 61°F to 86°F (16°C to 30°C).

LED Display and Digital Display

LEDs

The unit has two (2) 8-segment nixie tubes and eleven (11) LEDs on the main board. Each LED is lit for the corresponding set mode. Indicators LEDs are:

- High
- Low
- Auto
- Indoor Temperature
- Setpoint Temperature
- Dry
- Cool
- Constant Fan
- Heat
- Timer
- ON/OFF

Digital Display

When in cooling or heating mode, the digital display defaults to the set temperature. In Fan Mode, it displays indoor ambient temperature. When the display has three digits, the digital is rolling to display values.

When there is error or protection code displayed, the STATUS LED blinks. In OFF mode, the digital does not display the error code (except the low temperature protection). The unit does not display protection status codes 8, 9, or 10. When multiple protection codes overlap, they cycle through the display without priority. Refer to Table 4, p. 33 for a list of error codes.

Note: *If there is an error with the temperature sensor, only the indoor fan responds in cooling mode. Other loads do not respond, but the buttons are still valid.*

Mode Functions

Cooling Mode Functions

- When the ambient temperature is 2°F above setpoint, the unit operates under cooling. Both the outdoor fan and indoor fan operate in the set speed. When the starting condition of compressor is reached, outdoor fan operates and compressor begins operation 10 seconds later.
- When the ambient temperature reaches 2°F below setpoint, the unit stops operation, whereby, the compressor and outdoor fan stop operation. Under indoor fan cycle mode, the indoor fan stops operation after operating at set fan speed for 60 seconds (except when it requires the indoor fan to operate in protection mode). If the fan cycle mode is not selected, the indoor fan operates at the set fan speed.
- When the indoor fan is set at high speed, the outdoor fan operates at high speed.
- When the indoor fan is set at low speed, outdoor fan operates at low speed.
- When the unit starts in cooling mode for the first time and the indoor fan is set to low speed, the outdoor fan starts at high speed. After operating for 3-1/2 minutes and the outdoor tube temperature is below 140°F (60°C), the outdoor fan switches over to low speed. First time start-up includes, when switching to low speed cooling from non-cooling mode or when the unit starts low speed cooling for the first time or enter low speed cooling after a power failure.
- During cooling mode, and when there is no outdoor condenser high temperature condition, the unit stops:
  – When it reaches the setpoint.

– When the unit stops for a temperature sensor error.
– When the unit stops for freeze protection.
– When the start-up condition of outdoor fan is met.
– When the indoor fan operates at high fan speed for 3 seconds and then turn to set fan speed.

If high temperature protection occurs during cooling mode, the outdoor fan is forced to operate at high speed. When the start-up condition of outdoor fan in heating mode is met, the outdoor fan operates at high fan speed for 3 seconds and then turns ON to set the fan speed. When the indoor fan starts operation, the indoor fan operates at high fan speed for 3 seconds and then turns ON to set fan speed.

- Press the Constant Fan button when in cooling or heating mode to turn ON/OFF the constant fan function. this function is invalid in wired controller mode. If constant fan mode is ON, the fan motor constantly operates. If constant fan mode is OFF, the fan stops as the load stops. The fan speed is controlled by the Fan Speed button (if a wired controller is connected, the fan speed follows the command of wired controller). The controller controls whether the fan is operating or not. The status does not change when:
  – Switching modes.
  – When turning the unit ON/OFF.
  – Switching to wired controller mode.
  – Switching to panel mode.
  – Energizing after a power failure.

Heating Mode Functions

When the heating mode LED is lit, and the set fan speed LED is ON. The digital display shows the set temperature. If select displaying ambient temperature in additional function setting, the digital display shows as described in this mode. The set temperature and fan speed will keep the same when switching modes.

Function

For Heat Pump (General Type)

Note: *The electric heater and compressor cannot operate at the same time.*

- When ambient temperature of the space is 2°F below setpoint, the compressor operates in heating mode. The four-way valve and both the indoor/outdoor fans start operation at set speed. After 10 seconds, the compressor begins operation. If the compressor operates and satisfies the setpoint and minimum operation time of the compressor, then both the compressor and indoor/outdoor fans de-energize. If the compressor does not meet setpoint and the ambient temperature drops to 5°F below setpoint, the compressor de-energizes and after one second, the electric heater starts. The electric heater remains in operation until the setpoint +2°F is satisfied.

  Note: *The minimum compressor run time is 6 minutes*

- When there is a call for heat and the compressor cannot be energized due to the protection function, the electric heat energizes after 15 seconds and remains energized until the setpoint +2°F is satisfied.

Heat/Cool (Pure Electric Heating)

- When the ambient temperature of the space is 2°F below setpoint, the electric heater starts operating and the indoor fan operates at the set fan speed. When the setpoint +2°F is satisfied, the electric heater stops operating. When in fan cycle mode, the indoor fan operates at the condition of circulating residual heat. If the fan cycle mode is not selected, the indoor fan operates at the set fan speed.

Auto Fan Speed Mode

- ***Cooling Mode:***

  Note: *Under Auto Fan Speed control in any mode, there is a 3-1/2 minute delay when switching the speed of the indoor fan.*

- High Speed; when the ambient temperature is 4°F higher than setpoint.
- Low Speed; when ambient temperature is less than setpoint.
- Not Change; when the ambient temperature is 1°F to 4°F higher than setpoint.

- ***Heating Mode:***
  - High Speed; when the ambient temperature is 4°F lower than setpoint.
  - Low Speed; when ambient temperature is more than setpoint.
  - Not Change; when the ambient temperature is 1°F to 4°F lower than setpoint.

Additional Functions

After the unit is turned ON for 30 seconds, press and hold ▼ for 5 seconds to start up the configuration mode. After entering this mode, if adjusting the temperature compensation value by buttons to turn to unit ON/OFF condition, the load will be activated after 3 seconds. While if entering unit on or off condition due to the change of the ambient temperature, it can be activated only after quitting the configuration mode. The following functions are available when selecting the **Low Button**:

- Fahrenheit/Celsius Mode: press the ▲ or ▼ buttons to switch between F° or C°.
- Adjusting Cooling or Heating Values: press the ▲ or ▼ buttons to increase/decrease the temperature values in 1° increments. The adjusting range of the indoor ambient temperature compensation value is between -6°F and 6°F (-3°C and 3°C). The compensation temperature defaults to 0°F in either cooling or heating mode. The unit can allocate different compensation temperatures in cooling or heating mode, respectively.

  Note: *Trane recommends leaving the compensation value set to its default of 0°F.*
- Display Switchover Between Set Temperature/Ambient Temperature Mode: press the ▲ or ▼ buttons to set either set temperature or ambient temperature.
- Set Temperature Display: the digital display shows SP. After quitting configuration mode, the set temperature displays constantly in either heating or cooling mode.
- Ambient Temperature Display: The digital display shows AA. After quitting configuration mode, the ambient temperature displays constantly in either heating or cooling mode. Under certain circumstances, the unit displays the set temperature for 10 second and then switches to display ambient temperature as follows:
  - Press mode button (mode button includes Cool button and Heat button).
  - Re-energize after power failure.
  - Restart the unit.
  - Turn on the unit after EM turns off unit.
  - Adjust the set temperature using the ▲ or ▼ buttons.
- Quitting Configuration Mode: is stopped when pressing the mode button or if no button is pressed within 30 seconds.

Resetting Timer

Press ▲ or ▼ simultaneously for 3 seconds under the protection for compressor and electric heater minimum stop time or the protection for compressor minimum operation time, reduces the protection time.

Memory

The controller runs to the last mode set prior to a power failure. The following settings are also retained prior to a power failure:

- Operation mode.
- Set fan speed.
- Set temperature.
- value in minimum stop time of compressor.
- Fahrenheit/Celsius display mode.
- Cooling compensation temperature.

The unit operates in default Fan Mode when there is no memory. Fan speed is set to high with the T-value of 0 and Fahrenheit display mode. Cooling compensation temperature is 0 and heating compensation temperature is 0. The default set temperature is 71°F (22°C). The digital display shows the set temperature under cooling and heating mode.

Restore Factory Settings

When pressing the Low button and p for 3 seconds, the digital display shows 00 for 3 seconds in standby and OFF status. This indicates that the factory settings have been restored. The configuration information defaults to display:

- Fahrenheit.
- Heating compensation temperature of 0.
- Cooling compensation of 0.
- Set temperature.

The T-value is 0, the Fan Speed is set to High, and the set temperature is 71°F (22°C).

Dip Switches

The auxiliary dip switch controls are located behind the front panel and through an opening below the control panel. To access, you must remove the front panel. The dip switches are accessible without opening the control box, but the unit must be powered OFF to effectively change functions.

Note: *Factory settings for dip switches will be in the DOWN position. Refer to the following for the functionality of each dip switch position.*

Important: *Unit power must be cycled before changes to dip switch settings take effect.*

Table 4. Dip Switch Functions

Dip Switch No.	Up		Down		Default	Remarks
1	Electric Heat Only[a]		Heat Pump		Down	For Heat Pump Units Only
2	Wall Thermostat Enable[b]		Control Panel Enable		Down	
5,6	Up*Up[c] 68°F to 75°F (20°C to 24°C)	Up*Down 63°F to 80°F (18°C to 28°C)	Down*Up 65°F to 78°F (19°C to 26°C)	Down*Down 61°F to 86°F (16°C to 30°C)	Down*Down 61°F to 86°F (16°C to 30°C)	Configurations 5 and 6 combine to select setpoint range. When setpoint limit set, display always shows full. range.
7	Freeze Guard Disable		Freeze Guard Enable[d]		Down	

[a] Used for emergency heating.

[b] A wired wall thermostat can be connected to the unit. If so, this dip switch must be moved to the wall thermostat enable position before the wall thermostat begins to control.

[c] All setpoint limits provide a restricted range of temperature control.

[d] If the unit senses a room temperature below 40°F (4.44°C), the fan motor and electric strip heat turn on and warm the room to 50°F (10°C). The fan stops a short time after satisfying the temperature.

Service Installation

⚠ WARNING

Hazardous Service Procedures!

Failure to follow all precautions in this manual and on the tags, stickers, and labels could result in death or serious injury.

Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, MUST follow precautions in this manual and on the tags, stickers, and labels, as well as the following instructions: Unless specified otherwise, disconnect all electrical power including remote disconnect and discharge all energy storing devices such as capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. When necessary to work with live electrical components, have a qualified licensed electrician or other individual who has been trained in handling live electrical components perform these tasks.

⚠ WARNING

Hazardous Voltage!

Failure to disconnect power before servicing could result in death or serious injury.

Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Verify that no power is present with a voltmeter.

⚠ WARNING

Live Electrical Components!

Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

When it is necessary to work with live electrical components, have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks.

⚠ WARNING

Personal Protective Equipment (PPE) Required!

Failure to wear proper PPE for the job being undertaken could result in death or serious injury.

Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, MUST follow precautions in this manual and on the tags, stickers, and labels, as well as the instructions below:

- **Before installing/servicing this unit, technicians MUST put on all PPE required for the work being undertaken (Examples; cut resistant gloves/sleeves, butyl gloves, safety glasses, hard hat/bump cap, fall protection, electrical PPE and arc flash clothing). ALWAYS refer to appropriate Material Safety Data Sheets (MSDS)/Safety Data Sheets (SDS) and OSHA guidelines for proper PPE.**
- **When working with or around hazardous chemicals, ALWAYS refer to the appropriate MSDS/SDS and OSHA/GHS (Global Harmonized System of Classification and Labelling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection and handling instructions.**
- **If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other country-specific requirements for arc flash protection, PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASH CLOTHING. ENSURE ELECTRICAL METERS AND EQUIPMENT ARE PROPERLY RATED FOR INTENDED VOLTAGE.**

⚠ WARNING

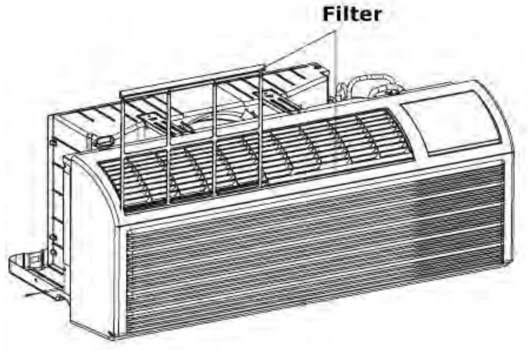
Hazardous Voltage and Gas!

Failure to turn off gas or disconnect power before servicing could result in an explosion or electrocution which could result in death or serious injury.

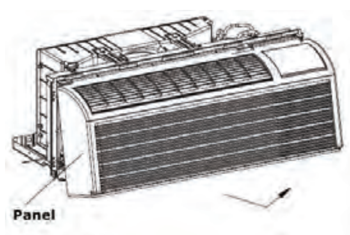
Turn off the gas supply and disconnect all electric power, including remote disconnects, before servicing the unit. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized.

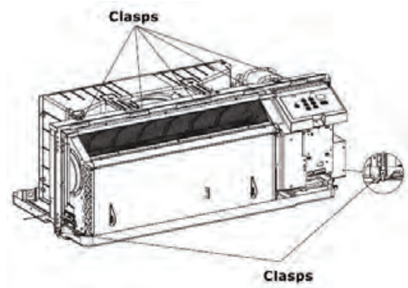
Disassembling the Unit

1. Grasp filter and pull upwards to remove it from the unit.

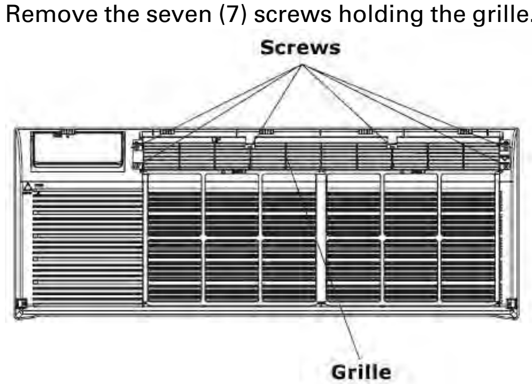


2. Remove the front panel from the unit by grasping the bottom corners and gently pushing in to release the cantilever snap joints.

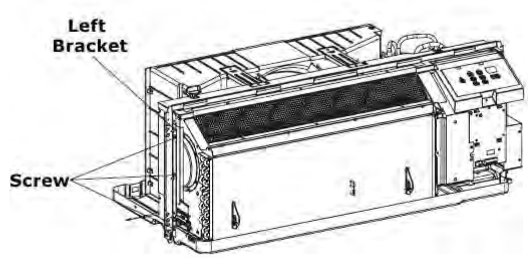




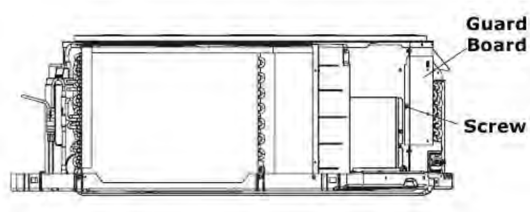
3. Remove the seven (7) screws holding the grille.



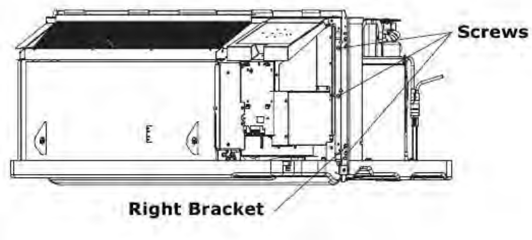
4. Remove the three (3) screws holding the left bracket and then remove the left bracket.



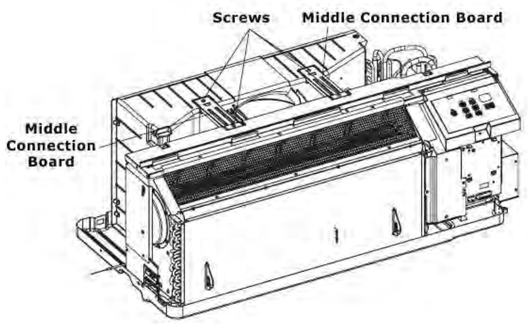
5. Remove the screw holding the guard board and pull is upwards to remove it.



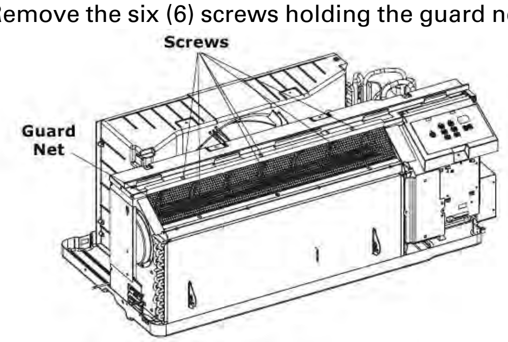
6. Remove the three (3) screws holding the right bracket and then remove the right bracket.



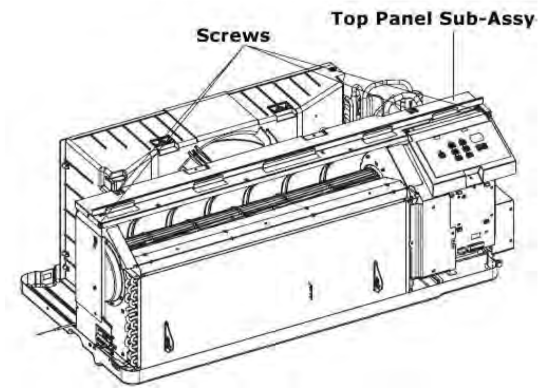
7. Remove the four (4) screws holding the middle connection board and then remove the middle connection board.



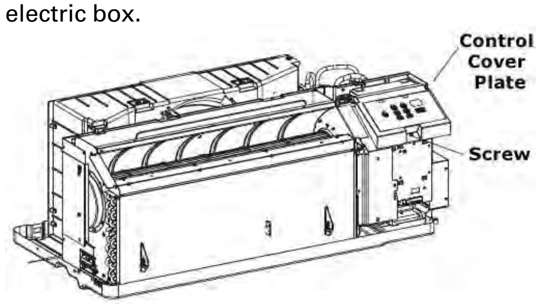
8. Remove the six (6) screws holding the guard net and then remove the guard net.



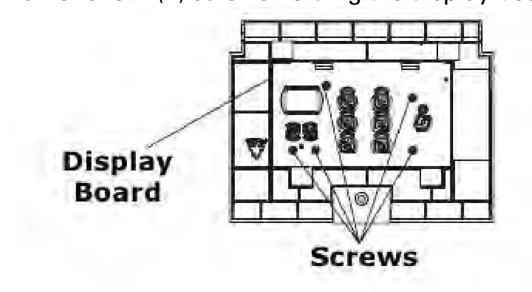
9. Remove the four (4) screws holding the top panel sub-assembly and then remove the sub-assembly.



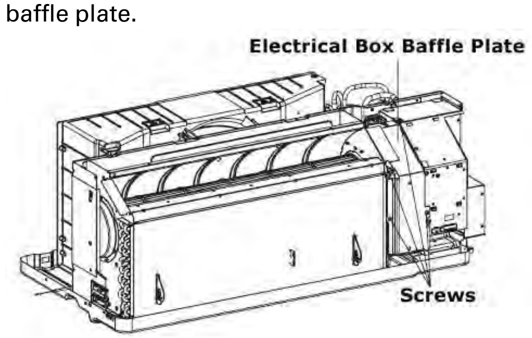
10. Removed the screw holding the control cover plate and pull out the wiring terminal connecting the control cover plate and the electric box. Then, remove the cover plate and electric box.



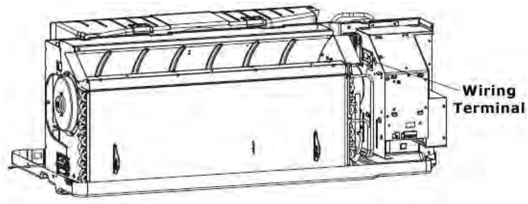
11. Remove four (4) screws holding the display board and then remove the display board.



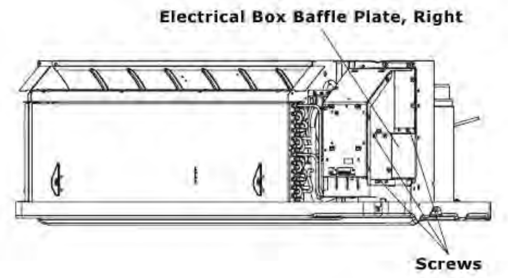
12. Remove four (4) screws holding the baffle plate for the electric box and then remove the baffle plate.



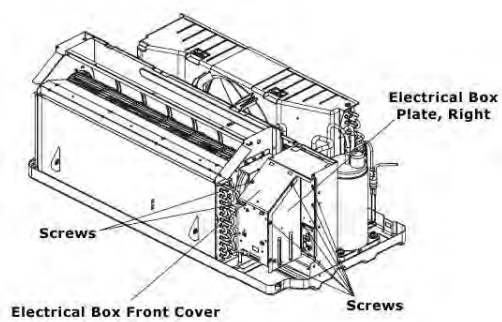
13. Pull out the motor wiring terminal.



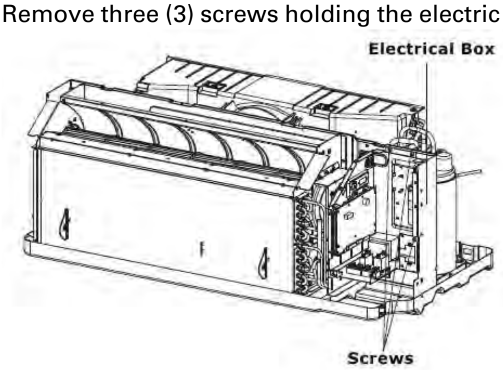
14. Remove four (4) screws holding the right-side baffle plate for the electric box and then remove the right-side baffle plate.



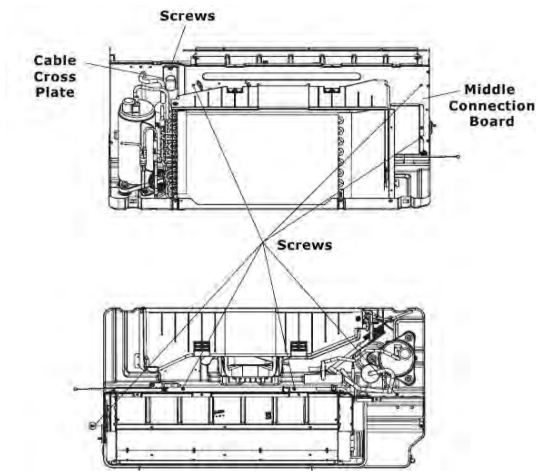
15. Remove seven (7) screws holding the right-side plate for the electric box and then remove the right-side plate.



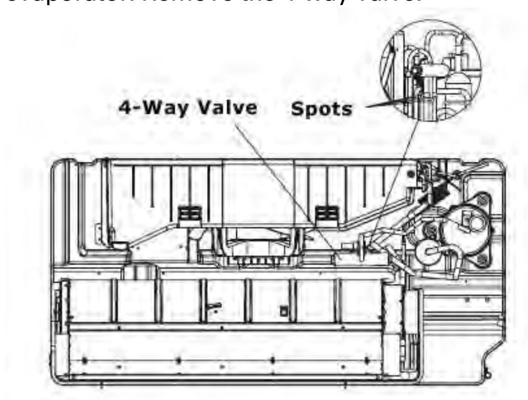
16. Remove two (2) screws holding the front cover of the electric box and then remove the front cover.
17. Remove three (3) screws holding the electric box and then remove the electric box.



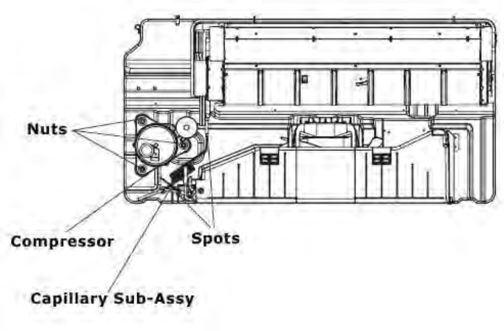
18. Remove seven (7) screws holding the middle connection board and then remove the middle connection board.



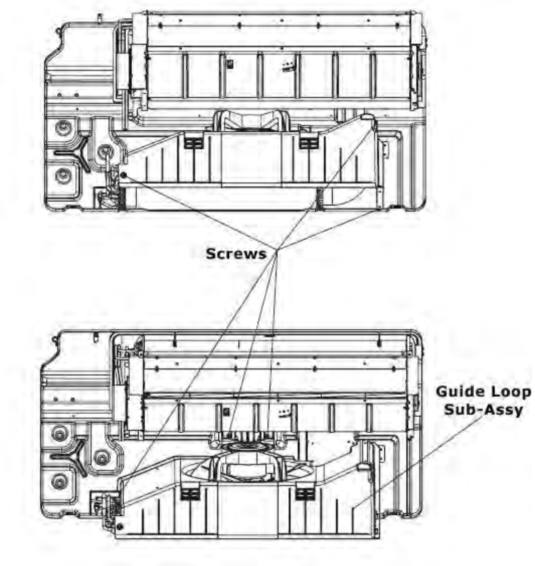
19. Remove the screw holding the cable cross and then remove the cable cross.
20. Unsolder the spot weld between the 4-way valve and the compressor, condenser, and the evaporator. Remove the 4-way valve.



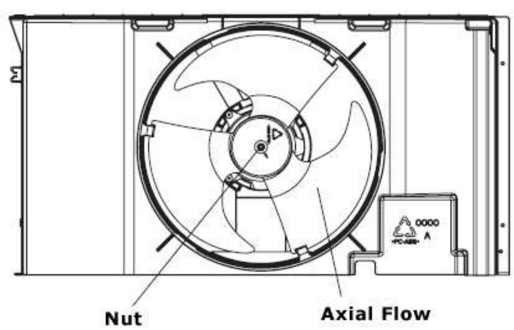
21. Remove three (3) nuts holding the compressor and then remove the compressor.



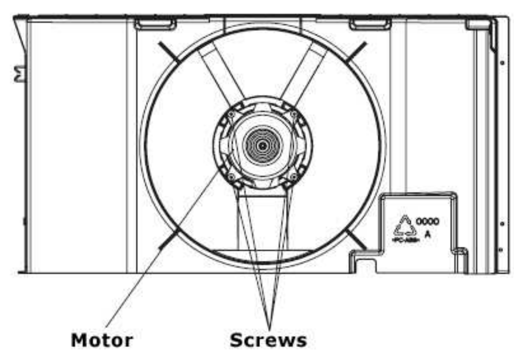
22. Unsolder the spot weld between the capillary sub-assembly and condenser Remove the capillary.
23. Remove six (6) screws holding the guide loop sub-assembly and then pull upwards to remove the guide loop sub-assembly.



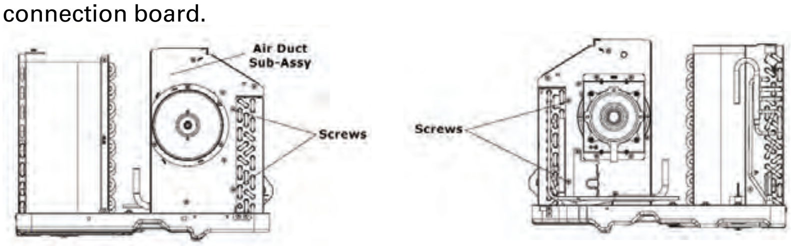
24. Remove the nuts holding the axial flow blade and the pull outwards to remove the axial flow blade.



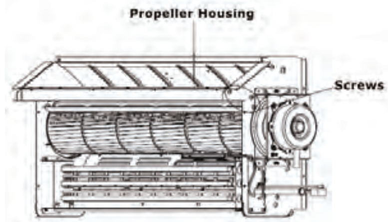
25. Remove four (4) screws holding the motor and then remove the motor.

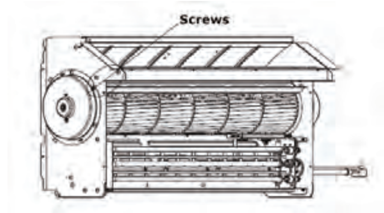


26. Remove four (4) screws holding the middle connection board and then remove the middle connection board.

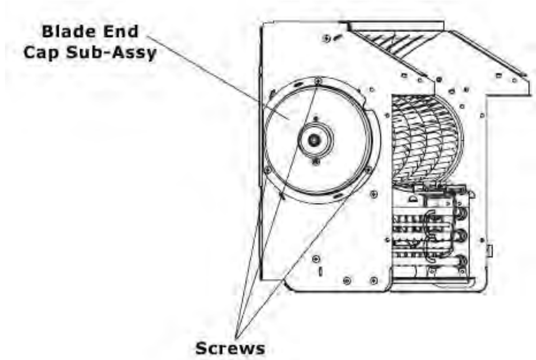


27. Remove four (4) screws holding the propeller housing and then remove the propeller housing.

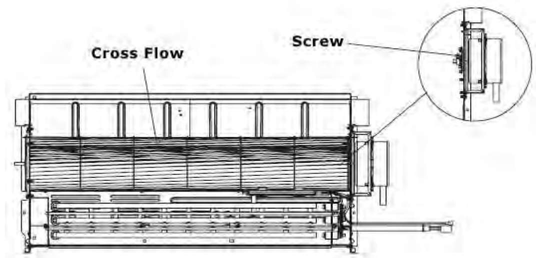




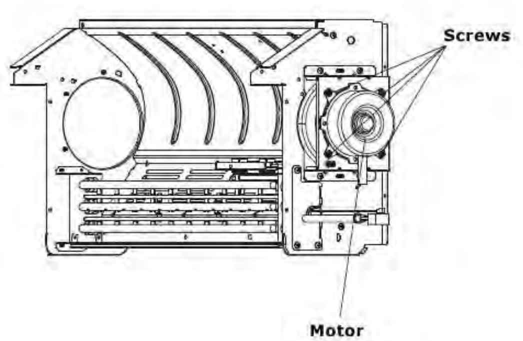
28. Remove three (3) screws holding the blade end cap sub-assembly and then remove the blade end cap sub-assembly.



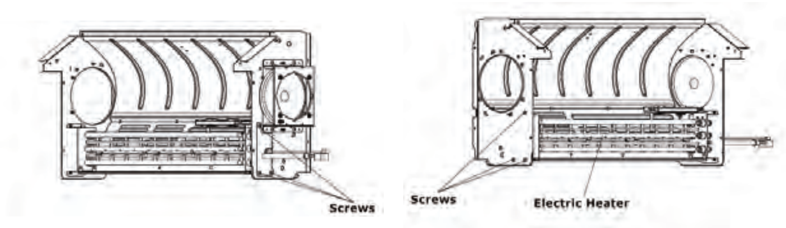
29. Remove screw holding the cross-flow blade and then remove the cross-flow blade.



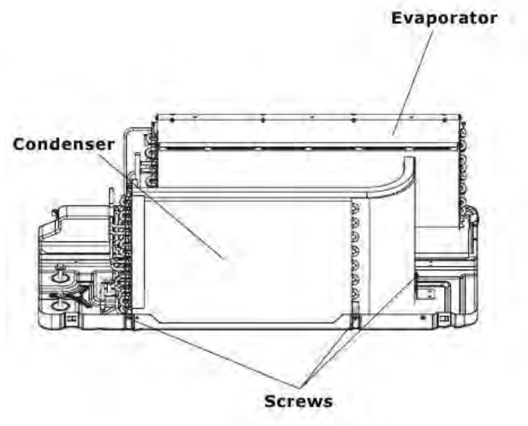
30. Remove four (4) screws holding the motor and then remove the motor.



31. Remove six (6) screws holding the electric heater and then remove the electric heater.



32. Pull the evaporator upwards to remove, the remove three (3) screws holding the condenser. Pull upwards to remove the condenser.



TRANE

Temperature and Resistance Charts

Ambient Temperature Sensors for Indoor/Outdoor, 15K

Temp.(°F)	Resistance(kΩ)	Temp.(°F)	Resistance(kΩ)	Temp.(°F)	Resistance(kΩ)	Temp.(°F)	Resistance(kΩ)
-2.2	138.1	68	18.75	138.2	3.848	208.4	1.071
-0.4	128.6	69.8	17.93	140	3.711	210.2	1.039
1.4	121.6	71.6	17.14	141.8	3.579	212	1.009
3.2	115	73.4	16.39	143.6	3.454	213.8	0.98
5	108.7	75.2	15.68	145.4	3.333	215.6	0.952
6.8	102.9	77	15	147.2	3.217	217.4	0.925
8.6	97.4	78.8	14.36	149	3.105	219.2	0.898
10.4	92.22	80.6	13.74	150.8	2.998	221	0.873
12.2	87.35	82.4	13.16	152.6	2.896	222.8	0.848
14	82.75	84.2	12.6	154.4	2.797	224.6	0.825
15.8	78.43	86	12.07	156.2	2.702	226.4	0.802
17.6	74.35	87.8	11.57	158	2.611	228.2	0.779
19.4	70.5	89.6	11.09	159.8	2.523	230	0.758
21.2	66.88	91.4	10.63	161.6	2.439	231.8	0.737
23	63.46	93.2	10.2	163.4	2.358	233.6	0.717
24.8	60.23	95	9.779	165.2	2.28	235.4	0.697
26.6	57.18	96.8	9.382	167	2.206	237.2	0.678
28.4	54.31	98.6	9.003	168.8	2.133	239	0.66
30.2	51.59	100.4	8.642	170.6	2.064	240.8	0.642
32	49.02	102.2	8.297	172.4	1.997	242.6	0.625
33.8	46.6	104	7.967	174.2	1.933	244.4	0.608
35.6	44.31	105.8	7.653	176	1.871	246.2	0.592
37.4	42.14	107.6	7.352	177.8	1.811	248	0.577
39.2	40.09	109.4	7.065	179.6	1.754	249.8	0.561
41	38.15	111.2	6.791	181.4	1.699	251.6	0.547
42.8	36.32	113	6.529	183.2	1.645	253.4	0.532
44.6	34.58	114.8	6.278	185	1.594	255.2	0.519
46.4	32.94	116.6	6.038	186.8	1.544	257	0.505
48.2	31.38	118.4	5.809	188.6	1.497	258.8	0.492
50	29.9	120.2	5.589	190.4	1.451	260.6	0.48
51.8	28.51	122	5.379	192.2	1.408	262.4	0.467
53.6	27.18	123.8	5.197	194	1.363	264.2	0.456
55.4	25.92	125.6	4.986	195.8	1.322	266	0.444
57.2	24.73	127.4	4.802	197.6	1.282	267.8	0.433
59	23.6	129.2	4.625	199.4	1.244	269.6	0.422
60.8	22.53	131	4.456	201.2	1.207	271.4	0.412
62.6	21.51	132.8	4.294	203	1.171	273.2	0.401
64.4	20.54	134.6	4.139	204.8	1.136	275	0.391
66.2	19.63	136.4	3.99	206.6	1.103	276.8	0.382

Tube Temperature Sensors for Indoor/Outdoor, 20K

Temp.(°F)	Resistance(kΩ)	Temp.(°F)	Resistance(kΩ)	Temp.(°F)	Resistance(kΩ)	Temp.(°F)	Resistance(kΩ)
-2.2	181.4	68	25.01	138.2	5.13	208.4	1.427
-0.4	171.4	69.8	23.9	140	4.948	210.2	1.386
1.4	162.1	71.6	22.85	141.8	4.773	212	1.346
3.2	153.3	73.4	21.85	143.6	4.605	213.8	1.307
5	145	75.2	20.9	145.4	4.443	215.6	1.269
6.8	137.2	77	20	147.2	4.289	217.4	1.233
8.6	129.9	78.8	19.14	149	4.14	219.2	1.198
10.4	123	80.6	18.13	150.8	3.998	221	1.164
12.2	116.5	82.4	17.55	152.6	3.861	222.8	1.131
14	110.3	84.2	16.8	154.4	3.729	224.6	1.099
15.8	104.6	86	16.1	156.2	3.603	226.4	1.069
17.6	99.13	87.8	15.43	158	3.481	228.2	1.039
19.4	94	89.6	14.79	159.8	3.364	230	1.01
21.2	89.17	91.4	14.18	161.6	3.252	231.8	0.983
23	84.61	93.2	13.59	163.4	3.144	233.6	0.956
24.8	80.31	95	13.04	165.2	3.04	235.4	0.93
26.6	76.24	96.8	12.51	167	2.94	237.2	0.904
28.4	72.41	98.6	12	168.8	2.844	239	0.88
30.2	68.79	100.4	11.52	170.6	2.752	240.8	0.856
32	65.37	102.2	11.06	172.4	2.663	242.6	0.833
33.8	62.13	104	10.62	174.2	2.577	244.4	0.811
35.6	59.08	105.8	10.2	176	2.495	246.2	0.77
37.4	56.19	107.6	9.803	177.8	2.415	248	0.769
39.2	53.46	109.4	9.42	179.6	2.339	249.8	0.746
41	50.87	111.2	9.054	181.4	2.265	251.6	0.729
42.8	48.42	113	8.705	183.2	2.194	253.4	0.71
44.6	46.11	114.8	8.37	185	2.125	255.2	0.692
46.4	43.92	116.6	8.051	186.8	2.059	257	0.674
48.2	41.84	118.4	7.745	188.6	1.996	258.8	0.658
50	39.87	120.2	7.453	190.4	1.934	260.6	0.64
51.8	38.01	122	7.173	192.2	1.875	262.4	0.623
53.6	36.24	123.8	6.905	194	1.818	264.2	0.607
55.4	34.57	125.6	6.648	195.8	1.736	266	0.592
57.2	32.98	127.4	6.403	197.6	1.71	267.8	0.577
59	31.47	129.2	6.167	199.4	1.658	269.6	0.563
60.8	30.04	131	5.942	201.2	1.609	271.4	0.549
62.6	28.68	132.8	5.726	203	1.561	273.2	0.535
64.4	27.39	134.6	5.519	204.8	1.515	275	0.521
66.2	26.17	136.4	5.32	206.6	1.47	276.8	0.509

Discharge Temperature Sensors for Indoor/Outdoor, 50K

Temp.(°F)	Resistance(kΩ)	Temp.(°F)	Resistance(kΩ)	Temp.(°F)	Resistance(kΩ)	Temp.(°F)	Resistance(kΩ)
-20.2	853.5	50	98	120.2	18.34	190.4	4.754
-18.4	799.8	51.8	93.42	122	17.65	192.2	4.609
-16.6	750	53.6	89.07	123.8	16.99	194	4.469
-14.8	703.8	55.4	84.95	125.6	16.36	195.8	4.334
-13	660.8	57.2	81.05	127.4	15.75	197.6	4.204
-11.2	620.8	59	77.35	129.2	15.17	199.4	4.079
-9.4	580.6	60.8	73.83	131	14.62	201.2	3.958
-7.6	548.9	62.6	70.5	132.8	14.09	203	3.841
-5.8	516.6	64.4	67.34	134.6	13.58	204.8	3.728
-4	486.5	66.2	64.33	136.4	13.09	206.6	3.619
-2.2	458.3	68	61.48	138.2	12.62	208.4	3.514
-0.4	432	69.8	58.77	140	12.17	210.2	3.413
1.4	407.4	71.6	56.19	141.8	11.74	212	3.315
3.2	384.5	73.4	53.74	143.6	11.32	213.8	3.22
5	362.9	75.2	51.41	145.4	10.93	215.6	3.129
6.8	342.8	77	49.19	147.2	10.54	217.4	3.04
8.6	323.9	78.8	47.08	149	10.18	219.2	2.955
10.4	306.2	80.6	45.07	150.8	9.827	221	2.872
12.2	289.6	82.4	43.16	152.6	9.489	222.8	2.792
14	274	84.2	41.34	154.4	9.165	224.6	2.715
15.8	259.3	86	39.61	156.2	8.854	226.4	2.64
17.6	245.6	87.8	37.96	158	8.555	228.2	2.568
19.4	232.6	89.6	36.38	159.8	8.268	230	2.498
21.2	220.5	91.4	34.88	161.6	7.991	231.8	2.431
23	209	93.2	33.45	163.4	7.726	233.6	2.365
24.8	198.3	95	32.09	165.2	7.47	235.4	2.302
26.6	199.1	96.8	30.79	167	7.224	237.2	2.241
28.4	178.5	98.6	29.54	168.8	6.998	239	2.182
30.2	169.5	100.4	28.36	170.6	6.761	240.8	2.124
32	161	102.2	27.23	172.4	6.542	242.6	2.069
33.8	153	104	26.15	174.2	6.331	244.4	2.015
35.6	145.4	105.8	25.11	176	6.129	246.2	1.963
37.4	138.3	107.6	24.13	177.8	5.933	248	1.912
39.2	131.5	109.4	23.19	179.6	5.746	249.8	1.863
41	125.1	111.2	22.29	181.4	5.565	251.6	1.816
42.8	119.1	113	21.43	183.2	5.39	253.4	1.77
44.6	113.4	114.8	20.6	185	5.222	255.2	1.725
46.4	108	116.6	19.81	186.8	5.06	257	1.682
48.2	102.8	118.4	19.06	188.6	4.904	258.8	1.64

Troubleshooting and Resources

Troubleshooting Error Codes and Malfunctions

Table 5. Digital Display Error Codes

Error Code No.	Error Description	How Displayed on Unit
1	Indoor ambient temperature sensor is open circuit or short circuit.	Displays F1, Status LED blinks one (1) time and cycles on/off every 3 seconds.
2	Indoor tube temperature sensor is open circuit or short circuit.	Displays F2, Status LED blinks two (2) times and cycles on/off every 3 seconds.
3	Outdoor tube temperature sensor is open circuit or short circuit.	Displays F4, Status LED blinks four (4) times and cycles on/off every 3 seconds.
4	Outlet air temperature sensor failure Refer to Table 5, p. 34.	Displays FJ.
5	Low temperature fault.	Displays FP.
6	Wrong wire connection for wired controller.	Status LED blinks nine (9) times and cycles on/off every 3 seconds.
7	High temperature protection for evaporator.	Status LED blinks eight (8) times and cycles on/off every 3 seconds.
8	High temperature protection for outdoor condenser.	Status LED blinks six (6) times and cycles on/off every 3 seconds.
9	Freeze protection for evaporator.	Status LED blinks five (5) times and cycles on/off every 3 seconds.
10	Frost protection for heat pump.	Status LED blinks seven (7) times and cycles on/off every 3 seconds.
11	Refrigerant loss.	Displays F0.
12	Overload condition.	Displays H3.
13	Compressor over-current condition.	Displays E5.
14	Electric heater element failure.	Displays A2.

Table 6. Malfunction Error Codes and Causes

Error Code No.	Error Code	Malfunction Description	A/C Status	Possible Causes
1	F1	Indoor ambient temperature sensor is open/short circuited.	The unit stops operation as it reaches the temperature point.	• The wiring terminal between the indoor temperature sensor and controller is loosened or has a poor contact. • There is a short circuit due to trip over of the parts on the controller. • The indoor ambient temperature sensor is damaged. Refer to the section, "Temperature and Resistance Information," p. 30. • The main board has failed.
2	F2	Indoor evaporator temperature sensor is open/short circuited.	The unit stops operation as is reaches the temperature point.	• The wiring terminal between the indoor evaporator temperature sensor and controller is loosened or has a poor contact. • There is a short circuit due to trip over of the parts on the controller. • The indoor evaporator temperature sensor is damaged. Refer to the section, "Temperature and Resistance Information," p. 30. • The main board has failed.
3	F4	Outdoor ambient temperature sensor is open/short circuited.	The unit stops operation as is reaches the temperature point.	• The wiring terminal between the outdoor temperature sensor and controller is loosened or has a poor contact. • There is a short circuit due to trip over of the parts on the controller. • The outdoor ambient temperature sensor is damaged. Refer to the section, "Temperature and Resistance Information," p. 30. • The main board has failed.
4	FP	Low temperature prevention protection.	A/C enters into pure electric heating mode and the low temperature protection starts.	• The indoor ambient temperature is lower than 40°F (5°C), continuously. • The indoor ambient temperature sensor is damaged. • The main board has failed.
5	FJ	Air outlet temperature sensor.	The panel control displays error code. This code does not display if unit is OFF, but the error LED does display. All loads, except the indoor fan, are turned OFF under cooling mode. All loads immediately stop under heating mode and the indoor fan blows residual heat for six (6) seconds at the set fan speed. The wired controller does not respond.	• The temperature sensor at the air outlet is loose. • There are foreign objects on the control board that may cause short circuit. • The temperature sensor at the air outlet has failed. • The main board #1 has failed.

Table 7. Malfunction Causes and Solutions

Status	Cause	Solution
Air Conditioner Cannot Be Started		
After energizing, operation indicator is not bright and the buzzer does not sound.	No power supply or poor connection for power plug.	Check for power failure. If so, wait for power recovery. If not, check power supply circuit and ensure the power plug is complete inserted into wall outlet.
Under normal power supply situations, the operation indicator is not bright after energizing.	Poor connection for wiring terminals.	Check the circuit according to the circuit diagram and properly connect the wires. Ensure all wiring terminals are tightly connected.
After energizing, the room circuit breakers immediately trips OFF.	Electric short.	Ensure the unit is properly grounded. Ensure the wires inside unit are properly connected. Check the wiring inside the unit and whether the insulation layer of the power cord is not damaged. If so, replace the power cord.
After energizing, the air switch trips OFF.	Improper model selection for the air switch.	Select the proper air switch.
After energizing, the operation indicator is bright while there is no display on the remote controller or the buttons have no action.	Malfunction of remote controller.	Replace the remote controller batteries. Repair or replace the remote controller.
Air Conditioner Is Cooling Poorly		
Fan motor not operating.	Fan motor malfunction.	Refer to the table section below, "Fan Motor Does Not Operate".
Filter blockage.	Filter is blocked.	Clean the filter.
Unit is not heating or cooling properly in heat pump mode or cool pump mode.	Capillary malfunction.	Replace the capillary.
Unit is not heating or cooling properly in heat pump mode or cool pump mode.	Refrigerant is leaking.	Investigate the cause of the leaks and repair. Add any necessary refrigerant.
Compressor is not operating.	Compressor malfunction.	Refer to the table section below, "Compressor Does Not Operate".
Electric Heater Provides Poor Heating		
Electric heat elements not energizing.	Heating relay on main board is damaged.	Replace main board.
Electric heat element not energizing.	Wiring harness between the main board and display board is loose.	Check wiring harness connection.
Protection of temperature limiter.	Air inlet blocked by objects.	Clean the filter and remove any objects obstructing the inlet.
When turning ON the unit, the heating effect is poor.	Malfunction of temperature limiter. Use a universal meter to measure the two contact points of the temperature limiter. If the resistance value is too large, the temperature limiter is damaged.	Replace the temperature limiter.
Unit is not heating.	Fuse is burned out.	Measure resistance across fuse, If fuse is bad, replace.
Fan Motor Does Not Operate		
Wrong wire connection or a poor connection.	Check the wiring status according to the circuit diagram.	Connect the wires according to the wiring diagram to ensure all wiring terminals are connected securely.
Wire harness connected to main board has a poor connection.	Check wire harness connection.	Ensure wire harness is connected securely.
Using a universal multi-meter measure the capacitance of the capacitor in micro farads. If the measured capacitance is not the same as rated capacitance the capacitor is damaged.	Fan capacitor is damaged.	Replace the fan capacitor.

Table 7. Malfunction Causes and Solutions (continued)

Status	Cause	Solution
Compressor Does Not Operate		
Wrong wire connection or a poor connection.	Check the wiring status according to the wiring diagram.	Connect the wires according to the wiring diagram to ensure all wiring terminals are connected securely.
Compressor relay on main board is damaged or the wire harness of the compressor is loose.	Ensure the relay is functioning correctly in cooling/heat pump mode.	Replace the main board.
Compressor capacitor is damaged.	Using a universal meter measure the micro-farad rating of the capacitor if it is not the same as the rating listed on the capacitor it is damaged.	Replace the compressor capacitor.
Compressor coil burnt out.	Measured resistance between compressor terminals is 0 or open.	Replace the compressor.
Compressor cannot operate.	Compressor cylinder may be blocked.	Open compressor to investigate. Replace the compressor.
Air Conditioning Leaking		
There is water leakage indoors.	Drainage duct blocked.	Eliminate any debris inside drainage duct.
There is water leakage indoors.	Unit has incorrect pitch.	Ensure unit is pitched a 1/4" downward from inside to outside the wall.

Resources

- *Packaged Terminal Air Conditioner Mechanical Specification* (PTAC-PRD001)
- *Packaged Terminal Air Conditioner Product Data Sheet* (PTAC-PRD002)
- *Control Block-off Plate Installation Instructions* (PTAC-SVN024)
- *Power Cord Assembly Installation Instructions* (PTAC-SVN025)
- *Drain Kit Installation Instructions* (PTAC-SVN026)
- *Grille Installation Instructions* (PTAC-SVN027)
- *Wall Sleeve Installation Instructions* (PTAC-SVN028)
- *Knock-Down Wall Sleeve Installation Instructions* (PTAC-SVN029)
- *Wired Controller Installation Instructions* (PTAC-SVN030)
- *Wireless Remote Control with Receiver Installation and Operation* (PTAC-SVU003)
- *Packaged Terminal Air Conditioner Warranty* (PTAC-SVW003)
- *Packaged Terminal Air Conditioner Installation, Operation, and Maintenance* (PTAC-SVX002)

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