

4. Recommended Practice for Heating, Ventilation and Air Conditioning Periodic Inspection and Maintenance

Approved October 16, 2001

APTA Rail Transit Standards Vehicle Inspection and Maintenance Committee

Approved January 24, 2002

APTA Rail Transit Standards Task Force

Authorized February 2, 2002

APTA Rail Transit Standards Executive Committee

Abstract: Heating, Ventilation and Air Conditioning (HVAC) are essential for passenger comfort, and sometimes health, in some North American climates. This recommended practice for inspection of air comfort systems is for all transit systems that consider properly functioning HVAC systems a pre-requisite for revenue service.

Keywords: light rail, heavy rail, heating, air conditioning, ventilation, HVAC, periodic inspection and maintenance

Introduction

(This introduction is not a part of APTA RT-RP-VIM-004-02, *Recommended Practice for Heating, Ventilation and Air Conditioning Periodic Inspection and Maintenance*.)

This Recommended Practice for Heating, Ventilation and Air Conditioning Periodic Inspection and Maintenance for rail transit vehicles represents a common viewpoint of those parties concerned with its provisions, namely, transit operating/planning agencies, manufacturers, consultants, engineers and general interest groups. The application of any standards, practices or guidelines contained herein is purely voluntary. In some cases, federal and/or state regulations govern portions of a rail transit system's operations. In those cases, the government regulations take precedence over these recommended practices. APTA recognizes that for certain applications, the standards or practices, as implemented by individual rail transit systems, may be either more or less restrictive than those given in this document.

This recommended practice describes the periodic inspection and maintenance requirements of HVAC systems found on rail transit vehicles. APTA recommends its use for:

- Individuals or organizations that inspect and maintain air comfort systems on rail transit vehicles;
- Individuals or organizations that contract with others for the maintenance or inspection of air comfort systems on rail transit vehicles; and
- Individuals or organizations that influence how air comfort systems are inspected and maintained on heavy and light rail equipment.

Participants

The American Public Transportation Association greatly appreciates the contributions of the following individual(s), who provided the primary effort in the drafting of the *Recommended Practice for Heating, Ventilation and Air Conditioning Periodic Inspection and Maintenance*:

Lisa Cobb

At the time that this recommended practice was completed, the VIM Committee included the following members:

Jayendra Shah, Chair

Ben Antonio, Vice Chair

Dave Barber
Richard Berk
David Blizzard
Stephen Bonina
Joseph Brattelli
Gordon Campbell
David Case
Dhiren Chakraborty
Lisa Cobb
John Condrasky
Richard Curtis

Phil Eberl
Chris Eichin
Kevin Johnson
David Kowalski
Paul Kovacs
Dave Kubicek
Brian Ley
Lloyd Mack
Joseph Marie
Bill McCoy
James O'Kelly

Thomas Peacock
Mike Perez
David Phelps
James Plomin
John Sadorra
Robert Spadafora
Clive Thornes
Brian Whately
Hannie Woodson

APTA Rail Transit Standards Vehicle Inspection and Maintenance Committee project consultant:

Gordon S. Campbell, *LDK Engineering*

APTA Rail Transit Standards project team:

Gabrielle Bayme, *Standards Development Program Specialist and Project Editor*
Saahir Brewington, *Administrative Assistant and Project Editor*
Antoinette Hankins, *Program Assistant*
Thomas Peacock, *Director-Operations & Technical Services*
David Phelps, *Senior Project Manager - Rail Programs*

Contents

1. Overview	4.1
1.1 Scope	4.1
1.2 Purpose	4.1
2. References	4.1
3. Definitions, abbreviations, and acronyms	4.1
3.1 Definitions	4.1
3.2 Abbreviations and acronyms	4.1
4. Frequency of conduct	4.2
5. Requirements and specific tasks	4.2
5.1 Materials	4.3
5.2 Tools	4.3
5.3 Safety/personal protective equipment	4.3
5.4 Training requirements	4.4
5.5 Inspection and maintenance	4.4
5.6 Correction of deficiencies	4.7

Recommended Practice for Heating, Ventilation and Air Conditioning Periodic Inspection and Maintenance

1. Overview

This recommended practice discusses HVAC systems in a general manner, including compressors, motors, fans, filters, condensers and evaporator coils. It also covers the basic outline for operational checks.

1.1 Scope

This recommended practice is intended for use by rail transit systems as a guide for developing systematic and comprehensive, equipment specific, HVAC inspection procedures.

1.2 Purpose

This document is created for the use of those developing HVAC inspection and maintenance programs for rail transit systems.

2. References

Original Equipment Manufacturer's Manuals for HVAC equipment inspection and maintenance.

Section 608 of the Clean Air Act (CAA) of 1990, as amended.

APTA RT-RP-VIM-010-02, Recommended Practice for Electrical Motor Periodic Inspection and Maintenance.

29 CFR 1910.242b, Compressed Air Used for Cleaning.

3. Definitions, abbreviations, and acronyms

3.1 Definitions

No definitions are included as part of this recommended practice.

3.2 Abbreviations and acronyms

ANSI	American National Standards Institute
CFR	Code of Federal Regulations
EPA	United States Environmental Protection Agency

HVAC	heating, ventilation and air conditioning
MSDS	material safety data sheet
OEM	original equipment manufacturer
OSHA	Occupational Safety and Health Administration

4. Frequency of conduct

Periodic inspection and maintenance tasks on the HVAC systems should be performed on a regular schedule as determined by the rail transit system. The frequency of any task contained within periodic maintenance and inspection should comply with all applicable federal, state and local regulations. Further, in the conduct of a rail transit system's periodic inspection and maintenance programs, frequencies for individual tasks may be established based on a number of additional factors, including but not limited to:

- OEM – recommended intervals
- Industry Experience
- Operating Environment/Conditions
- Historical Data
- Performance Requirements
- Failure Analysis
- Rail Transit System's Testing and Experience
- Reliability Centered Maintenance Programs

5. Requirements and specific tasks

CAUTION: Release of refrigerant into the atmosphere is illegal. All personnel conducting repair, recovery or evacuation on HVAC systems must possess current EPA certification according to Section 608 of the Clean Air Act of 1990, as amended.

WARNING: Only trained and qualified personnel should work on HVAC systems. High voltage, high pressure, rotating equipment, chemical hazards and extremes of temperature are present and can cause serious personal injury. All precautions mandated by the rail transit system, federal, state and local regulatory agencies, including the wearing of personal protective equipment, must be followed.

WARNING: Compressed air used for cleaning must be reduced to less than 30 psi, according to OSHA 29 CFR 1910.242b.

WARNING: Use only those cleaning products and lubricants proven safe and authorized for use by the rail transit system. Consult OEM and MSDS references for suitability for each application to prevent personal injury and damage to the equipment.

5.1 Materials

The following materials are normally required for inspection and maintenance of HVAC systems:

- OEM and rail transit system manuals, including schematics and drawings.
- Cleaning solutions.
- Lubricants.
- Refrigerant.
- Compressed air.
- Filters, and filter dryers.

5.2 Tools

The following tools are normally required for inspection and maintenance of HVAC systems:

- Recovery/Evacuation Unit and Recovery Cylinder.*
- Refrigeration Service Gauges.*
- Vacuum Pump.
- Mechanics Toolbox.
- Special Tools.
- Electronic, Ultrasonic or Ultraviolet Leak Detector or other leak identification device.*
- Air Flow Hood or anemometer, or other velocity/volume-measuring device.*
- Portable Test Unit.
- Scale, to weigh quantity of refrigerant installed and/or recovered.
- Temperature measuring device.

* These tools require periodic calibration as specified by the rail transit system's practices.

5.3 Safety/personal protective equipment

Appropriate personal protective equipment, meeting minimum ANSI standards and as required by the rail transit system, shall be worn at all times in the performance of these inspection and maintenance tasks.

5.4 Training requirements

Rail transit systems and/or their maintenance contractors should develop and execute training programs that provide employees with the knowledge and the skills necessary to safely and effectively perform the tasks outlined in this recommended practice.

5.5 Inspection and maintenance

The following suggested inspection and maintenance procedures are intended for use in conjunction with the OEM's recommended inspection and maintenance procedures. In the event of a conflict with this recommended practice and the manufacturer's recommendations, the manufacturer's recommendations should prevail.

5.5.1 System de-energized inspections

Microprocessor fault data logs and vehicle maintenance history files should be available and reviewed before work begins. Diagnostic information can pinpoint components that are repeatedly failing, perhaps intermittently. Troublesome components can be identified and receive more detailed inspection and functional checks.

5.5.1.1 General mechanical inspections

- a) Inspect housing latches/fasteners for damage and security. Replace/repair as required.
- b) Inspect housing seals for integrity and air bypass.
- c) Inspect housing, panels and structure for corrosion.
- d) Inspect fresh air and return air filters, louvers and grilles. Clean or replace according to OEM instructions or rail transit system requirements.
- e) Inspect all mechanical mounting components for damage and security.

5.5.1.2 Compressor

- a) For open-drive compressors, check the drive/motor coupling for security and excessive wear and play.
- b) Verify oil level in accordance with OEM procedures.
- c) For open drive compressors, check compressor shaft seal for refrigerant leakage. Repair or replace when leakage exceeds OEM recommendations.
- d) Check for refrigerant leakage on compressor fittings, gaskets and seals.
- e) Refer to APTA RT-RP-VIM-010-02, Recommended Practice for Electrical Motor Periodic Inspection and Maintenance for motor inspection.

- f) Extract oil sample where possible and test for proper color and acid content.

5.5.1.3 Piping

- a) Inspect piping for dirty or oily areas. Clean those areas and then use a leak detector to check for leaks. Repair as required.
- b) Check indicator on filter/dryer and replace dryer if it indicates moisture in the system.
- c) Clean all drip trays, drain pipes and nozzles. Inspect for leaks and repair as necessary.
- d) Insure all drains are free-running.
- e) Check condition of vibration-eliminator piping.
- f) Insure that expansion valve sensing bulbs are in correct location and in firm contact with evaporator discharge line, where possible without removing insulation.
- g) Check for integrity and proper installation of piping insulation.

5.5.1.4 Condensers and evaporators

- a) Clean the condenser and evaporator coils and fins with compressed air according to 29 CFR 1910.242b, or use an appropriate cleaning solution. If desired, the effectiveness of cleaning can be measured as a function of pressure drop across the condenser; rail transit system experience and OEM recommendations can establish the appropriate level.
- b) Inspect for damage to fins and coils, and evidence of leaking. Repair per OEM instructions.
- c) Clean and inspect all fan blades. Check that fans rotate freely and without obvious bearing noise.
- d) Clean evaporator drain pans and drain lines.

5.5.1.5 Electrical

- a) Inspect wiring for chafing or other damage, and tighten any loose connections.
- b) Inspect fusible link for continuity and/or damage.
- c) If it applies, inspect all motor commutators and brushes and replace as required.
- d) Lubricate motors, if required.
- e) If heaters are checked with a resistance test, verify resistance values. Check that properly rated fuses are installed in the heating system. Verify that heating resistance element mounting, insulators and hardware are properly installed and not damaged.

- f) Inspect all contactors for cleanliness and integrity.
- g) Perform insulation resistance test on high-voltage circuits.
- h) Inspect contactor tips for signs of arcing.
- i) Refer to APTA RT-RP-VIM-010-02, Recommended Practice for Electrical Motor Periodic Inspection and Maintenance for motor inspection.

5.5.2 System-energized functional tests

5.5.2.1 Controller

- a) Verify correct controller software version is installed.
- b) Verify correct operation of controller using an operational test that verifies appropriate control modes.
- c) Where hard logic is used, check contactor operation.

5.5.2.2 Refrigerant circuit operation

- a) Perform an operational (functional) check of the HVAC system. Monitor gauge pressures versus vehicle temperature to determine acceptable operation. This procedure is done by cycling the HVAC unit through its various cooling modes by simulating ambient and in-car temperatures through the use of a computer or other control box.
- b) Verify that airflow is sufficient.
- c) Check refrigerant level in receiver sight glass, if unit is so equipped.
- d) Verify proper condensate flow.
- e) Verify pump down on reciprocating compressor systems.
- f) Verify superheat at evaporator suction line, if equipped with adjustable thermal expansion valves.
- g) Verify no flash gases (bubbles) in liquid line sight glass, if unit is so equipped.

NOTE: Flash gases may be indicative of a low refrigerant charge or piping restriction.

- h) Check proper pressure switch operation, as required.
- i) Inspect for icing along suction lines, thermal expansion valves and at the evaporator.

5.5.2.3 Heaters

- a) Verify all heaters are operational and are heating the air as required. This may be done by checking heater resistance when not in operation, by checking power consumption in operation, or by checking the temperature near the heater.
- b) Check resistance to ground.
- c) Verify heater contactor operation.
- d) Verify operation of air flow switch device.

5.5.2.4 Mechanical

- a) Check for excessive vibration or noise in operation.
- b) Check compressor oil for proper color and level.
- c) Check unloaders for proper setting and operation.

5.6 Correction of deficiencies

Any deficiencies uncovered during the inspections required in Section 5.5.1 through 5.5.2 should be corrected and documented in accordance with rail transit system procedures and OEM recommendations.