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APTA Bus Maintenance Training
Working Group

Training Syllabus to Instruct Bus Technicians on Fan Drive Operations, Maintenance and Troubleshooting

Abstract: This *Recommended Practice* provides guidelines for establishing a standardized bus maintenance training program related to the theory of operation, maintenance and troubleshooting of bus fan drives and related equipment.

Keywords: 450 amp alternator, belt drive fan system, CAN J-1939, electric fan system, fan drives, fan motor, hydraulic fan system, motor controller, oil cooler

Summary: This *Recommended Practice* provides transit bus maintenance training and transit bus maintenance departments with typical information to evaluate, develop or enhance current training programs for the diagnosis, repair and maintenance of transit bus fan drives. Individual operating agencies should modify these guidelines to specifically teach the coach and OEM manufacturers and modes of operation on their local equipment. The training assumes prerequisite knowledge in electrical and electronics concepts, including the basics of bus multiplex operations. The depth of module development should be consistent with the operating agency's level of repair requirements as defined by the agency's Vehicle Engineering and Maintenance Department.

Scope and purpose: This *Recommended Practice* reflects the consensus of the APTA Bus Standards Program members in conjunction with transit labor organizations, including ATU and TWU, on the subject material, manuals, textbooks, test equipment, methods and procedures that have provided the best performance record based on the experiences of those present and participating in meetings of the program task forces and working groups. APTA recommends the use of this document by organizations that have a training department or conduct training for the maintenance of transit buses; organizations that contract with others for transit bus maintenance training; and organizations that influence how training for transit bus maintenance is conducted.

This document represents a common viewpoint of those parties concerned with its provisions, namely operating/planning agencies, manufacturers, consultants, engineers and general interest groups. The application of any standards, recommended practices or guidelines contained herein is voluntary. In some cases, federal and/or state regulations govern portions of a transit system's operations. In those cases, the government regulations take precedence over this standard. The North American Transit Service Association and its parent organization APTA recognize that for certain applications, the standards or practices, as implemented by individual agencies, may be either more or less restrictive than those given in this document.

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Participants

The American Public Transportation Association greatly appreciates the contributions of the **Bus Maintenance Training Working Group**, which provided the primary effort in the drafting of this document.

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1. Learning environment

For best application of this *Recommended Practice*, a combination of classroom lectures, mentoring, practical training and practice tests should be included in the training program.

2. Computer skills

Basic computer skills are now a standard for transit bus technicians. Basic skills and knowledge in the operation of a computer in a Microsoft Windows environment are essential.

3. Course learning objectives

The modules listed below implement the fan drives standards and learning objectives (see Appendix A) by providing a comprehensive overview of component operations and hands-on practice in diagnosing and repairing fan drives and related equipment. The underlying learning objectives, organization of the modules, and order of instruction of the various tasks have been developed through a labor-management committee of subject matter experts. When a transit bus mechanic demonstrates proficiency in the learning objectives of these modules, he or she should be capable of demonstrating consistent competence in maintaining fan drives and related equipment on the particular buses of the local fleet.

- **Module I: Electrical Fan Drives:** The objective of this module is to provide technicians with knowledge and hands-on practice of proper procedures for inspecting and maintaining transit bus electrical fan drives, including motor controllers, other control components, ignition and motor power circuits and alternators. Emphasis will be placed on properly identifying problems, determining necessary repair and properly performing routine preventive maintenance.
- **Module II: Hydraulic Fan Drives:** The objective of this module is to provide technicians with knowledge and hands-on practice of proper procedures for inspecting and maintaining transit bus hydraulic and belt-driven fan drives. Emphasis will be placed on properly identifying problems, determining necessary repairs and properly performing routine preventive maintenance.

4. Exam requirements

The minimum acceptable grade to pass the course and all practical tests is 75 percent. Students must pass written tests with a minimum grade of 80 percent. ASE has not developed tests in this subject area. Delivery of training should include written pre- and post-training tests and practical demonstrations from the students to confirm that the learning objectives have been achieved.

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Abbreviations and acronyms

- ASE** Automotive Service Excellence
- ATU** Amalgamated Transit Union
- CAN** controller area network
- EDSI** Educational Data Systems Inc.
- NATSA** North American Transit Services Association
- OEM** original equipment manufacturer
- OJT** on-the-job training
- PM** preventive maintenance
- PPE** personal protective equipment
- TWU** Transport Workers Union

Document history

Document Version	Working Group Vote	Public Comment/ Technical Oversight	CEO Approval	Policy & Planning Approval	Publish Date
First published	June 1, 2016	July 7, 2016	Sept. 6, 2016	Sept. 30, 2016	Oct. 6, 2016
First revision					
Second revision					

Appendix A: Fan drives learning objectives/training standards

NOTE: The committee decided not to create a specific order of instruction or assign a 100/200/300 level to these learning objectives. The content is sufficiently similar in difficulty that the distinction is not necessary.

Transit bus fan drives – learning objectives

Electric fan system

Primary motor controller
Diagnose and/or replace primary motor controller
Diagnose and/or replace temperature sensors (air and water)
Diagnose and/or replace circuit breakers

Individual motor controllers

Diagnose and/or replace motor controllers
Diagnose and/or replace address resistors
Diagnose and/or replace temperature sensors (air and water)

Electric fan motors

Diagnose electric fan motors
Repair electric fan motors
Replace electric fan motors

CAN J-1939 Interface

Diagnose CAN J-1939 interface
Repair CAN J-1939 wiring and connectors
Replace CAN J-1939 interface

Diagnostic techniques

Use diagnostic software
Access and interpret fault lights (engine compartment)
Diagnose ignition circuit
Diagnose main motor power circuit

Diagnosing, repairing and replacing fan reversing switch (engine compartment)

Alternator and voltage regulators

Diagnose, repair and/or replace alternator
Diagnose, adjust and/or replace voltage regulator
Diagnose, clean and/or replace air filter
Diagnose and clean air duct

Hydraulic fan system

Diagnose, maintain and/or replace oil
Diagnose, maintain, repair and/or replace oil to oil cooler
Diagnose, maintain, repair and/or replace independent oil cooler
Diagnose, maintain and/or replace electric fan for independent oil cooler
Diagnose, maintain and/or replace temperature sensor for independent oil cooler
Diagnose, maintain, repair and/or replace charge air cooler

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Diagnose, maintain, repair and/or replace hydraulic pump
Diagnose, maintain, repair and/or replace hydraulic fan drive motor
Diagnose, maintain, repair and/or replace belt-driven pumps
Diagnose, maintain, repair and/or replace gear-driven pumps
Replace hydraulic motor bracket
Diagnose, maintain, repair and/or replace switching block/fan control module/dumping valve/priority valve
Use diagnostic software for control block or fan assembly (e.g., Sauer-Danfoss, Eaton)
Replace hydraulic filters
Use hydraulic fluid level indicator; replace if needed
Use hydraulic fluid temperature sensor; diagnose problems related to hydraulic fluid overtemperature
Check hydraulic fan speed and pressure
Diagnose, maintain, repair and/or replace radiator fan bracket
Diagnose, maintain, repair and/or replace radiator fan shroud

Belt drive fan systems

Diagnose, maintain, repair and/or replace miter box

Appendix B: Sample curriculum

Fan Drives Module I

Electrical Fan Drives

Goal: Participants should understand and be able to explain and demonstrate how to identify electric fan drive components, and inspect, maintain and diagnose those components and related systems.

Objectives:

Following the completion of this module, the technician should be able to:

- understand how components of the electric fan system operate, and how they interface with bus data links;
- diagnose and replace motor controllers, circuit breakers, sensors and other control equipment;
- maintain electric fan motors;
- understand J-1939 protocol and use for diagnosis;
- maintain J-1939 data bus;
- use diagnostic software;
- diagnose ignition and motor power circuit problems; and
- maintain alternators, voltage regulators and related components.

Course description: Participants will receive classroom instruction and demonstrations on a bus, where a qualified instructor will provide knowledge and hands-on practice of proper procedures for inspecting and maintaining transit bus electrical fan drives, including motor controllers, other control components, ignition and motor power circuits and alternators. Emphasis will be placed on properly identifying problems, determining necessary repair, and properly performing routine preventive maintenance. Participants should leave the course with confidence in maintaining electrical fan drive equipment.

Recommended class size: 6:1 or fewer

Prerequisites: Electrical and electronics familiarization, including multiplexing functions

Delivery method (e.g., lecture, hands-on, online, lab): Instructor-led

Course duration: 8 hours, depending on number of types in use at agency

Target audience: All new and existing bus technicians.

Classroom equipment and supplies: Notepads, pens/pencils, flip chart or whiteboard board (and markers), classroom, laptop, projector, highlighters, note cards and name cards

Course materials, training aids and references: Student workbooks, manuals, handouts, PowerPoint, pre- and post-training questions; laptops with OEM software, buses for use in diagnostic practice.

Instructor:

Course developer: Brian Lester, EDSI

Subject matter experts: Darryl Desjairlais (New Flyer); John Webster (ATU Local 382)

Revision date: 10/22/13

Follow-up: 2016 unless new technology introduced

Instructor and course evaluation: Local course evaluation sheets should be used if present.

Job tasks/learning objectives/OJT checklist: The concrete tasks that can be performed to apply the knowledge taught in this course and reinforce the content are found in the learning objectives in Appendix A under the “Electric fan drives” heading.

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Fan Drives Module II
Hydraulic Fan Drives

Goal: Participants should understand and be able to explain and demonstrate how to identify hydraulic fan drive components. Participants will identify types of hoses and fittings and inspect, maintain and diagnose hydraulic fan components and related systems.

Objectives:

Following the completion of this module, the technician should be able to:

- review basic principles and theories of hydraulic system dynamics;
- understand how components of the hydraulic fan system operate;
- identify types of hydraulic hoses and fittings and demonstrate repair methods;
- maintain oil-to-oil cooler, independent oil cooler, electric fan motor and temperature sensor for coolers;
- maintain hydraulic pumps and hydraulic fan motor;
- maintain belt- and gear-driven pumps and miter box;
- maintain fan control module or similar equipment;
- use diagnostic software;
- diagnose hydraulic fluid overtemperature problems; and
- check hydraulic system flow and pressure.

Course description: Participants will receive classroom instruction and demonstrations on a bus, where a qualified instructor will provide knowledge and hands-on practice of proper procedures for inspecting and maintaining transit bus hydraulic and belt-driven fan drives. Emphasis will be placed on properly identifying problems, determining necessary repair and properly performing routine preventive maintenance. Participants should leave the course with confidence in maintaining hydraulic fan drive equipment.

Recommended class size: 6:1 or fewer

Prerequisites: Basic understanding of hydraulic principles, and electrical-electronic system familiarization including multiplexing

Delivery method (e.g., lecture, hands-on, online, lab): Hands-on and classroom

Course duration: 8 hours

Target audience: All new and existing bus technicians

Classroom equipment and supplies: Notepads, pens/pencils, flip chart or whiteboard board (and markers), classroom, laptop, projector, highlighters, note cards and name cards

Course materials, training aids and references: Student workbooks, manuals, handouts, PowerPoint, pre- and post-training questions; laptops with OEM software, buses for use in diagnostic practice

Instructor:

Course developer: Brian Lester, EDSI

Subject matter experts: Darryl Desjairlais (New Flyer); John Webster (ATU Local 382)

Revision date: 10/22/13

Follow-up: 2016 unless technology or manufacturers change earlier

Instructor and course evaluation: Local course evaluation sheets should be used if present.

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Job tasks/learning objectives/OJT checklist: The concrete tasks that can be performed to apply the knowledge taught in this course and reinforce the content are found in the learning objectives in Appendix A under the “Hydraulic fan drives” heading.