10. APTA PR-E-RP-011-98 Recommended Practice for Head End Power Load Testing

Approved January 22, 1998
APTA PRESS Task Force

Authorized March 17, 1999
APTA Commuter Rail Executive Committee

Abstract: This recommended practice provides guidance for load testing the head end power (HEP) generating system on passenger rail vehicles.

Keywords: head end power, load testing

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 Head End Power Load Testing.*

James Dietz

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

Doug Warner, *Chair*

Gilbert L. Bailey
Brad Barkman
Ronald Bartels
Richard Benjamin
Dick Bruss
Daniel L. Davis
James Dietz
Dave Elliott
Hassan A. Fazli
Bert Gagne
Peter Hale
Carl C. Herrmann
Stephen Hilbert
LeRoy D. Jones
Brian Ley
Otto Masek
Rich Mazur
Chuck Olson
David Phelps
Craig Prudian
George Scerbo
Ike Tingos
Steve Zuiderveen

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1. Overview

1.1 Scope

This recommended practice defines the requirements for load testing the head end power (HEP) generating system on passenger rail vehicles.

The passenger rail industry phased this recommended practice into practice over the six-month period from July 1 to December 31, 1999. The recommended practice took effect January 1, 2000.

1.2 Purpose

This document establishes a standard procedure for determining the performance of HEP generating system under the following conditions:

1. After initial assembly, major overhaul, or repairs affecting performance of the system;

2. To determine condition of equipment as a guide to required repairs; or

3. To test equipment as required for equipment inspection reports.

2. References

IEEE Std 100-1996, “The IEEE Standard Dictionary of Electrical and Electronics Terms”

3. Definitions, abbreviations and acronyms

3.1 Definitions

For the purpose of this recommended practice, the following definitions apply.

3.1.1 head end power (HEP): A system by which 480 VAC, 3-phase electrical power, to operate auxiliaries, is provided to railroad vehicles via a trainline system. The power source can be locomotive (hence "Head End"), power car, or wayside power source.

3.1.2 HEP trainline: An electrical cable system which allows HEP power to be transmitted over the entire length of a train. It includes both power and control conductors. The trainline may connect to equipment in each vehicle, or may simply pass straight through, providing a power path between vehicles on opposite ends of that vehicle.

3.1.3 HEP jumper cable: A cable assembly, having a 6 conductor (3 power and 3 control pins)

plug on one or both ends, which is used to provide a flexible electrical connection between two cars and/or locomotives or a wayside equipment.

3.1.4 HEP receptacle: The receptacle(s) mounted on the ends of rail vehicles and wayside equipment into which the HEP jumper cables mate.

3.1.5 trainline complete (TLC): A series continuity check circuit used to determine that all trainline jumper cables throughout the consist are plugged in. The circuit provides an indication at the HEP control panel and is interlocked with the HEP main contactor/ circuit breaker to allow trainlines to be energized only when the TLC is established.

3.1.6 wayside power: An installation which provides HEP from a ground-based source, used to provide power to the consist when the on-board source is unavailable, such as in a yard. Generally, utility power is used, though sometimes a diesel generator is provided.

3.1.7 HEP switchgear: The contractors, circuit breakers, power switches, overload protection and associated control components used to connect the HEP power source to the trainline system.

3.1.8 load box: A piece of wayside equipment used to provide a test load and for an HEP source to allow its performance to be measured. The equipment consists of a variable resistance load, cooling fan, load control switching, control panel and instrumentation.

4. Load box

The load box should consist of:

- variable resistance load
- cooling fan(s)
- load control switching
- control panel
- instrumentation
- suitable weather proof enclosure
- receptacles and cables to connect the unit to the vehicle being tested

4.1 Variable resistance load

The resistance load should be balanced and variable in 10% steps or smaller from zero to full load. Suitable contractors should be provided to effect these load changes, as well as isolate the entire load. It should be possible to apply approximately 50% of the load in a single step to allow testing of the source to a step load. The resistance load should enable the HEP source being tested to be continuously loaded to at least 110% of the source rated capacity.

4.2 Controls and indicators

A control panel should be provided to operate the load box, including on/off control, load adjustment, power on and fault indication.

4.3 Meters

The control panel should be provided with the following meters to show performance of the HEP system under test as follows: a voltmeter capable of reading each of the 3 phases, reading phase-phase voltage; 2% or better accuracy, an ammeter capable of reading each of the 3 phases, reading phase current; 2% or better accuracy, a wattmeter capable of reading combined load from all 3 phases; 2 % or better accuracy and a frequency meter: reading the frequency of the HEP source; +/- 0.25 Hz over the range of 55-65 Hz or better accuracy.

The meters should be rugged industrial quality, suitable for the operating environment, including but not limited to ambient temperature range.

4.4 Cables

Suitable cabling should be provided to connect the load box to the equipment under test.

If the load box will be used in the field on complete locomotives (or power cars), a suitable pair of receptacles and jumper cables should be provided to connect the load box to two of the HEP receptacles on the vehicle under test. The load box end of the cable system should provide the trainline complete circuit (by providing continuity between the #1 control pins of the jumper cables).

4.5 Certification

The load box should undergo periodic test and calibration, including meters, at least annually, or as specified by the manufacturer. A complete system functional test should be performed annually. Records should be kept with the equipment, and should be available upon request by test observers.

5. Procedure

5.1 Setup

a) Connect the load box to the HEP unit to be tested.

b) Check the load box instrumentation for proper initial readings.

c) Activate the load box, fan started, etc., but with zero load applied.

d) Warm up the HEP source as required to bring the engine up to normal operating temperature required before a load is applied.

5.2 Load test

In each of the following steps, watch the instruments to see whether the engine and voltage regulator respond correctly to the change. During the large-change steps, pay particular attention that control of the engine speed is maintained: the engine does not bog down when the load is applied, does not run away when the load is decreased, and that under/over frequency or voltage trips do not occur.

a) Apply load in steps up to the full source rated load.

b) Drop half of the load in one step.

c) Drop entire remaining load in one step.

d) Apply 50% of the rated load in one step.

e) Apply the remaining load (to attain full rated load) in one step.

f) Drop entire load in one step.

g) Gradually apply the load up to full rated capacity of the source. Allow the system to operate for one-half hour. (If the railroad requirement differs, that specified time should apply.) At the end of this period:

- confirm that the prime mover continues to operate normally (no overheating, etc.)
- the HEP switch gear shows no distress nor signs of overheating

For system which employ split-bus trainlines, the following should also apply:

h) Conduct step g above with the load box connected only to the left side trainline bus.

i) Conduct step g above with the load box connected only to the right side trainline bus.

j) If the single bus rating is less than the HEP rating with both buses active, conduct step g with the load applied to both buses simultaneously and the load at full system rated load.

5.3 Completion

- Reduce the load to zero and shut down the HEP source. If required, allow the system to cool off before shutting down the engine.
- Disconnect the load box.
- Complete the documents recording the load test.

The data sheet on the following page should be used to record test results of the Head End Power Load test unless a different form is required by the railroad. In either case, the data sheet should be fully completed, signed and filed for future reference.

6. Data sheet: Head end power load test

Locomotive/ Car Number _____Date of Test _____
HEP System Serial Number _____Tester _____
Reason for conducting load test _____
Serial Number of Load Box_____
Date of Load Box Certification_____

Setup

1. Load box instrumentation reads properly: Yes/ No
2. HEP system warmed up for _____ minutes

Load Test

1. Apply load in steps up to full source rated load _____
   Rated load: Voltage: _____ Volts
   Current: _____ Amps
   Power: _____Watts
   Frequency: _____Hertz
2. Drop 50% of the load in one step _____
3. Drop entire remaining load in one step. _____
4. Apply 50% of the rated load in one step. _____
5. Apply the remaining load (to attain full rated load) in one step.____
6. Drop entire load in one step. _____
7. Gradually apply the load up to full rated capacity of the source. Allow the system to operate for ½ hour. (If the railroad requirement differs, that specified time should apply.) At the end of this period:
   -confirm the engine (and inverter if equipped) continues to operate normally (no overheating, etc.) _____
   -the HEP switch gear shows no distress nor signs of overheating _____
   -record: Time spent at full load:_____ Min.
   Voltage: _____ Volts
   Current: _____ Amps
   Power: _____ Watts
   Frequency: _____ Hertz

For systems which employ split-bus trainlines, the following should also apply:

8. Conduct step 7 above with the load box connected only to the left side trainline bus. ____
9. Conduct step 7 above with the load box connected only to the right side trainline bus.____
10. If the single bus rating is less than the HEP rating with both buses active, conduct step 7 with the load applied to both buses simultaneously and the load at full system rated load._