3. APTA PR-E-RP-003-98 Recommended Practice for Load Testing of Diesel Engines

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Abstract: This recommended practice—adapted from Association of American Railroads RP-545, "Testing of Electrical Components"—establishes a standard procedure, within practical limits, for determining the performance of a diesel engine either to determine condition of equipment as a guide to required repairs or after initial assembly, major overhaul, or repairs affecting the performance of the equipment.

Keywords: load testing, diesel engines, horsepower

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1. Overview

1.1 Scope

This recommended practice covers load testing and determining horsepower output of diesel engines.

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 recommended practice establishes a standard procedure, within practical limits, for determining the performance of a diesel engine under the following conditions:

a) After initial assembly, major overhaul, or repairs affecting the performance of the equipment;

b) To determine condition of equipment as a guide to required repairs; or

c) To test equipment as required by items in 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 purposes of this recommended practice, the following terms and definitions apply. IEEE Std 100-1996, “The IEEE Standard Dictionary of Electrical and Electronics Terms”, should be referenced for terms not defined in this clause.

3.1.1 brake horsepower: The mechanical crankshaft output of the diesel power plant, equal to traction horsepower plus auxiliary load horsepower.

3.1.2 main generator: That engine-driven generator (including direct current generators and alternator-rectifier combinations) whose output provides the traction power to the propulsion system. (Note: Because some models of “main generator” contain both a traction and an auxiliary portion, the term “main traction generator” is herein used where ambiguity or confusion might result.)

3.1.3 traction horsepower: The rating for a diesel power plant which is the manufacturer's guaranteed input to the main generator for traction purposes at standard conditions. Auxiliaries are operated at nominal loads as specified by the manufacturer, except (1) air compressor is unloaded and (2) no power is supplied for head end power or other train service.

4. Technical information

4.1 Test set-up

With diesel engine in locomotive.

With diesel engine on a test rack.

4.2 Loading of engine

When the engine is tested in place on the locomotive, horsepower readings should be adjusted to the standard test conditions as described in 4.6. The main traction generator should be loaded by means of a water rheostat or resistance grid bank of sufficient capacity to load the generator to its maximum rated capacity plus any overload permitted by the manufacturer.

When the engine is tested in a rack, it may be connected to its companion main generator, special test generator, or a suitable dynamometer. If a main generator is used, suitable arrangements must be made to provide the required auxiliary load. The main generator load may be provided by water rheostats, resistance grids or any other suitable means. When special generators or dynamometers are used, they should be of sufficient capacity to permit loading them to include maximum generator capacity plus auxiliary load for the largest power plant to be tested.

4.3 Instruments

Data can be as comprehensive as the individual railroad's desire. Figure 1 shows a sample of horsepower curves. These curves are typical for the nominal ratings shown. Consult specific manufacturer' specifications for upper and lower corner point limits applicable to specific locomotive models.

When a test rack is used, suitable test instruments are generally available for use of permanent test generators or dynamometers and the readings can readily be converted to horsepower output at the engine coupling. When an engine is tested with its companion main generator, the principal readings will be those of generator volts, amperes and engine speed.

The manufacturer's ratings are generally based on some standard conditions of altitude, air and fuel temperature and specific gravity of the fuel. When such adjustment is desired, suitable test thermometers, hydrometers and barometers will be required.

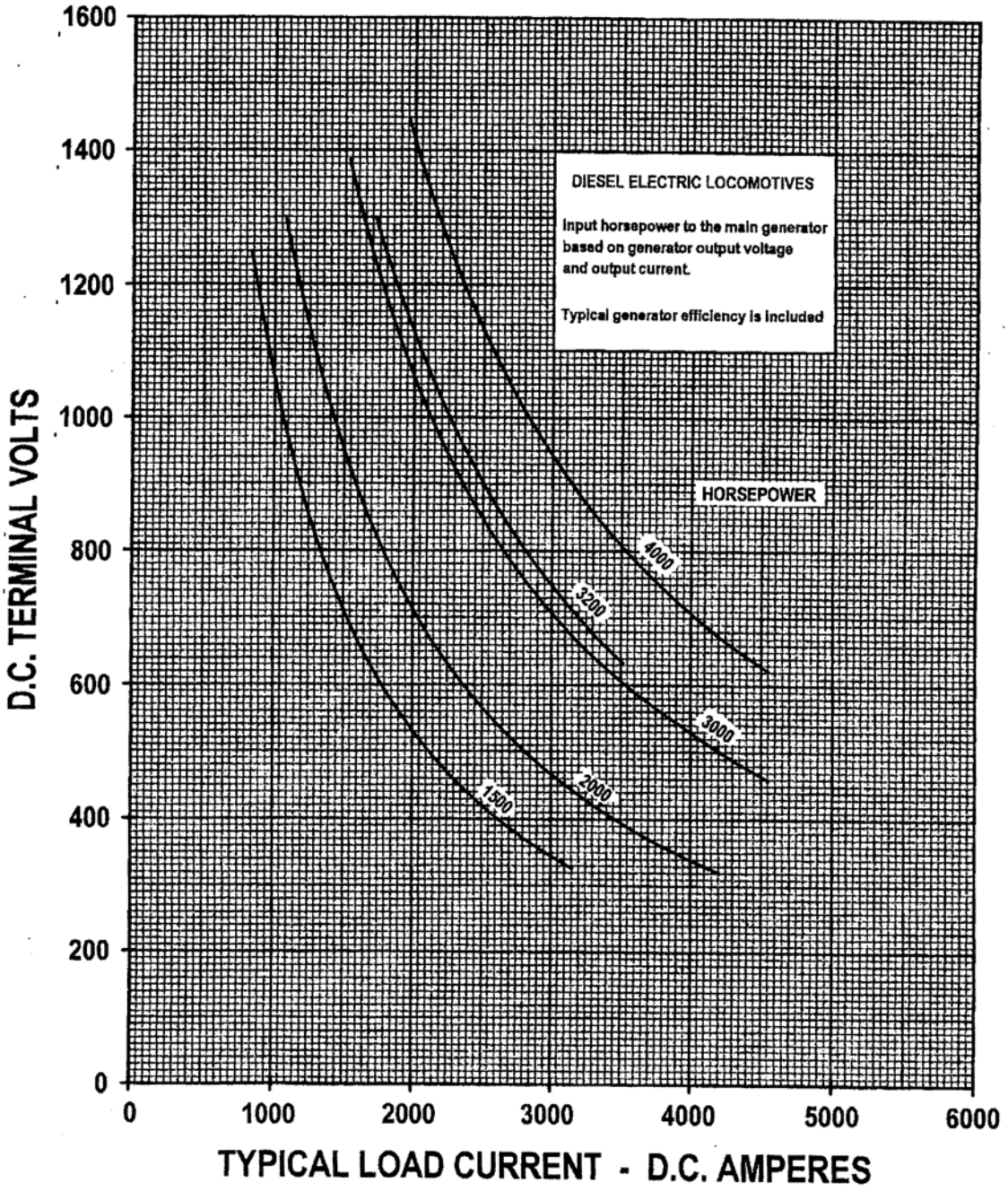

Figure 1 Typical Load Current D.C. Amperes

When tested in place on the locomotives, test voltmeters and ammeters or, if desired, a wattmeter and a suitable tachometer must be used. Again, adjustments to standard conditions can be made by taking readings of specific gravity of fuel, air and fuel temperatures and making correction for the altitude of the point of test.

4.4 Procedure

Load testing of newly overhauled engines must be preceded by a sufficient number of runs at no load and partial load to insure that all parts are in good condition or functioning properly and to insure that the engine and generator or other loading device have reached uniform and correct operating temperatures. Initial runs should comply with manufacturer's engine break-in procedures and schedules.

Load testing of engines likewise must be carried out with all equipment thoroughly warmed up and at uniform operating temperature.

Tests can be made at partial load and/or full loads as required for the purpose intended. Load test readings should be taken over a period of time sufficient to obtain average values. Where specific requirements of any test exceed the continuous current ratings of the generator, the generator short time limits should not be exceeded.

Horsepower at the output of the main traction generator can be determined as follows:

$$\text{Main traction generator output horsepower} = \frac{\text{Gen. Volts X Gen. Amps}}{746}$$

or, where the output is read in watts:

$$\text{Main traction generator output horsepower} = \frac{\text{Watts}}{746}$$

If the generator efficiency curve is available, horsepower input into the main traction generator can be found thus:

$$\text{Traction horsepower at Engine - Generator Coupling} = \frac{\text{Main Traction Generator hp}}{\text{Traction Generator Efficiency}}$$

As an alternate to the above formula, where the approximate results will suffice, the following may be used:

$$\text{Traction horsepower at Engine - Generator Coupling} = \frac{\text{Gen. Volts X Gen. Amps}}{700}$$

Brake horsepower of the engine can be determined as follows:

$$\text{Brake horsepower} = \frac{\text{Main Traction Generator hp}}{\text{Generator Efficiency}} + \text{Auxiliary Load hp}$$

Figure 1 shows the relationship between main generator volt-ampere output and engine horsepower input to the main generator for representative locomotive types. The typical generator efficiency has been taken into account on each of these curves. Prior to test, all items of mechanical and electrical equipment must be properly adjusted for full load conditions as required by builder specifications and instructions.

4.5 Permissible variation

Engines of the same type vary in output; this variance must be taken into account. Output of diesel power plants tested to determine their condition shall be subject to such permissible variation of rated output as may be specified by the engine manufacturer or the individual railroad.

4.6 Adjustment of results to standard conditions

Engines are usually rated at:

1. Sea level to 1000 feet (289 m)
2. Air temperature 60E F (15.5E C)
3. Fuel temperature 60E F (15.5E C)
4. Specific gravity of fuel 0.845

The engine builder's charts can be used to adjust results of tests to standard conditions by railroads desiring this refinement. For determining total horsepower of the diesel engine adjusted to standard conditions, the following may be used:

$$\text{Total horsepower} = \frac{\text{Brake Horsepower}}{\text{Standard Conditions Adjustment}}$$