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Compressed Air Quality for Passenger Equipment

Abstract: This standard defines the minimum quality of the compressed air for air brake and auxiliary pneumatic systems on passenger equipment, including a uniform basis for testing and measuring the quality of compressed air for compliance.

Keywords: air dryers, air supply system, compressed air quality

Summary: In pneumatic fluid power systems, power is transmitted and controlled by pressurized air within an enclosed circuit. For safe and reliable operation, rail passenger air brake systems require installation of an air supply system to compress ambient air; to remove water vapor, oil content and particles; and to prevent condensation within pneumatic system components. The design of the air supply system needs to take into consideration all the major components, including the compressor, the air dryer, oil separators, condensate collectors, reservoirs and other functional components as part of the air supply system. Only when the performance of all the components in the air supply system is properly coordinated can the quality of the final compressed air output be guaranteed for a safe and reliable pneumatic system.

Foreword

The American Public Transportation Association is a standards development organization in North America. The process of developing standards is managed by the APTA Standards Program's Standards Development Oversight Council (SDOC). These activities are carried out through several standards policy and planning committees that have been established to address specific transportation modes, safety and security requirements, interoperability, and other topics.

APTA used a consensus-based process to develop this document and its continued maintenance, which is detailed in the manual for the APTA Standards Program. This document was drafted in accordance with the approval criteria and editorial policy as described. Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

This document was prepared by the Mechanical Working Group as directed by the Passenger Rail Equipment Safety Standards Policy Planning Committee.

This document represents a common viewpoint of those parties concerned with its provisions, namely transit operating/planning agencies, manufacturers, consultants, engineers and general interest groups. APTA standards are mandatory to the extent incorporated by an applicable statute or regulation. In some cases, federal and/or state regulations govern portions of a transit system's operations. In cases where there is a conflict or contradiction between an applicable law or regulation and this document, consult with a legal adviser to determine which document takes precedence.

This document supersedes APTA PR-M-S-011-99, Rev. 2, which has been revised. Below is a summary of changes from the previous document version:

- Nomenclature changes for consistency and readability
- Format changes to align with current formatting requirements
- Addition of air supply system definition

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Introduction

This introduction is not part of APTA PR-M-S-011-99, Rev. 3, "Compressed Air Quality for Passenger Equipment."

This standard applies to all:

- railroads that operate intercity or commuter passenger train service on the general railroad system of transportation; and
- railroads that provide commuter or other short-haul rail passenger train service in a metropolitan or suburban area, including public authorities operating passenger train service.

This standard does not apply to:

- rapid transit operations in an urban area that are not connected to the general railroad system of transportation;
- tourist, scenic, historic, host railroads or excursion operations, whether on or off the general railroad system of transportation;
- operation of private cars, including business/office cars and circus trains, unless otherwise required by other standards or regulations; or
- railroads that operate only on track inside an installation that is not part of the general railroad system of transportation.

Scope and purpose

This standard defines the minimum quality criteria of compressed air for air brake and auxiliary pneumatic systems (including any external air supply used to charge/maintain/static test the train air system) on new and existing passenger locomotives and cars in normal operating environments. Meeting the requirements of this document will ensure compliance with 49 CFR 238.231. This standard provides a uniform basis for testing and measuring the quality of compressed air.

Compressed Air Quality for Passenger Equipment

1. Overview

In pneumatic fluid power systems, power is transmitted and controlled by pressurized air within an enclosed circuit. For safe and reliable operation, rail passenger air brake systems require installation of an air supply system to compress ambient air; to reduce water vapor; to minimize oil content and particles; and to mitigate condensation within pneumatic system components. The design of the air supply system needs to take into consideration all the major components, including the compressor, the air dryer, oil separators, condensate collectors, reservoirs and other functional components as part of the air supply system. Only when the performance of all the components in the air supply system are properly coordinated with a comprehensive vehicle preventative maintenance program can the quality of the final compressed air output be guaranteed for a safe and reliable pneumatic system.

This standard defines the minimum quality criteria of compressed air for air brake and auxiliary pneumatic systems, including any external air supply used to charge/maintain/static test the train air system at maintenance locations on new and existing passenger locomotives, and cars in normal operating environments. This standard provides a uniform basis for testing and measuring the quality of compressed air.

If additional filtration is required, it is the responsibility of the manufacturer to specify the air quality requirements for that system.

2. Qualification testing

2.1 Test objective

The air supply system qualification test shall be performed on the first production air supply system, at a test laboratory, with test equipment as defined by Section 4.1.2 and air inlet conditions as defined in Section 4.1.1. When the air supply system is not a self-contained system with an air dryer, the system components to be tested shall be arranged as on the actual vehicle to the greatest practical extent, replicating bends or using equivalent length, along with the same fittings, hoses, adapters, etc. The purpose of the test is to verify the proper operation of the air supply system and to demonstrate compliance with Section 2.2. Prior to conducting any measurements of the air supply system, follow the guidelines for qualification testing per Section 4.1.3.

2.2 Air quality criteria

2.2.1 Temperature

The outlet air temperature from the air supply system is recommended to be no more than 15 °F (8.3 °C) above the ambient air temperature, measured per Section 4.1.3.3.

2.2.2 Oil content

The outlet oil content of the air supply system (including liquid and vapor) shall not exceed 5 ppm by weight, measured per Section 4.1.3.4.

2.2.3 Solid content

The outlet solid particle mean size of the air supply system shall not exceed 10 µm with a maximum size of 40 µm. The maximum particle concentration shall be not more than 5 mg/m^3, measured per Section 4.1.3.5.

2.2.4 Dew point depression

The outlet dew point depression shall not be less than 30 °F (16.7 °C) throughout the entire operating cycle of the air supply system, measured per Section 4.1.3.6.

3. Periodic inspection and testing

3.1 Test objective

Periodic inspection and maintenance of the air supply system shall be performed per the manufacturer's recommendations to verify proper operation.

Periodic testing of the air supply system installed on passenger locomotives and cars shall be performed per Section 4.2 at regularly scheduled intervals, not to exceed 368 days, on a random sample basis and when a major component has been completely overhauled, replaced or repaired. The random sample shall be in accordance with ANSI/ASQ Z1.9 to obtain a 95% confidence level. The random sample shall demonstrate compliant air quality, per Section 3.2. If compliance is less than 95%, then the sampling interval shall be reduced until 95% confidence level is achieved. If compliance exceeds 95%, the sampling interval may be increased up to but not to exceed 368 days. All external air supply systems used to charge/maintain/static test the train air system shall be tested in accordance with Section 4.2 at regularly scheduled intervals, not to exceed 368 days, to demonstrate compliant air quality per Section 3.2.

In cases where regularly scheduled intervals coincide with the manufacturer-recommended preventative maintenance intervals, the test shall be performed just prior to the preventative maintenance activity. When the design of the air supply system has been changed from the original design configuration, it shall be tested in accordance with Section 4.1.

3.2 Air quality criteria

3.2.1 Temperature

The outlet air temperature of the air supply system is recommended to be no more than 15 °F (8.3 °C) above the ambient air temperature or within ±5 °F (±2.8 °C) of the value measured during the qualification unit test as measured in Section 4.1.3.2.

3.2.2 Dew point depression

The outlet dew point depression shall not be less than 25 °F (13.9 °C) throughout the entire operating cycle of the air supply system for ambient temperatures at or below 100 °F (37.8 °C), measured per Section 4.2.3.4.

For all ambient temperature conditions above 100 °F (37.8 °C), subtract 1 °F from the dew point depression requirement for each degree above 100 °F (37.8 °C).

For example, if the ambient temperature is 110 °F (43 °C), the dew point depression requirement would be 15 °F (8.3 °C).

4. Method for testing and measuring air quality

4.1 Qualification testing

4.1.1 Test scope

The air supply system shall be tested in a laboratory environment operating with ambient conditions of 100 °F (37.8 °C), 14.7 psig (1.01 bar) and a minimum relative humidity of 36%.

The test shall demonstrate that the air supply system conforms to all requirements specified in Section 2.

4.1.2 Test equipment

Test equipment shall be of laboratory quality and calibrated per the manufacturer's specifications. To ensure validity of test measurements, equipment must be protected from free contaminants (not associated with the air supply) and water.

Recommended Test Equipment:

- Oil and solid content measurements: AirCheck✓ Kit™ K810
- Dew point depression measurements (lab use): Vaisala DM70 and DMP74B
- Dew point depression measurements (field use): Kahn Easidew

4.1.3 Test procedure

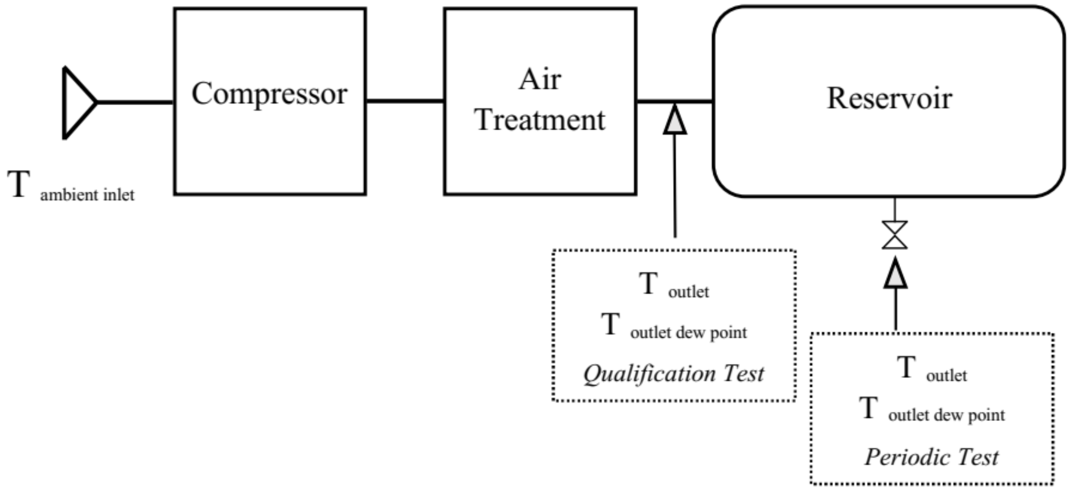
4.1.3.1 General

Ensure that the air supply system is in its proper operating condition prior to the beginning of the test. All adjustments are to be made before starting the test. No adjustments are to be made to the air supply system during any test run.

Establish a constant flow rate that will keep the air supply system running continuously within the normal operating pressure range of the air supply system. Operate the system at that steady-state condition for a sufficient period to stabilize outlet compressed air conditions prior to taking measurements, but no less than two full drying and regeneration cycles of each tower/element. Stabilization shall be considered achieved when the arithmetic average of the output compressed air dew point as recorded at regular observation intervals shows duplicate results within ±3.6 °F (±2 °C).

Take and record observations at the air treatment outlet within the approximate center of the outlet air stream at least 10 pipe diameters away from any restriction or flow control device (see **Figure 1**). Take readings at regular intervals to permit definition of characteristics of the air supply system to demonstrate compliance with Section 2.

FIGURE 1
Typical Test Configuration



NOTE: When testing an air supply system incorporating a single tower/element air dryer, stabilization must be achieved by cycling the compressor at fixed intervals, which shall not be changed during the test.

4.1.3.2 Ambient temperature

Measure the ambient air temperature at or near the air inlet to the air supply system.

4.1.3.3 Outlet temperature

The outlet air temperature shall be measured in the approximate center of the outlet air stream at the air dryer outlet unless there is a post air dryer filter or oil separator, at which point the air should be sampled at the outlet of this device.

4.1.3.4 Oil content

The oil content shall be measured in the approximate center of the outlet air stream at the air dryer outlet unless there is a post air dryer filter or oil separator, at which point the air should be sampled at the outlet of this device.

4.1.3.5 Solid content

The particle size and concentration of solid content shall be measured in the approximate center of the outlet air stream at the air dryer, oil separator or air filter if the system is equipped with post air dryer components.

4.1.3.6 Outlet dew point

The outlet dew point shall be measured in the approximate center of the outlet air stream at the air dryer. Determine the dew point depression as follows: Ambient inlet temperature minus air dryer outlet dew point temperature equals dew point depression.

NOTE: Ambient temperature measured at the dew point meter location is not acceptable, as the meter location maybe effected by the surrounding environment. The only acceptable measurement point is at the air inlet filter housing.

4.2 Periodic testing

4.2.1 Test scope

The air supply system shall be tested as installed. The test shall demonstrate that the air supply system conforms to all requirements specified in Section 3.

4.2.2 Test equipment

All pressure gauges used during the test shall be ASME Grade 2A gauges or equivalent, as specified by ASME B40.100. The gauge must be calibrated as specified by ASME requirements. Dew point and temperature measuring instruments shall be accurate and certifiable to within ±1.8 °F (±1 °C) in the range the measurements are taken. The instruments shall be calibrated to the manufacturer's specifications.

Recommended Test Equipment:

- Oil and solid content measurements: AirCheck✓ Kit™ K810
- Dew point depression measurements (lab use): Vaisala DM70 and DMP74B
- Dew point depression measurements (field use): Kahn Easidew

4.2.3 Test procedure

4.2.3.1 General

Ensure that the air supply system is in its proper operating condition prior to beginning the test. All adjustments are to be made before starting the test. No adjustments are to be made to the air supply system during any test run.

> **NOTE:** When sampling air from the air supply system, the towers/elements shall not be new, as the steady-state level of moisture in each tower/element may negatively affect the test results. The age of the desiccant shall be representative of at least 24 hours in normal service. Air shall be sampled at the outlet of the last main reservoir connected to the air supply system. The air being sampled is directly related to the condition of the air inside the reservoir; therefore, the inside of the air reservoir shall be free from liquid water and oil contaminants. If practical, the train shall run in normal service no less than 24 hours prior to testing.

Establish a constant flow rate that will keep the air supply system running continuously within the normal operating pressure range of the air supply system. Operate the system at that steady-state condition for a sufficient period to stabilize outlet compressed air conditions prior to taking measurements, but no less than two full drying and regeneration cycles of each element. Stabilization shall be considered achieved when the arithmetic average of the output compressed air dew point as recorded at regular observation intervals shows duplicate results within ±3.6 °F (±2 °C).

Whenever possible, isolate the friction brake equipment and other auxiliary systems downstream of the main reservoir(s) to prevent inconsistent results by avoiding any large pressure drops during air sampling.

Take and record observations, as illustrated in **Figure 1**, at the reservoir outlet at the approximate center of the outlet air stream at least 10 pipe diameters away from any restriction or flow control device. Take readings at regular intervals to permit definition of characteristics of the air supply system to demonstrate compliance with Section 3.

When testing an external air supply system (either shop or yard air), measurements shall be taken at the point of connection to rail equipment.

> **NOTE:** When testing an air supply system incorporating a single tower air dryer, stabilization must be achieved by cycling the compressor at fixed intervals, which shall not be changed during the test.

4.2.3.2 Ambient temperature

Measure the ambient air temperature at the air inlet to the air supply system.

4.2.3.3 Outlet temperature

The outlet air temperature shall be measured in the approximate center of the outlet air stream at or after the last main reservoir connected to the air supply system.

4.2.3.4 Outlet dew point

The outlet dew point shall be measured in the approximate center of the outlet air stream at or after the last main reservoir connected to the air supply system. Determine the dew point depression as follows: Ambient inlet temperature minus main reservoir outlet dew point temperature equals dew point depression.

References

ASME B40.100, "Gauges – Pressure Indicating Dial Type – Elastic Element," 1991.

ANSI-B93.45M, "Pneumatic Fluid Power – Compressed Air Dryers – Method for Rating and Testing," 1982.

ANSI/ASQ Z1.9, "Sampling Procedures and Tables for Inspection by Variables for Percent Nonconforming," 2018.

Compressed Air and Gas Institute, ADF 200, "Dual Tower Regenerative Desiccant Compressed Air Dryers – Methods for Testing and Rating."

ISO 8573-1, "Compressed air, Part 1: Contaminants and purity classes," 2010.

Definitions

air supply system: Those components used to transform ambient air to a pressurized state with controlled temperature, humidity, oil and solid contents, suitable for use as the energy source for rail vehicle air brakes and auxiliary device operation. An air supply system may be either individual components located closely and conveniently together, or in a unitized package suitable for direct mounting to a vehicle, generally including motor and compressor, governor controls and protection, inlet air filter, air dryer, oil separator, outlet air filter, and intercooler and/or aftercooler.

dew point: Temperature at which water vapor begins to condense.

dew point depression: The difference between inlet ambient temperature and outlet dew point temperature.

$(T_{\text{ambient}} - T_{\text{outlet dew point}})$

temperature: A specific degree of hotness or coldness as indicated on a standard scale as measured with a dry bulb type thermometer, unless otherwise noted.

Abbreviations and acronyms

µm	microns
ASME	American Society of Mechanical Engineers
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASQ	American Society for Quality
ISO	International Organization for Standardization
psig	pounds per square inch gauge

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