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# Compressed Air Quality for Passenger Locomotive and Car Equipment

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

**Keywords:** air dryers, air supply system, 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 are properly coordinated can the quality of the final compressed air output be guaranteed for a safe and reliable pneumatic system

**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 the train air system) 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. The passenger rail industry phased this standard into practice over the six-month period from July 1 to Dec. 31, 1999. It took effect Jan. 1, 2000.

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## Introduction

*This introduction is not part of APTA PR-M-S-011-99, Rev. 2, "Compressed Air Quality for Passenger Locomotive and Car Equipment."*

APTA recommends the use of this document by:

- individuals or organizations that operate rail transit systems;
- individuals or organizations that contract with others for the operation of rail transit systems; and
- individuals or organizations that influence how rail transit systems are operated (including but not limited to consultants, designers and contractors).

# Compressed Air Quality for Passenger Locomotive and Car 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 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 are properly coordinated 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 the train air system) 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.

## 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. System components to be tested shall be arranged as on the actual vehicle to the greatest practical extent, replicating bends or using equivalent length, and 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 of the air supply system, as measured per Section 4.1.3.3, shall be no more than 15 °F (8.3 °C) above the ambient air temperature, measured per Section 4.1.3.2.

#### 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 µ with an absolute size of 40 µ. 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, resulting in a statistically significant sample that demonstrates compliant air quality, per Section 3.2, for 95 percent of the operating fleet, or when a major component has been completely overhauled, replaced or repaired. If compliance is less than 95 percent, then the sampling interval shall be reduced until 95 percent compliance is achieved. If compliance exceeds 95 percent, the sampling interval may be increased up to but not to exceed 368 days.

All external air supply systems used to charge or maintain 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 shall be no more than 15 °F (8.3 °C) above the ambient air temperature.

### 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 (–9 °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 percent.

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.

### 4.1.3 Test procedure

#### 4.1.3.1 General

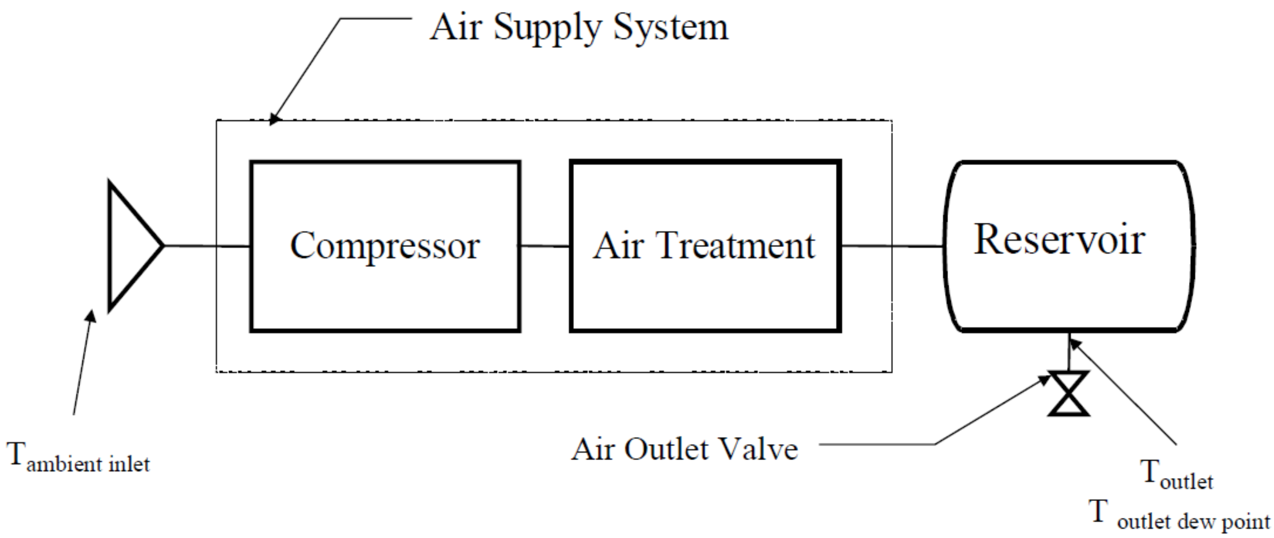
Ensure that the air supply system is in its proper operating condition prior to the beginning of the test. All adjustments are to be made before starting the test. No adjustments are to be made to the air supply system during any test run.

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. Stabilization shall be considered achieved when the arithmetic average of the output compressed air dew point as recorded at regular observation intervals show duplicate results within ±3.6° F (±2° C).

Take and record observations, as illustrated in **Figure 1**, 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 2.

> **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.

**FIGURE 1**
Typical Test Configuration




### 4.1.3.2 Ambient temperature

Measure the ambient air temperature at 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 or after the last main reservoir in the air supply system.

### 4.1.3.4 Oil content

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

### 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 or after the last main reservoir in the air supply system.

### 4.1.3.6 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 in the air supply system. Determine the dew point depression as follows: ambient temperature minus outlet dew point temperature equals dew point depression.

## 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 B40.1. 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.

### 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.

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. Stabilization shall be considered achieved when the arithmetic average of the output compressed air dew point as recorded at regular observation intervals show 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.

Take and record observations, as illustrated in **Figure 1**, 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, 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 in 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 in the air supply system. Determine the dew point depression as follows: ambient temperature minus outlet dew point temperature equals dew point depression.

## Related APTA Standards

**APTA PR-M-RP-001-97,** Recommended Practice for Air Connections, Location and Configuration of, for Passenger Cars Equipped with AAR Long Shank Tight Lock or Similar Long Shank Type Couplers

## References

ASME B40.1, Gauges—Pressure Indicating Dial Type—Elastic Element, 1991

American National Standard, B93.45M, Pneumatic Fluid Power, Compressed Air Dryers, Method for rating and testing.

Compressed Air and Gas Institute ADF 200, Dual Stage Regenerative Desiccant Compressed Air Dryer - Methods for Testing and Rating.

SAE J1649/1 - Compressed Air for General Use, Part 1: Contaminants and Quality Classes

## Definitions

**air supply system:** Those components used to transform ambient, breathable 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, as well as the inlet air filter, air dryer 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

| | |
|---|---|
| **µ** | microns |
| **ASME** | American Society of Mechanical Engineers |
| **NATSA** | North American Transportation Services Association |
| **psig** | pounds per square inch gauge |

## Summary of document changes

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

## Document history

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