



**GUIDELINE**

**ASHRAE Guideline 16-2018**  
(Supersedes ASHRAE Guideline 16-2014)

# Selecting Outdoor, Return, and Relief Dampers for Air-Side Economizer Systems

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#### NOTE

Approved addenda, errata, or interpretations for this guideline can be downloaded free of charge from the ASHRAE Web site at [www.ashrae.org/technology](http://www.ashrae.org/technology).

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(This foreword is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

## FOREWORD

*Control damper selection and sizing are a critical first step in the design of a control system. The system designer should take care to make the correct damper selections. Improper selection and sizing may cause hunting; improper temperature, flow, and pressure control; and other operational difficulties.*

*The objective of this guideline is to address the application and sizing of outdoor, return, and relief dampers used to control*

- *outdoor-air intake for economizer (free) cooling,*
- *minimum-ventilation outdoor airflow for indoor air quality, and*
- *building pressure.*

*This guideline focuses on the three most common damper configurations for systems employing an air-side economizer:*

- Supply and return fan*
- Supply and relief fan*
- Supply fan with gravity (nonpowered) relief*

*These configurations have outdoor, return, and relief dampers. For other damper configurations, such as multiple return dampers within a system, the general information in this guideline is still beneficial.*

*The methods of control described in this guideline are not intended to indicate a control preference but to show how dampers typically operate in heating, ventilating, and air-conditioning systems that include an air-side economizer.*

*This is a revision of Guideline 16-2014. This guideline was prepared under the auspices of ASHRAE. It may be used, in whole or in part, by an association or government agency with due credit to ASHRAE. Adherence is strictly on a voluntary basis and merely in the interests of obtaining uniform guidelines throughout the industry. Changes made for the 2018 edition include updated references.*

## 1. PURPOSE

This guideline provides the basis for selecting and sizing control dampers (outdoor, return, and relief) commonly found in constant-air-volume (CAV) and variable-air-volume (VAV) air-handling units (AHU) and systems with air-side economizers.

## 2. SCOPE

**2.1** This guideline covers the application of mixed-air control dampers in AHUs and systems that incorporate air-side economizer systems for cooling.

**2.2** This guideline addresses the selection of control dampers based on damper characteristics and damper pressure drop.

**2.3** This guideline is not intended to cover dampers used elsewhere in heating, ventilating, and air-conditioning (HVAC) systems.

**2.4** This guideline does not cover air mixing.

## 3. DEFINITIONS

**3.1** Definitions of most terms used in this guideline can be found in *ASHRAE Terminology of Heating, Ventilation, Air Conditioning, & Refrigeration* (ASHRAE 1991).

**3.2** Terms used in this guideline that are not found in *ASHRAE Terminology of Heating, Ventilation, Air Conditioning, & Refrigeration* or that are used differently are defined in this section.

**maximum outdoor-air damper:** a modulating damper or set of dampers used to control the outdoor airflow to the system in excess of minimum ventilation outdoor air for free cooling (air-side economizer). Also called economizer outdoor-air damper. May also serve to provide the minimum outside airflow control.

**minimum outdoor-air damper:** a two-position damper in parallel with the maximum outdoor-air damper to provide the minimum outdoor air required for ventilation.

**path pressure drop:** the pressure drop in the air path that is affected by the control damper.

**relief air:** building return air discharged by the AHU equipment to control building pressure when an HVAC system is operating in the economizer cycle.

**ventilation air:** the minimum amount of outdoor air required for the purpose of controlling air contaminant levels in buildings.

**$\alpha$ -value:** the ratio of path pressure drop, including fully open control damper pressure drop, to the pressure drop across the fully open damper at design flow.

## 4. SYSTEM ARRANGEMENTS

### 4.1 General

**4.1.1** This guideline covers air-handling systems that include an air-side economizer. The most common variations are:

- Arrangement 1 (Figure 1): HVAC system with a return fan
- Arrangement 2 (Figure 2): HVAC system with a relief fan
- Arrangement 3 (Figure 3): HVAC system with a gravity or motorized relief damper

**4.1.2** Figures 1–3 show features and controls that are optional. For example, supply/return/relief fan motors are shown with variable-speed drives as the method of controlling fan capacity. Other methods of fan capacity control may be used. The figures shown are VAV systems. This guideline also applies to CAV systems.

**4.1.3** The supply-air temperature sensor (T-1) normally controls dampers D-2 and D-3 so that one damper closes as the other opens (Figure 4). For Arrangements 2 and 3, sequencing the dampers (Figure 5) reduces energy costs in VAV systems by reducing pressure drop in the mixing mode. This has an impact on the way dampers are selected (see Section 4.3.3.4, second paragraph).

**4.1.4** The required minimum outdoor-airflow rate must be delivered to the building regardless of the ambient conditions or the supply-airflow rate. The type of minimum outdoor-air control system has an impact on plenum pressure PL-2 and,