



New Requirements for Rooftop Units with Economizers

From ASHRAE 90.1 and California Title 24

Background

The management of outside air is vital in today's commercial buildings and has gotten a lot of regulatory focus in the last couple years. ASHRAE 62.1 defines the ventilation and indoor air quality requirements and in addition ASHRAE 90.1 and California Title 24 define requirements of the outside air to provide free cooling using economizers. However, economizers and energy recovery are not factored into equipment efficiency ratings of EER, IEER, or SEER.



To complicate matters even more, recent studies for ASHRAE 90.1 have shown significant issues with economizer reliability due to damper and related control issues. Several issues have arisen and been the focus of new updates in ASHRAE 90.1-2013 and 90.1-2016. These have significant changes which impact the design and application of rooftop units with economizers. This effects both water source and air source rooftop product.

Historical Economizer Issues

Many issues associated with economizers have been identified and an effort has been undertaken to improve their reliability. Here is a listing of the most common reliability issues as identified by the ASHRAE 90.1 Study*:

- Solar impact on changeover temperature sensor failure
- Supply temperature sensor failure and inaccuracy
- Integrated economizer controls and operational issues

- Damper linkage failure
- Economizer damper motor not functioning
- Economizer disconnected altogether
- Minimum ventilation position not properly set
- Changeover sensor inaccuracy and failure
- Building pressurization (improper exhaust/relief)
- Exhaust air recirculation
- Damper blade leakage (outside and return)
- Lack of maintenance
- Lack of and improper commissioning

Consequently, the study found that a very high percentage of installed economizers had been disabled due to these issues. This called for significant changes to the economizer regulations and they subsequently started in the 2013 revision of ASHRAE 90.1.

Economizers Improvements: ASHRAE 90.1 and California Title 24

Many of the recent regulatory standards have continued to address some of the many issues associated with economizers design and application. ASHRAE 90.1-2013 made the most significant changes ever to economizers, along with California Title 24 & ASHRAE 90.1 -2016.

ASHRAE 90.1-2013 adds:

- New digital enthalpy sensors with accuracy limits
- Advanced controllers with integrated diagnostics
- Smart economizer controllers
- New high limit control concepts
- Integrated control logic to limit damper cycling
- 2 speed fan and economizer for units over 65k Btuh
- 2 stages of mechanical cooling for units over 65k Btuh
- Integrated mechanical cooling/economizer
- 100% damper open until LAT < 45 degF

*Lord, Richard, (2013, June 22-26). Air-Side Economizer Improvements and New Regulations [Conference Seminar]. ASHRAE Annual Conference, Denver, CO, United States.

California Title 24-2013 adds:

- Fault detection and diagnostic system. (>54k Btuh)
- Tip sealed damper ratings
- Fault condition reporting
- Manual control test routine
- Factory or field certified functional test procedure.

ASHRAE 90.1-2016 revision goes further and adds:

- Damper leakage update
- Fault detection and diagnostics system with economizer status
- Required faults for display
- Return and Relief Fan Controlled to maintain building pressure
- Return or relief fans of ECM design for no more than 30% of power at 50% design airflow.

What to Look For in a Water Source Rooftop with Economizer?

Many of these issues are resolved in a few major feature upgrades to the typical rooftop unit. Table 1 shows the regulatory issue and the major feature solution. These can be broken down into 6 major features: Digital Temperature and Enthalpy Sensors, Tip sealed dampers with robust damper mechanism, Variable Speed EC Fan Motors, Multi-Stage Compressor, Advanced Communicating Controls, and Integrated Economizer Controls.

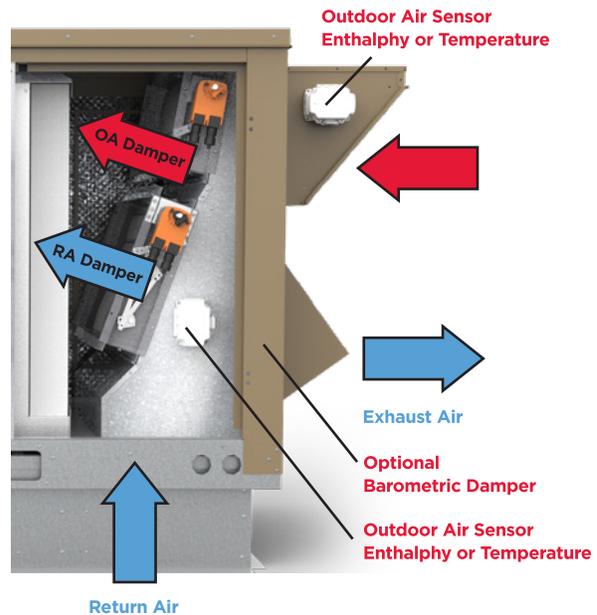
Table 1. Rooftop w/Economizer Major Features

Regulatory requirements	Rooftop w/Economizer Major Feature					
	Digital Temperature and Enthalpy Sensors	Tip Sealed Damper Rating	Variable Speed EC Fan Motors	Multi-Stage Compressor	Advanced Communicating Controls	Integrated Economizer Controls
ASHRAE 90.1-2013 Requirements						
New digital enthalpy sensors with accuracy limits	X					
Advanced controllers with integrated diagnostics					X	
Smart economizer controllers						X
New high limit control concepts						X
Integrated control logic to limit damper cycling						X
2-speed fan and conomizer for units over 65k Btuh			X		X	
2 stages of mechanical cooling for units over 65k Btuh				X		
Integrated mechanical cooling/economizer						X
100% damper open until LAT<45 degF					X	
California Title 24-2013 Requirements						
Fault detection and diagnostic system (>54kBtuh)					X	X
Tip sealed damper ratings		X				
Fault condition reporting					X	X
Manual control test routine						X
Factory or field certified functional test procedure					X	X
ASHRAE 90.1-2016 Requirements						
Damper leakage update		X				
FDD system with economizer status						X
Required faults for display					X	X
Return and relief fan controlled to maintain building pressure			X		X	X
Return and relief fans of ECM design for no more than 30% of power at 50% design airflow.			X			

1. Digital Temperature and Enthalpy Sensors

Prior sensor technology has been shown to be problematic. This includes sensors that have had moisture intrusion and ultimate failure to poor or non-existent calibration. To exacerbate the problem, if the sensor did fail, few control systems were able to identify the issue and notify the user.

The new breed of communicating digital sensor solves a number of issues including better sensor design, communication capability, fault identification and the ability to be calibrated.



2. California Title 24 Rated Tip-sealed dampers with more robust damper mechanism.

A major issue with dampers became obvious with the review. Dampers not only failed due to mechanical opening mechanisms, but once closed the dampers also did not seal.



California Title 24-2013 now requires that all dampers have measured and certified leakage rates as well as fault codes to notify when the mechanical damper system has failed.

3. Variable Speed EC Fan Motors

The study also found that belt/sheave blower systems were rarely adjusted properly and nearly all systems were designed around a single peak airflow.



Promoting a two stage economizer requires that at least two airflows be utilized. The Variable speed EC motor, so prevalent in residential systems, has not been deployed as successfully in larger commercial applications. Recently, new variable speed EC plenum fans have been applied to rooftop units and the resulting airflow flexibility has not only satisfied the new regulations, it has produced very high efficiency units and application flexibility. Now at least two stages of economizer and airflow can be utilized routinely by the economizer.

4. Multi-Stage Compressors

A similar requirement calls for multiple stages of mechanical cooling. Utilizing multiple fan speeds and multiple compressor stages can greatly enhance the efficiency and application flexibility of the system. This will no doubt become routine in the future.



5. Advanced Communicating Controls

Implementing an advanced control that can display fault codes in plain English, calibrate sensors, select economizer high limit modes, allow fan speed selection and manage multiple compressor stages is essential to several of the new requirements. These advanced requirements will cause equipment manufacturers to completely redesign controls.

Other features often found with these advanced controls include energy, performance and refrigeration monitoring, cloud access, and BACnet accessible configuration and troubleshooting of both the economizer and the rooftop.



6. Integrated Economizer Controls

The study found one of the 'fatal' flaws of the existing technology was the use of 24VAC only signals between the rooftop control and the enthalpy (economizer) controls. This means that any interaction between economizer and rooftop control is limited to only whether a cooling call is present. All other important information such as sensor faults and temperatures, outdoor air temperature, leaving air temperature, return air temperature, fan speed, etc. cannot be communicated between the controls. Integrating the rooftop system controller and the economizer control via communication (or even the same control for both) is a crucial update required to satisfy several of the identified issues.

Traditional Rooftop Control and Enthalpy (economizer) Control



Integrated Rooftop and Economizer Control



The Bottom Line

On your next project look for the water source rooftop that includes technologies 1 through 6 shown above. As state and local codes become updated to ASHRAE 90.1-2013 and 2016 these features will become requirements. The WaterFurnace Rooftop includes all of these features plus many more.

Learn more at waterfurnace.com/Commercial



visit us at waterfurnace.com

WaterFurnace International, Inc.,
9000 Conservation Way, Fort Wayne, IN 46809-9794.
©2021 WaterFurnace International Inc.