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BEST DRAFT CONTROL: MANUAL DAMPERS IN MULTIPLE BOILER SYSTEMS

WHITEPAPER

Decades of evolving codes have led to much confusion over how dampers can and cannot be used.

Contrary to popular belief, manual dampers are allowed and are quite effective—if not essential—in mechanical draft applications with multiple boilers.

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Introduction

There are many uninformed opinions floating around about how the codes are written for manual dampers in natural draft and mechanical draft applications. While manual dampers can be highly effective in controlling draft, some believe they are not allowed by code. Simply not true. The misconception comes from years of naming confusion, evolving codes and the way they are interpreted.

When used to control draft in a boiler exhaust system, manual dampers are up to code and are quite effective — if not essential — in many applications with multiple boilers. ENERVEX has a close relationship with the people who write and enforce building codes. We've spent a great deal of time dissecting these standards to ensure that engineers and contractors don't build something that will get them into trouble. In this paper we will share what we've learned over decades of experience with draft control and dampers, including:

- **Causes of draft in the combustion process**
- **Difference between natural and mechanical draft**
- **Problems caused by excessive draft and inadequate draft**
- **Types of dampers and how they work**
- **Why barometric dampers can be a waste of energy and fuel**
- **Tips for efficient, code-compliant damper usage**

Causes of Draft

During boiler operation, air moves into the burner area and combustion chamber as combustion air. As part of the combustion process, the fuel is mixed with air and burned. The mix of air and combustion gases continues onward, moving out of the combustion chamber, up through the boiler or furnace heat exchanger, through the flue vent connector, and on into the chimney where these gases are vented to the outside. The force with which these gases move inside the chimney is the "draft."

Natural vs. Mechanical Draft

There are two types of draft, *Natural Draft* and *Mechanical Draft:*

Natural draft happens when air or flue gases flow due to the difference in density of the hot flue gases and cooler ambient air. The difference in density creates a pressure differential that moves the hotter flue gases into the cooler surroundings. Chimney height, weather conditions, and a number of other factors, including codes, make natural draft difficult to control.

Mechanical draft is draft produced by an exhaust fan or blower. Mechanical draft allows more precise draft control and higher, more efficient rates of combustion. Mechanical draft can be forced or induced. It's an easier option vs. natural draft — particularly in plants requiring a high flow rate of air and gases of combustion (such as multiple-boiler plants), or where chimneys do not meet local building ordinances.

Poor Draft Control Causes Problems

Draft Control in heating applications and other flue gas systems is crucial to protecting the safety of building occupants, the environment and equipment.

Too much draft. Excessive draft increases the operating cost of a heating appliance because heat is vented out through the chimney instead of remaining in the building

where it could've been used for something good. This often results in:

- Higher fuel costs
- Reduced combustion efficiency
- Increased chimney temperatures to unwanted levels
- Excessive carbon monoxide and emissions from the stack
- Flame impingement and embrittlement of the boiler metal (loss of ductility)
- Internal damage to the burner and/or boiler
- Reduced heating appliance life expectancy

Too little draft can result in incomplete combustion, causing dangerous situations including:

- Soot-clogging of heating equipment
- Heating appliance malfunctions
- Burner puffbacks
- Backpressure or overheating in the combustion chamber
- Carbon monoxide leaks into building
- Excessive emissions from the stack
- Reduced heating appliance life expectancy

Optimal appliance operation and efficient fuel burning require a perfect and constant draft. Unfortunately, **draft is not constant.** In many situations, dampers or 'draft retarders' must be used to maintain the proper amount of oxygen, primary air and secondary air in the furnace if you are to achieve complete combustion.

As such, an old BOCA Code M-624.7.1 says you must install 'adequate means for limiting draft for EACH boiler.' You can install a manual damper to easily make flow adjustments when certain conditions alter draft, for example:

- Wind fluctuations or air blowing over a chimney top
- A second appliance using the same chimney as the heater
- Tall chimney heights, typically over 30 feet
- Temperature differences between inside and outside the building
- Burner firing rate
- Barometric conditions

> *Proper draft control reduces environmental problems; extends the life of equipment; and delivers the most efficient combustion*

Without a manual damper, draft control is very difficult because available draft drops off the further you go away from the stack. Installing a manual damper at each boiler allow you to adjust (retard) flow and keep draft constant at required levels, both in the combustion chamber and out through the stack. This venting design is up to code — even without a barometric damper in place. We'll cover this in more detail later.

To test whether there's a problem in your draft system, you can monitor oxygen content in the products of combustion. If the content is unfavorable, you may use the manual damper to retard flow or draft in the combustion process.

BEST VENTING DESIGN: WHICH DAMPER?

It's not surprising that people get hung up on the term 'manual damper' when they read the words in the current code handbook:

"Manually operated dampers are not permitted in vent connectors." But how you define the "manual damper" depends completely on how you are using it.

Let's take a quick look at the four types of dampers and how each operates:

Balancing (fixed) baffles, often called "manual dampers"

- Installed in the appliance connector
- Are locked in a permanent, fixed position; not intended to open and close manually
- Are allowed when used to balance system draft in multi-appliance systems
- Should not be used as a positive shut-off or for automatic control
- May require a safety interlock such as a spill switch unless the appliance is equipped with a blocked flue/ low-draft switch

Barometric dampers

- Installed between the boiler and the chimney
- Require a larger chimney to accommodate additional flow
- Use a small weight and adjustment screws to open a hinged door and introduce boiler room air into the stack when draft is excessive
- Send excessive draft from the boiler room to the inside of the chimney
- Wasted heat goes up and out, rather than someplace useful
- May require a draft fan to be effective

Automatic vent dampers

- Small motor (actuator) powers the damper open when the thermostat calls for heat and closes the damper once the thermostat is satisfied
- Can also serve as a balancing baffle, where the "open" position can be defined (set) as the position where the draft is perfect for the appliance
- Has a safety interlock – an end switch
- As soon as the damper is open, the end switch closes, allowing the burners to begin firing
- If the end switch does not close, the burner can't fire and flue gases will not vent up the flue

Manual dampers

- Installed in the chimney inlet of manually fired fireplaces and some manually fired boilers
- Can only be completely open or closed; used to manually open and close access to the inlet of the chimney to prevent downflows and heat loss
- Interlock is rarely, if ever, used as the heating system is considered a manually operated system with constant supervision

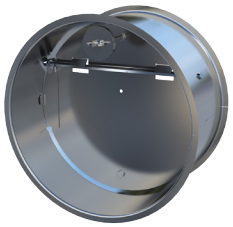
Results Matter; Names Do Not

Regardless of what you call them, dampers (or 'draft retarders') have been used for decades with great success and can be found in the best venting designs.

Which damper type is best? Automatic dampers save money by closing off the flue after the appliance shuts down. Rather than escaping up the flue after the appliance stops, heat remains inside of the system for heat recovery.

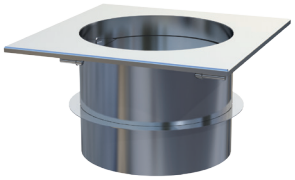
You will hear noise in plenty of online forums arguing that you should skip the balancing baffle (manual damper) and use a barometric damper. You should not. While

Balancing baffle



Barometric damper

Automatic vent damper



Manual damper

barometric dampers carry a lower initial cost, they can only be installed on boilers with negative venting such as Category I and II appliances; boilers with pressurized vents such as Category III and IV appliances would spill flue gases out of the barometric dampers into the room unless a mechanical draft system is installed or you have a very tall chimney. In addition, if you use a barometric damper, you may need a bigger chimney or bigger draft fan in the stack.

Many engineers say you should add a manual damper below the barometric damper and above the appliance outlet. It depends on what you're trying to do, but in most mechanical draft applications, you should not use a barometric damper. In the long run, a balancing baffle or automatic damper offer the best draft control; safest and most efficient combustion; and greatest energy/fuel savings. Period.

There may not be a need for a barometric damper if you have a manual damper.

Barometric dampers waste energy and do not provide maximum draft control. The best venting designs utilize a balancing baffle or automatic damper that allows operators to limit heat escape from the boiler room and route it to somewhere useful.

CODE MISINTERPRETATION

It seems very black and white in current code verbiage:

"A manually operated damper shall not be placed in any appliance vent connector." (NFPA 54 12.14)

However, go back to the original code handbook (1975) and you will see that manual dampers — when used to retard draft and used with a safety interlock — are allowed. Automatic dampers have a built-in safety interlock that will not allow heating systems to fire if the damper is not open. A balancing baffle does not normally have a safety interlock, but in the case of Category I appliances you can install a thermal spill switch near the draft hood or draft diverter to prevent flue gases from spilling into the building in the event of positive pressure. For Category III and IV applications, an end switch can be made part of the balancing baffle to warn against potential blockage. Furthermore, code says that manually operating dampers shall not be placed in chimneys, vents or chimney or vent connectors of liquid- or gas-burning appliances. However, balancing (fixed) baffles, which are sometimes used on the appliance side to balance system draft on startup, "shall not be classified as manually operated dampers" (BOCA M-718.2.13).

> *Manual dampers open/close the flue; They do NOT balance the system.*

The terminology really depends on what you're trying to do in each distinct application. When dealing with multiple heating appliances, manual dampers and draft retarders are considered 'baffles.' In ventilation applications, they are called 'manual dampers.' Call it whatever you want to call it — manual damper, baffle, whatever — it doesn't change fact that these dampers are the most effective means of draft control in a multiple-boiler situation.

In summary,

- Manual (fixed-position) and automatic dampers are allowed, but must be listed and include a safety interlock
- Dampers are used to retard flow and balance a multi-appliance system
- If you use barometric dampers, you may need a bigger chimney and draft fan — and a spill switch to detect and prevent spillage from the barometric damper
- In most multiple-boiler applications, barometric dampers carry a higher long-term cost

STIILL NOT SURE?

Call us. ENERVEX has been in the mechanical draft and venting design business for three decades. We understand the codes inside out. Let us help you determine the damper or mechanical draft solution that's right for your application. We offer a complete, integrated line of listed exhaust fans, mechanical draft products and controls to help you save on fuel costs and improve the overall performance of your systems.

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