Recommended Practices for Integrating Automated Surface Blowdown Control Systems with Mechanical Boiler Blowdown Heat Recovery Systems

Applicable Systems: Madden HV, HVX, and HC Series Mechanical Blowdown Heat Recovery Systems

Two Examples of Boiler Drum Surface Blowdown Flow Control

Example of an **automated**, conductivity-based blowdown flow control set up

Madden's **Manual** Orifice Meter Blowdown Control Valve

Pictured Examples of Madden HVX, HV, and HC series Heat Recovery Systems

Purpose of This Document

This document is intended to provide general recommendations and best-practice guidance for the setup and use of automated, conductivity-based boiler surface blowdown control systems (opposed to Madden's manual orifice meter flow control valves) when discharging to a mechanical boiler blowdown heat recovery system, rather than to a traditional atmospheric blowdown tank or separator.

⚠ **The critical point** – when using automated conductivity-based boiler surface blowdown systems with mechanical heat recovery systems (opposed to an atmospheric blowdown tank without heat recovery), ***it is important to adjust the blowdown rate to be slow and steady, NOT a short intermittent "burst".***

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SECTION 1 – Overview of Boiler Drum Surface Blowdown

Boiler drum surface blowdown is the controlled removal of a small percentage of boiler water from the steam drum to limit the concentration of dissolved and suspended solids created by evaporation. As steam is generated, minerals and contaminants remain behind and accumulate in the boiler water. Surface blowdown removes this concentrated water near the normal waterline, where total dissolved solids (TDS) are highest, and replaces it with fresh make-up water to maintain proper boiler chemistry and efficiency.

Properly managed surface blowdown improves boiler reliability, heat transfer efficiency, and operating life, while excessive or poorly controlled blowdown results in unnecessary energy, water, and chemical losses.

SECTION 2 – Automated Conductivity-Based Blowdown Systems

Modern automated surface blowdown systems typically consist of:

- A conductivity sensing probe,
- A controller that compares real-time conductivity to a target setpoint,
- And a motorized or actuated control valve that opens when blowdown is required.

These systems are commonly programmed to sample boiler water at regular intervals and initiate blowdown only when conductivity exceeds an allowable threshold. When used without heat recovery, this intermittent approach can be an efficient method of maintaining water quality while minimizing total blowdown volume.

SECTION 3 – Madden Manual Orifice Meter Blowdown Systems

Madden's manual orifice meter blowdown controls are heavy-duty, mechanical flow control devices designed to provide a fixed, continuous surface blowdown rate. Each unit contains a hardened stainless steel orifice plate with seventeen selectable orifice sizes, allowing precise and repeatable adjustment of blowdown flow over a wide operating pressure range. Integrated sediment filtration and gravity discharge contribute to long service life and resistance to erosion or wire-drawing.

These devices have been used successfully in industrial boiler rooms for decades and remain well-suited for applications with steady steam production and stable make-up water demand.

SECTION 4 – Suggestions for when to use Automated Conductivity-Based Blowdown Systems vs. Madden's Manual Metering Valve

Today, automated conductivity-based blowdown control is the industry norm, particularly in facilities with variable boiler loads, fluctuating make-up water quality, or limited operator oversight. Automated systems reduce manual intervention and dynamically respond to changing boiler conditions.

That said, ***the Madden Orifice meter is typically more durable than the actuated control valves commonly used in conductivity systems.*** They are also more consistent and simpler to troubleshoot when and if the need arises. If these features are attractive, these are the situations we recommend using our Orifice Meter control valves over automated conductivity-based blowdown systems:

- Boiler rooms with very steady steam production,
- Facilities prioritizing maximum mechanical durability,
- Applications where simplicity and reliability outweigh the need for dynamic control,
- Or environments where operator-driven sampling is already well established.

In these cases, the steady, continuous flow produced by an orifice meter aligns exceptionally well with mechanical heat recovery performance.

⚠ SECTION 5 – Integrating Automated Blowdown with Mechanical Heat Recovery Systems

(This is the Pertinent Guidance Section)

The remainder of this document assumes that an automated surface blowdown control system will be used in conjunction with a Madden mechanical boiler blowdown heat recovery system (HV, HVX, or HC series).

Section 5A – Why Slow, Steady Blowdown Is Critical for Heat Recovery

Madden heat recovery systems are purely mechanical devices. Their heat transfer surface area, flash volume, and retention time are fixed by design. They cannot dynamically expand or contract to accommodate large, short-duration flow spikes.

⚠ A common mismatch occurs when systems are sized correctly based on average blowdown rate per the stated average boiler steam production, but then operated with intermittent, high-rate discharge events via the conductivity-based control valve system.

For example:

- A boiler producing 100,000 PPH of steam may require an estimated 5% surface blowdown to maintain proper drum water quality (5,000 PPH average).
- A 5,000 PPH heat recovery system is selected accordingly.
- If the automated system opens once per hour for a short duration, the instantaneous blowdown rate during that event may be many times higher than the system's design capacity.

This creates two fundamental issues:

1. Reduced Heat Recovery Efficiency – High-velocity blowdown passes through the flash tank and heat exchanger faster than heat can be effectively transferred, particularly in the liquid-to-liquid heat exchange section.

2. Increased Mechanical and Thermal Stress (repeated high-energy flow in bursts increases internal turbulence, thermal cycling, and long-term wear) – conditions mechanical heat recovery systems are intentionally designed to avoid.

Mechanical heat recovery performs best when blowdown flow is slow, steady, and continuous, not intermittent or burst-driven.

SECTION 5B – Typical Control Valves Used in Automated Blowdown Systems

Most automated conductivity blowdown systems utilize one of the following valve types:

- On/off motorized ball valves,
- Electrically actuated globe valves,
- Pneumatically actuated globe or control valves.

In many installations, these valves are configured primarily as open/close devices, rather than true modulating flow control elements.

SECTION 5C – Preferred Solution: *Modulating* the Automated Control Valve

When the automated blowdown system includes a true modulating control valve, the preferred solution is to limit the maximum valve opening so that the resulting blowdown flow rate does not exceed the design capacity of the heat recovery system. *Remember, slow and steady, not fast and intermittent.*

Example Scenario:

- Control Valve capacity at 100% open = 50,000 PPH blowdown flow rate
- Selected heat recovery system capacity and desired max flow rate: 5,000 PPH
- Therefore, the recommended limit for this valve opening: approximately 10%

This approach preserves automated conductivity control while ensuring stable, compatible flow into the heat recovery system and is Madden's preferred integration method whenever practical.

If modulating the existing valve is not an option, read the following section 5D.

SECTION 5D – Alternate Solution: Downstream Manual Flow Limiting (Recommended with Considerations)

If valve modulation is not available – or if operators prefer to avoid additional programming complexity – Madden recommends installing a manual flow-limiting device downstream of the automated control valve. Examples include:

- A manually set globe valve,
- A needle valve rated for boiler pressure,
- A fixed orifice plate,
- Or a Madden orifice meter installed in series.

This approach ensures that even when the automated valve opens fully, the maximum blowdown rate delivered to the heat recovery system remains within its mechanical design limits.

⚠ **Important Integration Considerations**

When using downstream flow limitation, the following points should be understood:

- Automated conductivity controllers typically do not measure flow directly; they respond to changes in boiler water conductivity.

- If the system operates on a true conductivity feedback basis (blowing down until a setpoint is reached), downstream flow restriction will not “confuse” the controller. Instead, the controller may simply operate the valve for longer durations or at higher frequency to achieve the desired conductivity reduction.
- If the system operates on a fixed time-based schedule without conductivity feedback, downstream restriction may reduce the total mass of blowdown removed per event. In these cases, timing or control parameters may need adjustment to maintain water quality targets.
- Excessive restriction should be avoided; the flow-limiting device must still allow sufficient blowdown capacity to maintain conductivity under worst-case operating conditions.
- Conductivity probe sampling and flushing requirements must still meet the control manufacturer’s recommendations. In particular, probe location and sample line configuration should ensure adequate refresh rate regardless of downstream flow-limiting devices.

In practice, downstream flow limitation is a commonly used and effective method for stabilizing blowdown flow to mechanical heat recovery systems, provided the control philosophy and operating expectations are understood.

SECTION 6 – Summary of Madden’s Recommendations

- Automated conductivity-based blowdown control is fully compatible with mechanical heat recovery when properly integrated.
- Mechanical heat recovery systems perform best with slow, continuous, and stable blowdown flow.
- Average blowdown rate alone does not protect against instantaneous overload conditions.
- Modulating control valves or downstream mechanical flow-limiting devices should be considered whenever automated systems are used.
- Proper integration improves:
    - Heat recovery efficiency,
    - Equipment reliability,
    - And long-term service life.

SECTION 7 – General Disclaimer and Scope of Responsibility

The recommendations provided in this document represent Madden Engineered Products’ guidance based on field experience with mechanical blowdown heat recovery systems. They are intended to support proper integration and long-term performance of Madden heat recovery equipment.

Nothing in this document:

- Overrides boiler manufacturer requirements,
- Overrides automated blowdown system manufacturer instructions,
- Replaces water treatment provider recommendations,
- Or supersedes jurisdictional or regulatory requirements.

Final responsibility for boiler control strategy, blowdown logic, and system tuning remains with the boiler manufacturer, control system supplier, water treatment provider, and facility engineering staff.

These recommendations are offered solely to promote optimal performance and service life of Madden mechanical blowdown heat recovery systems.