EQUIPMENT
Total Facilities Optimization

DATE: Mar 3, 2026
TO: M/E Engineering
ATTN: Jen Kuhn

RE: Kleinhans Music Hall — Steam Boiler Piping Review & Velocity Confirmation

Stark Equipment, LLC, acting in our capacity as Manufacturer's Representative for the boiler equipment installed at Kleinhans Music Hall, has reviewed the proposed steam piping interconnection plan for the new boiler plant. We are writing to express our full concurrence with the piping arrangement as per the planned install and to provide the supporting engineering calculations that confirm the system will perform reliably and efficiently once commissioned.

System Description

The new boiler plant consists of two (2) newly installed low-pressure steam boilers, each rated at 1,985 MBH gross output. The proposed piping configuration connects each boiler independently to a common 12-inch steam header via a 6-inch outlet pipe. The 12-inch header is configured as an effective drop-leg, with 5 inches of clearance below the bottom of the connecting 6-inch branch pipes. The steam supply takeoff at the far end of the header rises vertically several feet before entering the distribution system. This geometry is a time-honored and proven arrangement for low-pressure steam systems.

Drop-Leg Header Configuration

The existing 12-inch header that functions as a drop-leg is oversized as a result of the previously installed steam system being significantly larger. This larger size suits it well to perform the 3 major functions we are looking for out of a steam header:

1. Water Separation: The oversized header (12" versus the 6" boiler outlets) dramatically reduces steam velocity within the header, causing entrained moisture droplets to fall out of suspension and collect in the bottom of the header rather than being carried into the distribution system.

2. Condensate Drainage: The 5-inch clearance below the 6-inch inlets provides a reservoir for collected condensate, preventing re-entrainment into the steam flow. Proper drip trapping of the header will allow this condensate to be continuously and safely removed.

3. Dry Steam Supply: The steam supply riser at the end of the header takes off from above, ensuring that only dry steam — not slugs of water — enters the distribution mains. This virtually eliminates the risk of water hammer and protects terminal equipment.

This arrangement effectively functions as an integral steam separator and is widely recognized in industry literature, including publications by the Hydronics Institute (I=B=R) and engineering references such as the ASHRAE Handbook of HVAC Systems and Equipment.

Steam Velocity Calculations

The following calculations confirm that steam velocities in both the 6-inch boiler outlet pipes and the 12-inch header are well within accepted engineering limits for low-pressure steam systems.

Design Basis & Assumptions

Parameter	Value
Boiler rated gross output (each)	**1,985 MBH**
Number of boilers	**2**
System operating pressure	**Low pressure (0–2 psig)**
Steam latent heat (conservative, 0 psig / 212°F)	**970 BTU/lb**
Steam specific volume (0 psig, conservative)	**26.8 ft³/lb**
6" Schedule 40 pipe inside diameter	**6.065 inches**
6" pipe cross-sectional area	**0.2006 ft² (28.89 in²)**
12" Schedule 40 pipe inside diameter	**11.938 inches**
12" pipe cross-sectional area	**0.7773 ft² (111.93 in²)**

Steam Generation Rate

At full-rated output, each boiler generates steam at the following mass and volumetric flow rates:

Steam flow per boiler = 1,985,000 BTU/hr ÷ 970 BTU/lb = 2,046 lb/hr

Volumetric flow per boiler = 2,046 lb/hr × 26.8 ft³/lb = 54,843 ft³/hr (914 CFM)

Combined flow (both boilers) = 4,092 lb/hr (1,828 CFM)

Calculated Velocities vs. Industry Limits

Pipe / Location	Flow (CFM)	Velocity (FPM)	Industry Limit (FPM)	% of Limit
6" outlet pipe — Boiler #1 (full load)	914	4,556	6,000	75.9%
6" outlet pipe — Boiler #2 (full load)	914	4,556	6,000	75.9%
12" steam header (both boilers, full load)	1,828	2,352	6,000	39.2%

Note: Industry-accepted maximum velocity for low-pressure steam mains is 4,000–6,000 FPM, with an absolute upper limit of 8,000–10,000 FPM before noise, erosion, and water entrainment become significant concerns (reference: ASHRAE Handbook — HVAC Systems and Equipment; Spirax Sarco Steam Engineering Tutorials). Calculations conservatively assume atmospheric (0 psig) steam properties; at 2 psig the steam density is slightly higher, which would result in marginally lower velocities.

Commentary & Conclusions

The calculated results demonstrate the following:

- The 6-inch boiler outlet pipes, at 4,556 FPM under full simultaneous load, operate at approximately 76% of the recommended maximum velocity. This is a comfortable margin that provides excellent steam flow without the noise, turbulence, or moisture carry-over associated with high-velocity mains.
- The 12-inch steam header, at only 2,352 FPM, operates at just 39% of the recommended limit — less than half. This extremely low velocity in the header allows it to perform its moisture-separation function effectively.
- The step-up in pipe area from the 6-inch outlets (0.20 ft² each) to the 12-inch header (0.78 ft²) represents a combined inlet area ratio of approximately 1.9:1, meaning velocity is cut nearly in half the moment steam enters the header. This transition is the physical mechanism that causes moisture to precipitate and settle.

It is Stark Tech's professional opinion that the piping design as proposed will meet or exceed design expectations. The combination of appropriately-sized boiler outlet pipes, an oversized drop-leg header, and a top-takeoff steam supply riser will deliver clean, dry steam to the system at all load conditions, from part-load operation of a single boiler to both boilers running at full capacity.

The owner can be fully assured that once the system is commissioned and properly trapped, the new boiler plant at Kleinhans Music Hall will operate quietly, efficiently, and without the water

hammer, moisture carryover, or pipe noise problems that plague improperly designed steam systems. The piping plan reflects sound engineering judgment, and Stark Tech fully endorses it.

We trust this letter provides the technical reassurance necessary for all parties. Please do not hesitate to contact our office should you require any additional calculations, documentation, or clarification.

Sincerely,

George Denecke

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