COOLING-TOWER NOISE CONTROL FOR THE NIAGARA FALLS CASINO

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1. INTRODUCTION

The new casino built on the Canadian side of Niagara Falls is located very close to the waterfalls. In the design phase, there was a concern that the noise from the large cooling towers serving the casino would interfere with the natural sound of the falls. Cooling towers usually have multiple large-diameter propeller fans that generate a significant level of low-frequency noise. The intakes for these fans are typically located on the sides of the unit, so fan noise is also radiated horizontally from these openings. Traditional methods for noise control include sound-barrier walls, silencers or noise enclosures. Barrier walls usually have no adverse effect on the performance of the cooling towers. However, silencers and noise enclosures must be carefully designed to minimize airflow resistance and maintain proper operation of the cooling tower. This paper discusses the techniques used to successfully reduce the noise propagation from the casino cooling towers.

1.1 Induced-Draft Cooling Towers

These are the most common type. The propeller fans on top of the unit discharge air upward. Air is drawn into the intakes on the sides of the unit, and passes through a stream of water. Some of the water evaporates into the airstream causing cooling. Figure 1 shows the typical fan noise spectrum. The blade pass tone is typically below 63 Hz. Other noise sources include the spraying and splashing sounds of water, as well as motor, belts and gearbox noises.

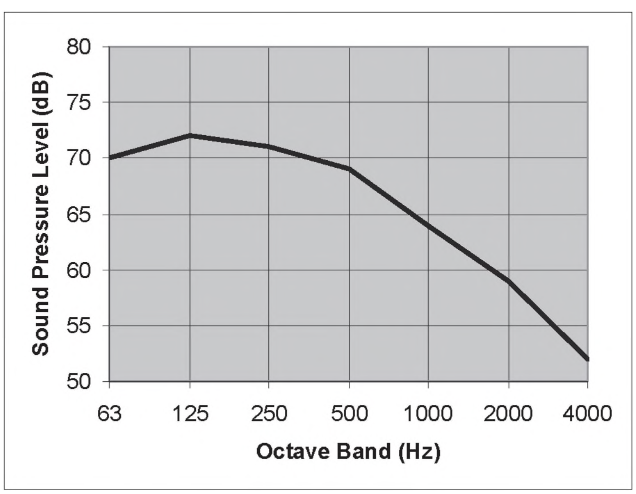

Figure 1. Typical induced-draft cooling tower fan noise spectrum for 2800-kW unit at 15 m (800-ton unit at 50 ft), based on CTI Code ATC-128 (Schaffer 2005).

1.2 Casino Cooling Towers

The casino required 3 double-cell cooling towers with each unit providing 6900 kW (1970 tons) of cooling. In addition to the noise impact of the cooling towers on the natural sound of the waterfalls, there was also a potential impact on the hotel tower that was part of the development. Figure 2 shows the proximity of the cooling towers with the falls.

Figure 2. Proximity of cooling towers with the waterfalls (located near the left side of this picture taken during construction).

1.3 Noise Control Options

Available noise control options for cooling towers include; low-noise fans, reduced fan speed and sound-attenuation components such as noise-barrier walls and silencers. In this case, the decision was made to provide rectangular absorptive silencers on the cooling tower fan discharge and air intakes.

2. SILENCER DESIGN

2.1 Silencer Design Parameters

The 6 discharge silencers each handle an airflow volume of 108,500 L/s (230,000 cfm). Each silencer is 3500 x 3500 x 3000 mm long (11.5 x 11.5 x 10 feet). A rectangular silencer design with a circular bullet was used. The design pressure drop was 15 Pa (0.06 in. wg).

The 12 intake silencers each handle an airflow volume of 54,250 L/s (115,000 cfm). Each silencer is 3500 x 5200 x 900 mm long (11.5 x 17 x 3 feet). These are standard rectangular silencers with a design pressure drop of only 3 Pa (0.01 in. wg).

The installed discharge and intake silencers are shown in Figure 3.

Figure 3. Installed discharge and intake silencers.

2.2 Silencer Insertion Loss

The insertion loss requirements for the silencers were specified by the acoustical consultant and are given below in tables 1 and 2.

Table 1. Discharge silencers required insertion loss.

Octave Band (Hz)	63	125	250	500	1k	2k	4k	8k
Insertion Loss (dB)	4	14	22	25	11	6	2	1

Table 2. Intake silencers required insertion loss.

Octave Band (Hz)	63	125	250	500	1k	2k	4k	8k
Insertion Loss (dB)	6	8	16	29	24	12	11	10

3. MAINTENANCE ISSUES

The silencers were constructed with G 90 galvanized steel to resist corrosion from the discharge air which is 100% saturated with water vapor. Plenums were provided above the fans for access and servicing. Regular inspections and maintenance are required to detect and prevent rusting.

4. STRUCTURAL ISSUES

Separate structural steel frames were provided to support the weight of the silencers. The wind loading on the silencers also had to be considered in the system design.

5. RESULTS

Sound level reading taken after construction confirmed that the cooling tower noise levels met the design criteria. Figure 4 shows an overall view of the cooling tower silencer system.

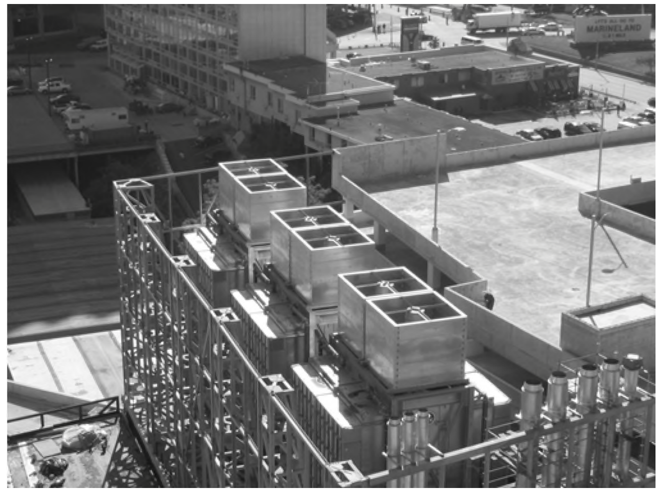

Figure 4. Overall view of cooling tower silencers.

REFERENCES

Schaffer, Mark E (2005). *A Practical Guide to Noise and Vibration Control for HVAC Systems (2nd Edition)*, ASHRAE, Atlanta, GA.