

# MANAGEMENT OF AMPLIFIED SOUND GENERATED BY BAND-SHELL PERFORMANCES IN A DYNAMIC URBAN SETTING

**Ellen Buchan**

Ellen Buchan, P.Eng. Alberta Infrastructure, 6950-113 st, Edmonton, AB T6H 5V7, [ellen.buchan@gov.ab.ca](mailto:ellen.buchan@gov.ab.ca)

## 1. INTRODUCTION

Over the years, residential areas surrounding the Edmonton Legislature Grounds' Band Shell have grown and residents have raised concerns about the sound levels generated from Band-shell performances. In response to the community's concerns, a project was started by Alberta Infrastructure to develop a system and procedure for monitoring and controlling these amplified performances. The intent was to provide Sound System Operators with a clear indicator of their sound levels so they could voluntarily take action to limit it. In addition, the system would record and maintain accurate records of event noise for future reference by the Legislature Grounds Staff.

The "first generation" Legislature Sound Monitoring System was introduced in 1997 at the Alberta Legislature Grounds Band Shell Site. It has continued to evolve over the last 15 years, expanding, incorporating new technology and functionality; shaping today's current system, which is the subject of this paper.

## 2. METHODS AND RESULTS

### 2.1 Primary System Functionality

The monitoring system relays real-time feedback to the event's Sound System Operator and Legislature Grounds Staff, indicating when the levels are approaching or exceeding the noise limits. To accomplish this, a warning light is triggered to indicate that the levels are approaching the limit and a horn is triggered to indicate that the limit has been exceeded.

The monitoring system also records the sound levels during an event. Continuous levels and corresponding statistical data are displayed and saved to hard drive and USB stick. The system user can view this data for future reference.

### 2.2 Site Plan

Figure 1 displays the Legislatures Grounds in relation to the surrounding community, Band Shell Site and Monitoring System Components. A microphone at measurement station #1 is encased in a custom designed weather protective housing positioned on top of a high pole about 30m north of the stage. A second microphone at measurement station #2 is enclosed in a pre-manufactured weather protective housing on the roof of the Legislature Building, about 200m northwest of the Band Shell. The locations of these measurement stations were chosen to be unobtrusive and

intercept the line of site from the stage to the affected condominiums/apartments, northeast and northwest of the stage. The warning light is clearly visible from the band shell stage. The horn is located on the Band Shell, in very close proximity to the performers. The core data acquisition electronics and accessories are housed in an equipment cabinet mounted on the wall of the nearby washrooms.



Figure.1. Alberta Legislature Grounds Band Shell Sound Monitoring System Site Plan

### 2.3 Primary System Components

A variety of hardware pieces and software platforms have been evaluated and often implemented over the life of the Monitoring System. The current system's primary components are described as follows:

Both measurement station encasements' house a microphone that is protected from moisture, birds, and insects. Pre-amplifiers condition both microphone level input signals for line level data acquisition. An encrypted wireless transmitter/receiver pair facilitates the connectivity between measurement station #2 and the core data acquisition system. An equipment cabinet located near the Band Shell houses a desktop computer complete with a National Instruments Data Acquisition Card and output relays. This desktop computer runs National Instruments Sound and Vibration Toolkit Software and Microsoft Remote Desktop. Finally, a Wireless Air-Card connected to the desktop computer allows the Legislature Grounds staff to access the system remotely.

## 2.4 Maximum Permissible Daytime Sound Levels

### Measurement Station #1

Edmonton Bylaw 7255 states that 65 dB(A) is the residential property line limits of allowable noise during the day (7am to 10pm)<sup>1</sup>. However, in development of the Monitoring System, a noise study, limited to Station #1 (30m from the Band Shell) and the Northeast Community (200 to 400m from the Band Shell), revealed that Band Shell music falling below the daytime noise bylaw limit was still definitely audible at the residences (and very likely annoying to the occupants). Therefore, basic bylaw compliance did not seem like a sufficient restriction.

Further investigation detected existing background noise levels in the northeast community ranging from 47 dB(A) to 56 dB(A). The maximum permissible level allowed at the site was selected so the resulting maximum level heard in the residences was more restrictive than the bylaws and equivalent to the ambient noise range maximum. The maximum permissible daytime sound limit was set to 75 dB(A) at measurement station #1, as a compromise between city bylaws and ambient levels.

### Measurement Station #2

In 2006 noise complaints were issued by residents of the growing community located to the northwest of the Band Shell site. At this time, only Measurement Station #1 was in use. It was concluded that the system was not calibrated to keep events from disturbing new local residents to the northwest due primarily to the sound system directivity. It was reasonable to predict the SPL correlation between the northwest community (440m from the stage) and Measurement Station #2 (about 200m from the stage). It was also reasonable to assume that the range of background noise levels in the community northwest of the band shell was comparable to those measured in the noise study (they are similar urban residential communities). Measurement Station #2 was installed and intergraded into the Monitoring System and its maximum permissible daytime sound limit was calculated, then set to be 59 dB(A).

## 2.5 Sound Source Localization to Prevent False Alarm Triggers

Due to site limitations, Station #2 had to be installed 200m from the Band Shell. At this distance, Station #2's maximum permissible daytime sound level is only about 10dB higher than the ambient level atop the Legislature Building roof. As such, this Measurement Station is susceptible to false triggers (events exceeding Station #2's maximum permissible sound level that do not originate from the Band Shell Stage).

Sound source localization can be determined by comparing receiver level-differences. This logic was incorporated into the Monitoring System's software program to minimize false triggers. The program executes a level-difference

calculation between Station #1 and #2 SPL values at the instant when the Monitoring System detects an exceedance. A warning signal is only triggered if this level-difference is within reasonable tolerances of the theoretically predicted level-difference. Further, this method of verifying source location was possible because the source signal arrives at Station #2 0.5 sec after Station #1, allowing ongoing 5sec and 60 sec Leq SPL data acquired by the Monitoring System to capture meaningful level-difference criteria.

The implementation of sound source localization logic into the software program resulted in a 98% reduction in false triggers at measuring station #2 and an unanticipated, but desirable, reduction in false triggers of 100% at station #1. These results were calculated with data acquired by the Monitoring System for two 9 hour daytime periods while no performances or events were taking place at the band shell.

## 3. DISCUSSION

The success of the Monitoring System has been measured by a decrease in the frequency of community complaints received by Legislature Grounds Staff. This trend is encouraging; however, it would be interesting to conduct a more in depth study on the communities' satisfaction with the noise levels originating from the site. Additional feedback could benefit system development in the future.

The Legislature Staff that operate the Monitoring System have provided mostly positive feedback about its ease of use. They can independently operate the "windows based" software interface and are able to input event schedules and view the records of past event SPL data, graphs statistics and more. Sound System Operators are educated on the function of the Monitoring System prior to performances/events. Numerous operators have been observed lowering their sound levels in response to feedback from the warning signals.

Introducing an automated Sound Monitoring System to the Legislature Grounds Band Shell performance site has reduced the level of community complaints reported to the Legislature Grounds Staff and has supported the continued programming and operation of this public venue (April through October, yearly).

## REFERENCES

<sup>1</sup>City of Edmonton, "Bylaw No.7255"

## ACKNOWLEDGEMENTS

The Author would like to acknowledge Kelly Kruger, Steven Bilawchuk, Jason McCrank for their contributions to the development of this system over the last 15 years.