

# ACOUSTICAL VERIFICATION TESTING OF GROUND RUN-UP ENCLOSURE AT VANCOUVER INTERNATIONAL AIRPORT

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## 1 Introduction

The Vancouver Airport Authority (Airport Authority) manages the Vancouver International Airport (YVR) on behalf of Transport Canada under a long-term ground lease. The Airport Authority is responsible for noise management activities, and has a comprehensive noise management program to meet this responsibility. In 2010, Airport Authority approved a capital project to construct a ground run-up enclosure (GRE) to further reduce noise disturbances from run-ups, i.e. engine testing after maintenance.

A GRE is a three-sided structure into which aircraft are positioned while performing a run-up. Propeller aircraft are associated with the majority of run-ups at YVR, and the Airport Authority selected the dimensions of the GRE to safely accommodate power-in/power-out operations of the most common aircraft types expected to use the facility.

While a number of potential sites for the GRE on the airfield were identified, siting and orientating is a challenge due to the many factors that must be considered, and trade-offs between acoustical and non-acoustical factors often need to be made. In general, the main factors include: aerodynamic usability; acoustical performance; proximity and ease of access to maintenance facilities; airport zoning (height) restrictions; and interferences with radio and navigation signals.

To help with site selection, URS Aviation created a noise model using CadnaA® with a GRE meeting the general dimensional requirements and then completed prediction modeling using run-up noise profiles collected for the Saab SF 340 and Beechcraft 1900 aircraft. This resulted in selecting a site on the south side of the airport, off Apron I.

The design and construction of the GRE was then awarded to Blast Deflectors Inc. (BDI), of Reno Nevada, with a requirement to meet a specified arithmetic average insertion loss (IL) of 15 dBA at directions 60°-300° at a distance of 400 feet from the operating engine (0° is along the axis of the tested aircraft) to be determined based on measurements made at 60°, 90°, and 135° relative to the aircraft axis. The calculation of the acoustical performance was to be determined using the methodology outlined in the ANSI/ASA Standard Method S12.8-1998, *Methods for Determining the Insertion Loss of Outdoor Noise Barriers*. [1]

## 2 Method

### 2.1 Testing Set Up

Construction of the GRE was completed in January 2012, and the acoustical verification testing was completed by staff from ESA and BKL Consultants Ltd. on January 17, 2012, between the hours of 9 pm and 12 am.

During the measurements, 1-second Leqs and 1/3-octave spectral data were captured using Type 1 Larson-Davis Laboratories (LDL) Model 824 sound level analyzers. Calibrations were performed prior to the measurements using a Brüel & Kjær (B&K) Type 4230 or LDL Model CAL200 acoustical calibrator. With the exception of the reference noise level measurement, all measurements were completed at a height of approximately 1.5 meters above the ground.

Due to the location of adjacent buildings and hangars, only two ground-level receiver measurement sites were suitable for the acceptance testing: 50° at 400' from the aircraft (MP1) and 125° at 250' from the aircraft (MP2). While not the most ideal, this was the best possible measurement set-up.

Measurements were also completed at a reference location (REF) 90° and approximately 60' from the closest aircraft engine. The REF location was positioned at a height of approximately 55' to minimize the effect of the GRE wall on measurements. See Figures 1 and 2 for the acceptance testing measurement locations relative to the aircraft inside and outside the GRE.

As shown in the figures, an acoustical barrier, approximately 8' in height and treated with 4" thick open-face fiberglass absorptive material on the microphone side, was positioned behind the MP2 location to mitigate reflection noise from the neighboring buildings in close proximity.

Measurements were completed for three aircraft: Saab 340, Beechcraft B1900, and Falcon 900B. Each aircraft performed three full power one-minute run-ups inside and outside the GRE.

### 2.2 Atmospheric Conditions

Atmospheric conditions were recorded continuously using a Davis Portable Weather Station, positioned at the REF measurement location, in accordance with ANSI/ASA S12.8. The standard specifies that measurements are not valid for wind speeds in excess of 5 m/s, or for changes in

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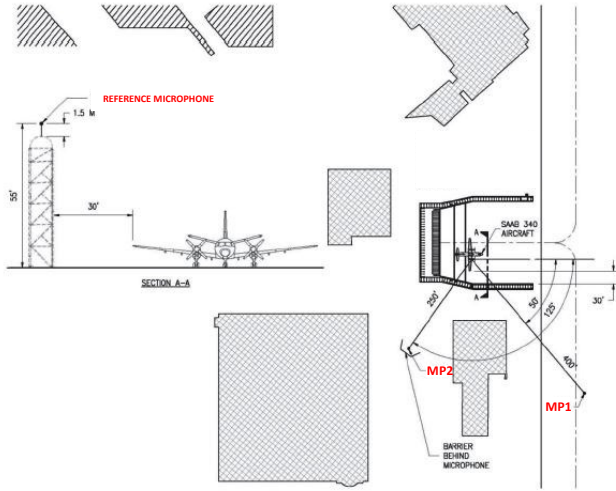
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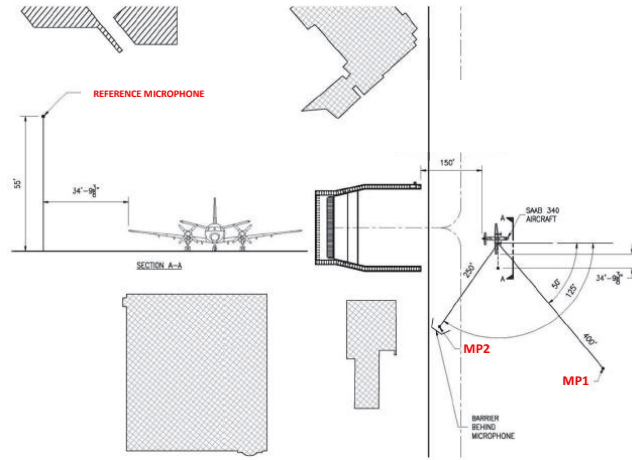
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wind class between measurements of the same aircraft inside and outside the GRE.

Specifically, changes in the wind direction during the Beechcraft 1900 run-ups resulted in all measurements for this aircraft being excluded for use in the verification study. While some measured data for the Saab 340 and the Falcon 900B were also affected, enough unaffected data was collected to proceed with insertion loss calculations.



**Figure 1:** Measurement Locations for Aircraft Inside GRE



**Figure 2:** Measurement Locations for Aircraft Outside GRE

### 3 Results

Barrier insertion loss (IL) was calculated for each study aircraft using the following:

$$IL = (L_{AR} - L_A) - (L_{BR} - L_B)$$

Where  $L_{AR}$  is the average reference level (at REF) after barrier insertion (i.e. inside the GRE),  $L_A$  is the average receiver level at MP1 or MP2 after barrier insertion,  $L_{BR}$  is the average reference level before barrier insertion (i.e., outside GRE), and  $L_B$  is the average receiver level before barrier insertion. Measured levels and calculated IL for the two studied aircraft are summarized in Table 1.

**Table 1:** Measured sound levels and IL (dBA)

Aircraft	Site	$L_{AR}$	$L_A$	$L_{BR}$	$L_B$	IL
Saab	MP1	112	111	111	117	7
SF 340	MP2	112	77	111	98	22
Falcon	MP1	108	93	108	109	16
900B	MP2	108	73	108	99	26

### 4 Discussion

The IL performance at MP1 likely suffered due to the reduced shielding provided by the south wall of the GRE: the angle of this measurement site ( $50^\circ$ ) relative to the aircraft heading was outside of the range specified for the effective performance of the GRE ( $60^\circ$ - $300^\circ$  relative to the aircraft heading of  $0^\circ$ ). The IL performance of the GRE at MP2 was likely improved due to the reduced distance between the barrier (GRE) and the site (250 feet instead of 400 feet specified). This reduced barrier-to-receiver distance produced an increased sound path length difference, increasing the barrier's noise attenuation performance. Although the measurement sites were not as specified or desired, they were the best available given the project site layout. Additionally, the acoustical shortcomings of site MP1 were largely negated by the acoustical benefits of site MP2.

Average IL performance of the GRE for the two ground-level measurement sites was 15 dB and 21 dB for the Saab SF 340 and Falcon 900B, respectively. As such, the IL performance of the GRE satisfied the minimum specified 15 dBA IL performance criteria.

### 5 Conclusion

Since its opening in January 2012, over 70% of the high power run-ups of propeller and business jet aircraft maintained on the south side of the airport have been performed inside the GRE. In addition, the GRE has become the primary location for run-ups performed during the noise sensitive hours between 10 pm and 7 am, with approximately 90% of high power run-ups performed during this time period performed inside the facility. There have been no reports of run-ups being adversely impacted due to adverse winds and the overall feedback from the maintenance operators has been very positive.

While the surrounding buildings at the site posed challenges to meet measurement requirements contained in the ANSI/ASA S12.8 standard, the GRE was observed to meet the acoustical insertion loss required in the design specification.

### Acknowledgments

Thank you to Pacific Coastal Airlines and Pattison Airways for providing crew and aircraft for use during the testing.

### References

- [1] American National Standards Institute (ANSI). 1998. Methods for Determining the Insertion Loss of Outdoor Noise Barriers. Reference No. ANSI S12.8-1998. New York, Acoustical Society of America.