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Content: Vancouver Island Motorsport Circuit, proposed phase 2 extension – revised – noise study and sound impact assessment

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Comment: This report contains 23 pages and 5 appendices. Copying or quoting in parts must be authorized by us.
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1 Summary

We (BeSB GmbH Berlin acoustical consulting) are a global operating engineering office for sound and vibration technology. We have extensive experience in noise measurement, noise prognosis and noise evaluation for a large variety of motor sport facilities especially in Germany, but also globally for two decades. We were hired by Fasken Martineau DuMoulin LLP to perform a detailed noise study of the new layout for the planned construction phase 2 extension of Vancouver Island Motorsport Circuit (VIMC) operation causing noise immission in the surroundings.

Vancouver Island Motorsport Circuit is a motorsports test and club facility located in the municipality of North Cowichan on Vancouver Island, about 5 km to the northwest of the city center of Duncan. This noise study for the new layout of the planned construction phase 2 of VIMC contains a validation of sound impact due to various activities on this motorsports venue.

Figure 1-1 shows the project area, the contours of the circuit and the surrounding neighborhood. The closest dwellings and a few more in the wider environment are marked with IP 01 to IP 17 (Immission Point).

Figure 1-1: Surrounding area of VIMC and location of selected dwellings
We have developed an acoustical calculation model for prognosis of sound levels in the neighborhood of VIMC caused by circuit operation. This model is taking into account the sound emission according to the driving dynamics of sports cars and the sound propagation towards the neighborhood using a calculation method according to ISO standards for a downwind situation favorable for sound propagation.

A sound level prognosis was prepared for four typical driving events. Furthermore we did a prognosis of noise due to road traffic on Highway 18 situated south of VIMC in order to obtain a standard of comparison with usual ambient noise exposure in the area.

Table 1-1 shows the calculation results of noise impact in the neighborhood of VIMC. The results are given as the average sound level $L_{Aeq,op}$ during actual driving operation and also the sound level $L_{Aeq,14h}$ averaged throughout the 14 hour daytime (7 am – 9 pm; including operation pauses and off-peak hours with no operation).

<table>
<thead>
<tr>
<th>Immission Point</th>
<th>Driving experience</th>
<th>Member Track Day</th>
<th>Busy Member Track Day</th>
<th>Very Busy Member Track Day</th>
<th>Highway 18</th>
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<tr>
<td>IP 01</td>
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<td>IP 11</td>
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<td>IP 12</td>
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<td>IP 13</td>
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<td>IP 17</td>
<td>41</td>
<td>38</td>
<td>50</td>
<td>47</td>
<td>52</td>
</tr>
</tbody>
</table>

The relevant noise bylaw of North Cowichan does not provide explicit sound level limits. Instead the sound impact in the neighborhood of VIMC is evaluated according to the noise limits given in the relevant noise bylaw of the neighboring community of Cowichan Valley Regional District. According to
this bylaw, for so-called continuous noise an average sound level of $L_{Aeq,op} = 60$ dBA should not be exceeded.

As one can see in Table 1-1, even on a Very Busy Member Track Day (worst case scenario) the sound impact will not exceed 60 dBA for $L_{Aeq,op}$ at any location in the neighborhood.

Also, depending on the type of operation and especially at locations near the highway (IP 01 to IP 05 and IP 16), the daily average sound level $L_{Aeq,14h}$ caused by VIMC is in the same range as the usual noise caused by road traffic on Highway 18. In more quiet areas further away from the highway, on a Very Busy Member Track Day the motorsport noise may be perceptible (depending on the influence of other ambient noise sources such as airplanes, road traffic, nature etc.) but well below the limit of $L_{Aeq,15min} = 60$ dBA.

As our calculations assume a steady downwind situation and also permanent "at the limit" driving with a high percentage of full throttle, which both naturally and realistically cannot always be the case, our results must be seen as worst-case. Realistically, most of the time the actual sound level will be lower than the prognosis sound levels (Table 1-1).

For full report details, please see our study in the following pages.
2 Task and approach

We (BeSB GmbH Berlin acoustical consulting) are a global operating engineering office for sound and vibration technology. We have extensive experience in noise measurement, noise prognosis and noise evaluation for a large variety of motor sport facilities especially in Germany, but also globally for two decades. We were hired by Fasken Martineau DuMoulin LLP to perform a detailed noise study of the new layout of the planned construction phase 2 extension of Vancouver Island Motorsport Circuit (VIMC) operation causing noise immission in the surroundings.

This noise study for the new layout of the planned phase 2 of the Vancouver Island Motorsport Circuit (VIMC) contains a physical analysis of sound impact due to various possible activities on the motorsports test and club facility.

We have prepared sound level prognosis for four typical driving events and evaluated the sound impact in the neighborhood according to the noise limits given in the relevant CVRD Bylaw No. 3723\(^1\) including a brief discussion on appropriate noise limits for motorsport venues.

The sound calculations for the specific types of operations are done with the help of an acoustical computer model. The input data used in the acoustical model comes from our daily sound measurements at various kinds of motorsports facilities in Central Europe.

The results of the calculations are presented as single point computations at specific locations in the neighborhood as well as sound level distribution plans ("sound maps") for the surrounding area.

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\(^1\) Cowichan Valley Regional District Bylaw No. 3723 – Noise Control Bylaw, 2013
3 Description of the motorsports facility and its surroundings

Vancouver Island Motorsport Circuit (VIMC) is a motorsports test and club facility located in the municipality of North Cowichan on Vancouver Island, about 5 km to the northwest of the city center of Duncan. The surrounding area is mainly characterized by forest areas and wood-processing companies without larger settlements. The closest dwellings are single houses situated at specific points mainly in the south of the motorsports venue. The distance between the closest dwelling and Vancouver Island Motorsport Circuit is about 250 m.

The existing core of the project is a 2.3 km long main circuit that makes use of the existing land contours and can be used in various combinations via short connecting sections. The circuit is designed and built to FIA standards including the paved circuit, run off areas and impact barriers.

The planned new construction phase 2 extends the existing circuit to a total length of 5.7 km. The existing 2.3 km long circuit and the 3.4 km long extension can be used either combined or separately. The average lap time for a sports car on the combined 5.7 km long circuit is about 170 seconds.

The new layout for the construction phase 2 also includes a new Club House / operation control and an additional parking space for club members, customers and visitors.

The typical operations on the circuit are driving experience programs that are instructor led, circuit taxi experiences and Track Days for club members and customers. The venue is only operated during daytime.

Common vehicles on the circuit are street legal upper class sedans and other vehicles all in stock configuration. Occasionally there can also be vintage and modern sports cars.

Figure 3-1 shows the new masterplan layout of construction phase 2 / VIMC².

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² submitted by Tilke architects on March 7th 2018
Figure 3-1: New Masterplan layout of construction phase 2 of VIMC
4 Sound impact assessment

4.1 Sound transmission

Our sound prognosis is carried out using the licensed software package for noise calculation CadnaA (v.2018.161) by Datakustik GmbH (Germany). The calculations for sound propagation are performed according to international standard ISO 9613-2:1996 "Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation." The heights and positions of the Club Houses / control buildings situated directly at the venue (according to the plans submitted by Tilke architects) are included in our acoustical computer model as well as a digital elevation model of the surrounding area and the motorsports facility itself. The sound propagation was determined as a worst-case-scenario with omni directional downwind conditions, which are favorable for propagation of sound from the source to the receiver.

The traffic noise of the Cowichan Valley Highway 18 located south of the venue was modeled in accordance with the FHWA TNM. This sound model contains data of various vehicle types on North American highways, including automobiles, medium and heavy trucks, buses and motorcycles.

For hard ground as the main circuit and the parking space, we used a ground absorption factor of G=0 (reflecting). The gravel bed along the run off areas was modeled with a ground absorption factor of G=0.3 (1/3 absorbent, 2/3 reflecting). The remaining area consist of porous ground mostly and for this we have set a ground absorption factor of G=1. As the circuit is partly surrounded by dense forests we also included sound attenuation due to dense vegetation in the model.

Regarding the temperature and humidity conditions, we used a temperature of 10°C and a rel. humidity of 70%. These values are in compliance with ISO 9613-2 and provide the lowest possible air attenuation in the relevant frequency range (= worst-case-calculation approach).

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3 According to ISO 9613-2 omni directional downwind means the "worst case" downwind situation regarding sound propagation; the ISO specifies this as wind speed between approximately 1 m/s and 5 m/s, measured at a height of 3 m to 11 m above the ground.

4 FHWA TNM: Federal Highway Administration - Traffic Noise Model
4.2 Vehicle noise data

The sound of a car driving on the circuit is not constant, but dependent on the driving dynamics, respectively speed but foremost engine load. Therefore static line source models (as used for ordinary road traffic noise) are inadequate for modeling a motorsport circuit. Instead we are using the so called moving point source model. For this purpose the circuit is divided into very short segments, each 5 m long. Using the Sports Car speed calculation plan submitted by Tilke Engineers and Architects (Aachen, Ger.), which includes the speed profile of the circuit, break points and the total lap time, we determine the speed and the operating state of the engine on each segment. The speed calculation for the circuit extension is attached in Appendix 1.

Regarding the operating state of the engine and the sound emitted, we distinguish between three acoustical relevant operating states: full engine load (FL), partial engine load and overrun operation (engine brake). Using the operating state of a car and also its speed (which results in a "resting time" on the particular section), one can calculate the equivalent sound power level of each single 5 m segment of the circuit.

The result of the calculation described above - the relative equivalent sound power level of the circuit for sports cars - is shown in Figure 4-1.
Figure 4-1: Distribution of relative equivalent sound power level of the circuit based on speed profile

Based on the relative equivalent sound power level of the circuit, we are able to simulate all kinds of vehicles driving on the circuit by adding the sound power level at full engine load of the specific vehicle (or an averaged sound power level of a class of vehicles) at every segment of the circuit.

The input data used in the computer model is based on sound emission data of all types of vehicles gathered by us at major test and motorsports circuits in Germany and elsewhere in Europe.

As spectral input data, we are using a representative frequency spectrum of a mix of different types of cars. Regarding sound propagation, this mixed spectrum of mainly racing cars (that tend to have low-frequency intense engine sounds) can be seen as a worst-case-calculation approach.

The following Table 4-1 shows the spectral input data used in our computation.
To be able to evaluate the noise impact due to operation of VIMC in context with the overall noise situation in the neighborhood, we also included Highway 18 in our acoustical calculation model. As input data, we are using traffic counts that were captured on a working day forenoon in June 2017. Table 4-2 shows the input for our calculation model.

Table 4-2: Traffic counts / input for calculation model

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>Numbers per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automobiles</td>
<td>375</td>
</tr>
<tr>
<td>Medium trucks + buses</td>
<td>50</td>
</tr>
<tr>
<td>Heavy trucks</td>
<td>50</td>
</tr>
<tr>
<td>Motorcycles</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>500</td>
</tr>
</tbody>
</table>

Figure 4-2 shows the project area, the contours of the circuit and the surrounding neighborhood. The closest dwellings and a few more in the wider environment are marked with IP 01 to IP 17 (Immission Point).
4.3 Calculation of typical operation

In this study on the acoustical situation at VIMC, we determine a sound prognosis calculation for typical events at the main circuit. The scope of events represents the range of day-by-day sound levels and seasonal fluctuations, which is representative for a motorsports facility like this.

The physical quantity to describe the emission of a sound source (in the present case vehicles) is the sound power level \( L_{WA} \). It is given in dBA. To non-experts the sound power level \( L_{WA} \) may be unfamiliar and in fact in many automotive or motorsporting regulations the more familiar quantity sound pressure level SPL, measured at a certain distance from the circuit, is used. The sound pressure level SPL is also given in dBA. The relation between the sound power level \( L_{WA} \) (dBA) and the sound pressure level SPL (dBA) that one can measure in a certain distance \( (r / \text{meter}) \) is:

\[
\text{SPL} = L_{WA} - 10 \log_{10}(2\pi r^2)
\]

This equation is valid for a sound source on reflecting ground like asphalt. With this equation, e.g. the relation between the \( L_{WA} \) and the SPL, that one can measure at 50 feet / 15 meters (which is a common measuring distance at motorsport circuits) is calculated as SPL\(_{15\text{m}}\) = \( L_{WA} - 31.5 \text{ dBA} \). In the listing of emission data of various types of vehicles in chapter 5 we have listed both, the sound power level \( L_{WA} \) and the SPL\(_{15\text{m}}\).

The sound emission of an entire circuit depends on the full load (FL) sound power level \( L_{WA,FL} \) of different classes of vehicles during operation, the number \( (n) \) of vehicles on the circuit, the number of driving hours \( (t) \) per vehicle and a 14 hour daytime rating period between 7 am and 9 pm.

As basic input for our computer model, we use the energy equivalent sound power level during operation \( L_{WA eq,op} \). The equation to calculate the input for our computer model with the information described above is:

\[
L_{WA eq,op} = L_{WA,FL} + 10 \log_{10}(n)
\]

With this input, the resulting parameter of our sound prognosis calculation at
residential locations is the average sound level during circuit operation $L_{Aeq,op}$.
This approach also covers short periods of 15 minutes with constant operation (see CVRD Bylaw No. 3723, sect. 4.1, definition continuous sound).

To characterize the average sound level in the neighborhood during daytime, we use the parameter $L_{Aeq,14h}$, which is the energy equivalent sound pressure level during a period of 14 hours (daytime 7 am – 9 pm, including operation pauses and off-peak hours with no operation).

To calculate the $L_{Aeq,14h}$, we use the energy equivalent sound power level during a rating period of 14 hours $L_{WA,14h}$ as input for our calculation model. The equation to calculate the $L_{WA,14h}$ with the information described above is:

$$L_{WA,14h} = L_{WA,FL} + 10 \log_{10} \left( \frac{nt}{14} \right)$$
5 Typical operation

The specific types of operation simulated are:

1 Driving experience program and circuit taxi experience:
Drive event with street legal standard cars as e.g. Subaru WRX, BMW M235, Alfa Romeo 4C and Porsche Cayman S models. We assume 6 street licensed standard cars, including upper class sedans, driven in a sporty style at the same time for 8 hours.
average vehicle at full load:
SPL_{15m} = 88.5 dBA
L_{WA,FL} = 120 dBA
resulting equivalent sound power level during operation: L_{WA,eq,op} = 127.8 dBA
resulting 14h-equivalent sound power level: L_{WA,eq,14h} = 125.4 dBA

2 Member Track Day
This event is carried out with street legal GT class cars and upper class sedans as e.g. Porsche Cayman S and 911 Carrera, GT3 regular and RS models, V8 powered Camaros and Mustang 350R's. We assumed 10 cars driving on the combined circuit at the same time for 8 hours.
average vehicle at full load:
SPL_{15m} = 95.5 dBA
L_{WA,FL} = 127 dBA
resulting equivalent sound power level during operation: L_{WA,eq,op} = 137.0 dBA
resulting 14h-equivalent sound power level: L_{WA,eq,14h} = 134.6 dBA

3 Busy Member Track Day
This event is carried out with the same types of vehicles as operation type 2 (see above). We assumed 15 cars driving on the combined circuit at the same time for 10 hours.
average vehicle at full load:
SPL_{15m} = 95.5 dBA
L_{WA,FL} = 127 dBA
resulting equivalent sound power level during operation: L_{WA,eq,op} = 138.8 dBA
resulting 14h-equivalent sound power level: L_{WA,eq,14h} = 137.3 dBA
4 Very Busy Member Track Day

This event is carried out with the same types of vehicles as operation type 2 (see above). As construction phase 2 extends the total length of the circuit, in theory, more cars are able to drive on the combined circuit. So we assumed 22 cars driving on the combined circuit at the same time for 10 hours.

average vehicle at full load:

\[ \text{SPL}_{15m} = 95.5 \text{ dBA} \]
\[ \text{L}_{WA,FL} = 127 \text{ dBA} \]

resulting equivalent sound power level during operation: \( \text{L}_{\text{WAeq,op}} = 140.4 \text{ dBA} \)
resulting 14h-equivalent sound power level: \( \text{L}_{\text{WAeq,14h}} = 139.0 \text{ dBA} \)

The operator of VIMC estimates, that the 'Very Busy Member Track Day' will be a rare operation type. Most of the days will be in the "Driving experience program" and 'Member Track Day' range.

VIMC is planning to establish an absolute limit of the sound power level for each vehicle of \( \text{L}_{WA,FL} = 138 \text{ dBA} \) or \( \text{SPL}_{15m} = 106.5 \text{ dBA} \). These kinds of cars (e.g. historic racing GT-vehicles) will be driving at VIMC only in rare cases and very limited numbers.

To calculate the (non-continuous) maximum sound impact that occurs in the neighborhood due to operation of VIMC (see CVRD Bylaw No. 3723, sect. 4.1, definition non-continuous sound), we simulated two cars with the maximum allowable sound power level of \( \text{L}_{WA,FL} = 138 \text{ dBA} \) (\( \text{SPL}_{15m} = 106.5 \text{ dBA} \)) driving closely together on the circuit (forming one single source with doubled sound power).
6 Calculation results

In the following, we present the results of the simulations of typical operation on the combined circuit (phase 1 and new layout of phase 2) of VIMC as described in chapter 5.

Table 6-1 below displays the average sound level at the residential locations IP 01 to IP 17 in the neighborhood during operation. The location of IP 01 to IP 17 can be found in Figure 4-2. The parameter $L_{Aeq,op}$ is the average sound level (also: energy equivalent sound pressure level) during operation (also short 15 min periods of constant operation).

<table>
<thead>
<tr>
<th>Driving experience</th>
<th>IP 01</th>
<th>IP 02</th>
<th>IP 03</th>
<th>IP 04</th>
<th>IP 05</th>
<th>IP 06</th>
<th>IP 07</th>
<th>IP 08</th>
<th>IP 09</th>
</tr>
</thead>
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<td>53</td>
<td>54</td>
<td>52</td>
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<tr>
<td>Busy Member Track</td>
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<td>49</td>
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<tr>
<td>Very Busy Member</td>
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</tbody>
</table>

Table 6-2 shows the average sound impact at residential locations IP 01 to IP 17 as the average sound level $L_{Aeq,14h}$ during a period of 14 hours (daytime).
Table 6-2: Sound impact (daytime average) at residential locations (IP height 2 m)

<table>
<thead>
<tr>
<th></th>
<th>L_{A_{eq,14h}}/dBA</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>IP 01</td>
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<tr>
<td>Driving experience</td>
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<tr>
<td>Member Track Day</td>
<td>41</td>
</tr>
<tr>
<td>Busy Member Track Day</td>
<td>50</td>
</tr>
<tr>
<td>Very Busy Member Track Day</td>
<td>53</td>
</tr>
</tbody>
</table>

Table 6-3 displays the sound impact in the neighborhood due to the traffic noise of Cowichan Valley Highway 18.

Table 6-3: Sound impact (IP height 2 m) at residential locations due to traffic noise

<table>
<thead>
<tr>
<th></th>
<th>L_{A_{eq}}/dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IP 01</td>
</tr>
<tr>
<td>Traffic noise Highway 18</td>
<td>55</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>L_{A_{eq}}/dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IP 10</td>
</tr>
<tr>
<td>Traffic noise Highway 18</td>
<td>44</td>
</tr>
</tbody>
</table>

Table 6-4 displays the maximum (non-continuous) sound impact peaks L_{A_{Fmax}} in the neighborhood due to operation of Vancouver Island Motorsport Circuit.

Table 6-4: Maximum sound impact peaks at residential locations (IP height 2 m)

<table>
<thead>
<tr>
<th></th>
<th>L_{A_{Fmax}}/dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IP 01</td>
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<tr>
<td>Maximum sound level</td>
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<table>
<thead>
<tr>
<th></th>
<th>L_{A_{Fmax}}/dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IP 10</td>
</tr>
<tr>
<td>Maximum sound level</td>
<td>65</td>
</tr>
</tbody>
</table>
7 Noise evaluation

7.1 Noise By-Law and noise legislation

As VIMC is located in the District of North Cowichan, the relevant bylaw regulating noise in the neighborhood is the North Cowichan Noise Bylaw No. 2857. It is a "nuisance-based" bylaw which "prohibits noise that may disturb any individual in the neighborhood". It does not provide any sound level limits. As the perception of noise is a highly subjective and emotional matter, it is difficult to classify the sound impact from the operation of VIMC in this context. For this reason, it is suitable to consult the Noise Bylaw No. 3723 of the neighboring Cowichan Valley Regional District (see also Noise Report Wakefield Acoustics in VIMC6). This noise bylaw provides sound level limits for continuous and non-continuous noise outdoors at the point of reception. The bylaw defines continuous sound as any noises or sounds other than construction noise, continuing for a period, or periods, totaling 3 minutes or more in any 15-minute period; non-continuous sound is defined as any noises or sounds other than continuous sound and construction noise.

The following Table 7-1 displays the limits of CVRD Bylaw No. 3723.

<table>
<thead>
<tr>
<th>Time of day</th>
<th>Continuous Noise Limit $L_{Aeq}$/dBA</th>
<th>Non-Continuous Noise Limit $L_{Amax}$/dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 am - 9 pm</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>9 pm - 7 am</td>
<td>50</td>
<td>65</td>
</tr>
</tbody>
</table>

The average sound level (also: energy equivalent sound pressure level) during operation $L_{Aeq,op}$ (see chapter 6.2) can be applied directly to the noise limits for continuous noise.

In order to classify and compare these limits to national and international noise standards, we would like to give a short overview about legal limits at other motorsports venues in Canada and Germany.

5 Cowichan Valley Regional District Bylaw No. 3723 – Noise Control Bylaw, 2013

Canada:
Rocky Mountain Motorsports Park (RMMP), located about 50 km in the north of the city of Calgary (AB), is a newly planned motorsports venue very similar to VIMC (see http://www.rockyviewmotorsports.com). The venues development plan provides a noise level limit at the closest dwellings of 

$$L_{Aeq} = 60 \, \text{dBA}$$

during each hour of operation.\(^7\)

Regarding noise evaluation of RMMP authorities adopted the City of Calgary Bylaw \#5M2004, Part 9: Regulation of Noise. Paragraph 28 of this Bylaw (Continuous Sound in Residential Developments) defines a sound level \(L_{Aeq}\) of 65 dBA measured over a one hour period (= \(L_{Aeq,1h}\)) during daytime as criterion that shall not be exceeded at any point of reception within a residential development.

The measure \(L_{Aeq,1h}\) is practically equivalent to the average sound level during operation \(L_{Aeq,op}\) or \(L_{Aeq,15min}\) of CVRD Bylaw No. 3723. Thus, Bylaw \#5M2004 has an even 5 dB higher noise level limit than CVRD Bylaw No. 3723.

Germany:
In Germany the relevant noise limits for motorsports venues are given in the federal executive order "TA Lär" of 1998. The TA Lär is relevant not only for motorsport noise but for all kinds of commercial sources of noise. For a neighborhood such as the surrounding of VIMC, the TA Lär is targeting a limit of 60 dBA determined during daytime over a sixteen (6 am – 10 pm) hour period that shall not be exceeded outside the closest dwellings.

The relevant noise measure of TA Lär is the so-called rating level \(L_r\), which is based on the average sound level \(L_{Aeq}\) over the 16 hour daytime period (6 am – 10 pm) and adjustments can be added for certain characteristics of the sound like tonality and impulses. Motorsport sound usually does not contain impulses (sound peaks with very short duration <1s). A supplement due to tonality (engine sounds, tire squeaking) of +3 dB for the entire noise impact

\(^7\) see http://www.rockyviewmotorsports.com/pdf/RMM-Development-Plan.pdf
and http://www.rockyviewmotorsports.com/pdf/Proposed-Bylaw.pdf

\(^8\) see https://www.calgary.ca/CA/city-clerks/Documents/Legislative-services/Bylaws/5M2004-CommunityStandards.pdf
is appropriate. Since the $L_r$ is determined over a 16 hours period and a motorsports venue normally has an effective operating time of not more than 8 hours (50% impact time), an adjustment of -3 dB has to be subtracted from the $L_r$ measure.

So in Germany, the rating level for a venue like VIMC would be:

$$L_r = 60\text{ dBA (}L_{Aeq,op}\text{)} + 3\text{ dBA (tonality)} - 3\text{ dBA (50% impact time)} = 60\text{ dBA.}$$

This means the limit for the rating level $L_r$ of 60 dBA in Germany equals the limit for continuous noise $L_{Aeq,op}$ of 60 dBA given in CVRD Bylaw No. 3723.

As a conclusion one can say that the sound level limits provided in the CVRD Bylaw No. 3723 are reasonable limits for a venue as the VIMC. The limits are in accordance with German noise regulations and even below some other regulations applied in Canada.

### 7.2 Evaluation and discussion

In order to evaluate the noise impact of VIMC, we compare the calculation results of the average sound level during operation ($L_{Aeq,op}$) from Table 6-1 with the limit for continuous noise at daytime (7 am - 9 pm) given in Table 7-1.

As one can see, the calculation results for all typical operation scenarios displayed do not exceed the noise limit of $L_{Aeq} = 60$ dBA for continuous noise.

Furthermore the results of maximum sound levels $L_{Aeq,max}$ according to Table 6-4 do not exceed the limit of 80 dBA for non-continuous noise.

There is no operation between 9 pm and 7 am, so the noise limits for nighttime need no further attention.

If we compare the daytime average sound level $L_{Aeq,14h}$ of VIMC (see Table 6-2) with the sound impact results for traffic noise (see Table 6-3), it shows that at locations closer to the highway (IP 01 - IP 05 and IP 16) the sound impact through traffic noise is in the same range. Nevertheless, single noise events by e.g. heavy trucks driving on the highway can easily overpower the sound impact through operation of the circuit.
In more quiet areas further away from the highway though, especially on a Very Busy Member Track Day the motorsport noise will be significantly perceptible.

As the operator of VIMC estimates, that the "Very Busy Member Track Day" will be a rare operation type, on most of the days the sound impact in the neighborhood will be well below ($\geq 6$ dBA) the sound limit for continuous noise of $L_{\text{eq}} = 60$ dBA.

**Quality of prognosis:**
All calculation results given in chapter 6 are worst case (downwind) calculations regarding meteorological conditions according to ISO 9613-2.

As described in chapter 4.2, we use a Sports Car speed profile to calculate the distribution of sound power on the circuit. This approach represents a situation, where a vehicle is driven constantly "at the limit". From our experience, this does not represent the daily operation of a venue as VIMC. In point of fact, private Track Days as they happen on this kind of venue include drivers with different levels of experience and driving skills. Also not every lap is driven with maximum speed and engine load. Therefore the idealized speed profile approach overestimated the overall sound power during operation.

On the whole, from our experience, measurement results may be 3 to 5 dB lower than the numbers given in Table 6-1 and Table 6-2.
Appendix

- Speed Calculation Porsche GT3 RS for VIMC (construction phase 2, version 2) 07-03-2018 [Tilke Engineers and Architects, Aachen]
- Sound map: Driving experience program and circuit taxi experience
- Sound map: Member Track Day
- Sound map: Busy Member Track Day
- Sound map: Very Busy Member Track Day
Broke point

\( V_{\text{max}} = 180.5 \text{ km/h} \)

broke distance = 70.07 m

Broke point

\( V_{\text{max}} = 117.7 \text{ km/h} \)

broke distance = 22.75 m

Broke point

\( V_{\text{max}} = 134.8 \text{ km/h} \)

broke distance = 39.74 m

\( V_{\text{curve}} = 88.2 \text{ km/h} \)

\( V_{\text{curve}} = 87.0 \text{ km/h} \)
Vancouver Island Motorsport Circuit

Driving experience program and circuit taxi experience

Sound map

Equivalent sound pressure level during operation

\[ L_{\text{Aeq,op}} \]

- \( 40 \text{ dBA} \)
- \( 45 \text{ dBA} \)
- \( 50 \text{ dBA} \)
- \( 55 \text{ dBA} \)
- \( 60 \text{ dBA} \)

Calculation according to ISO 9613-2,
grid: 50 m x 50 m, height: 2.0 m
Scale: 1 : 17500 (DIN A4)
Coordinates: UTM 10U (WGS84)
Background map: Google Earth

Supplement to report no. 61541G03-17  date: 2018-10-02
Vancouver Island Motorsport Circuit

Member Track Day

Sound map

Equivalent sound pressure level during operation

\[ L_{\text{eq,op}} \]

- 40 dBA
- 45 dBA
- 50 dBA
- 55 dBA
- 60 dBA

Calculation according to ISO 9613-2, grid: 50 m x 50 m, height: 2.0 m

Scale: 1 : 17500 (DIN A4)
Coordinates: UTM 10U (WGS84)
Background map: Google Earth

Supplement to report no. 61541G03-17
date: 2018-10-02
Calculation according to ISO 9613-2, grid: 50 m x 50 m, height: 2.0 m
Scale: 1 : 17500 (DIN A4)
Coordinates: UTM 10U (WGS84)
Background map: Google Earth
Supplement to report no. 61541G03-17 date: 2018-10-02

Vancouver Island Motorsport Circuit

Busy Member Track Day

Sound map
Equivalent sound pressure level during operation
L_{A_{eq,op}}

- \text{Yellow} = 40 \text{ dBA}
- \text{Orange} = 45 \text{ dBA}
- \text{Pink} = 50 \text{ dBA}
- \text{Red} = 55 \text{ dBA}
- \text{Dark Red} = 60 \text{ dBA}
Vancouver Island Motorsport Circuit

Very Busy Member Track Day

Sound map

Equivalent sound pressure level during operation

$L_{\text{Aeq,op}}$

- 40 dBA
- 45 dBA
- 50 dBA
- 55 dBA
- 60 dBA

Calculation according to ISO 9613-2, grid: 50 m x 50 m, height: 2.0 m

Scale: 1 : 17500 (DIN A4)
Coordinates: UTM 10U (WGS84)
Background map: Google Earth

Supplement to report no. 61541G03-17 date: 2018-10-02
Dear Andrew,

Vancouver Island Motorsports Circuit (VIMC) plans sound level measurements to determine appropriate sound level limits for the neighborhood. The community and its acoustic consultants from Navcon Engineering as well as the neighbours should be involved in this process. The main objective of the measurements is to find a suitable solution for the venue and the people in the area.

The whole process is subdivided into two steps:

1) the actual measurements
2) the determination of sound level limits from the measurement results and a monitoring concept to ensure, that future operation of the venue stays within these limits

In the following, we would like to suggest a measuring concept for VIMC.
1. **Measurements**

Who is involved in the process

The measurements should be carried out in coordination with the municipality and the neighbors.

The actual measurements should be checked and observed by engineers in the neighborhood and also on the circuit.

**Operation of the venue**

Operation of the circuit during measurements should represent a maximum operation regarding number and type of vehicles (worst case operation). All recently introduced mitigation measures will be taken into account (no sports mode, no obtrusive race vehicles etc.).

Operation should be carried out as follows:
- Minimum number of 5 stints of 20 minutes duration each with maximum operation on the circuit.
- In between stints a pause of 40 minutes to change measurement location in the neighborhood
- Free driving w/o instructor car
- Proper weather conditions (dry track)

**Measurement instruments and weather conditions**

All sound level meters, microphones and calibrators must be of class 1 (IEC 61672-1). The devices should record the average sound level $L_{Aeq}$ and the maximum level $L_{A,max}$ with a time resolution of 1 second.

On the day of measurement there should be no precipitation and a dry circuit for optimum driving conditions. The ground should neither be frozen nor covered with snow.

**Measurement points**

Sound measurements are carried out parallel at trackside and in the neighborhood.

The main trackside microphone should be positioned at a suitable position at the first third of the start/finish straight with a distance of 15 m to the driving line. A second trackside microphone should be positioned at a similar spot at one of the other straights in order to ensure the vehicles go “full throttle” there also. The position of the second microphone can be moved to a different straight from stint to stint.

The choice of the measurement position in the neighborhood depends strongly on weather resp. wind direction. In order to guarantee optimum sound propagation a steady downwind situation (wind going from circuit to receiver) is essential. If the wind direction does not allow measurements at specific dwellings (see our report 6154.1G01-17 of 2017/09/26), the measurements must be carried out at suitable “substitute measurement points” regarding sound propagation conditions (downwind, similar vegetation) and distance to the circuit.

The measurements should be carried out at least at three measurement points in the neighborhood.
Duration of measurements
The main measurement instruments at trackside should be running non-stop from the beginning of operation until the end including pauses. The second trackside measurement instruments will be relocated from stint to stint as needed.

The measurements in the neighborhood should be carried out during the stints (20 minutes) with suitable downwind conditions.

After each stint, the meter should run for an additional 10 minutes to record the actual ambient noise without circuit operation.

2. Determination of sound level limits and noise monitoring

Determination of sound level limits
As the operation during the measurements should represent a worst case operation of the circuit, it is senseful to derive sound level limits out of the measurement results.

For that, a suitable period of time (duration of measurements) has to be evaluated regarding the average sound level $L_{Aeq}$ and the maximum level $L_{Amax}$. The readings for $L_{Aeq}$ and $L_{Amax}$ then can be set as limits in the neighborhood and also as trackside reference values.

Future noise monitoring
To ensure and prove towards municipality, that operation is within these limits, VIMC agreed to install a permanent noise monitoring system.

VIMC is planning permanent noise monitoring at track side but also directly in the neighborhood. Since measurements in the neighborhood can be superimposed by other sound sources we like to point out that it can be very time-consuming to subsequently interpret and evaluate the measurement data with regard to the sound exposure actually caused by VIMC.

So, the basis of a permanent noise monitoring system is to measure the sound emission at trackside, to ensure that limits in the neighborhood are not exceeded. Permanent measurements in the neighborhood can complement the monitoring if necessary. This noise monitoring principle is implemented at various facilities and especially at motorsports venues.

For further details, please see our report 6154.1G01-17 of 2017/09/26, chapter 10.

Yours sincerely
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