Report to Elder Conservatorium

18 May, 2012

Compiled by

Ian O’Brien MAudSt MPhil BMus MAudSA(CCP)
Audiologist, Musicians’ Hearing Services

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1.0 Background

Musicians’ Hearing Services was engaged by the Elder Conservatorium, Adelaide to deliver educational talks, assess sound exposure to staff and students, investigate approaches to hearing conservation, provide high quality hearing protection as required by students and staff and to deliver a report including observations and recommendations.

2.0 Sound Level Measurements

2.1 Method

All sound level measurements were taken according to requirements as stipulated in AS/NZS1269.11. Seven Casella CEL460 Class II data logging dosimeters and three Casella CEL632 Class I integrating sound level meters were used. All units were calibrated prior to and at the conclusion of each individual measurement session. Several of the units were belt-worn by individual musicians, with the microphones mounted on the shoulder close to the ear being measured. The remainder were mounted on boom microphone stands and positioned within 30cms of the ear being measured.

Measurement commenced when students arrived to warm up, and as such some durations were slightly longer than others for the same rehearsal. Additionally, players who finished their duties prior to the completion of the rehearsal returned their dosimeters at this point. If a break or rest period occurred during a rehearsal the units continued to gather data to include exposure during this rest period as per guidelines in the standard.

Artefacts (such as incidental microphone bumps) were removed on analysis by examination of profile graphs and comparison with profile graphs of neighboring units.

Each venue was inspected and the investigator discussed specific issues with each of the ensembles’ directors and with a selection of students in each ensemble, particularly those playing typically high exposure level instruments.

2.2 Glossary of Terms

2.2.1 ‘Decibel’ and ‘dBA’

The decibel (dB) scale is used to measure sound. The scale itself is logarithmic to accommodate the large variations in sound pressure or intensity. Sound levels over time are usually measured using the ‘A’ filter (hence ‘dBA’) as this broadly represents the sensitivity of the human ear.
2.2.2 dBALEQ

Noise levels over time are expressed in what is known as ‘level equivalent’ decibels, or ‘LEQ’. This is simply a representation of the total amount of sound energy experienced over the duration of sound level measurement. It may also be thought of as the level of steady state sound that would represent the same amount of sound energy actually experienced by the fluctuating sound levels typical of music rehearsal.

2.2.3 Noise dose

Because noise induced hearing loss occurs over time, the agreed level of acceptable or ‘safe’ dBALEQ is based upon duration. 100% of a daily noise dose is considered to be 85dBALEQ over eight hours. As duration reduces, this allowable level increases at logarithmic rate. Hence 88dBALEQ is double 85dBALEQ and considered safe for half the time (four hours). 91dBALEQ is considered safe for two hours and so on. 112dBALEQ is considered safe for approximately one minute of exposure.

2.2.4 dBC Peak

For very high transient sounds (such as a cymbal crash) the safe allowable level is measured using a C (or relatively flat) decibel weighting, which is considered more accurate at extremely high intensities. The maximum allowable peak level is 140dBC.
3.0 Observations

3.1 Noise level readings

3.1.1 Latin band

1600hrs, 2nd May 2012
Madley RSL
Circular configuration
Repertoire: Various

<table>
<thead>
<tr>
<th>Run #</th>
<th>Instrument</th>
<th>Duration (mins)</th>
<th>dBALEQ</th>
<th>dBC Peak</th>
<th>% of daily noise dose during rehearsal</th>
<th>Minutes to exceed daily safe noise level at this LEQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Director LE</td>
<td>94</td>
<td>95.7</td>
<td>135.6*</td>
<td>230%</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>Percussion RE</td>
<td>113</td>
<td>92.8</td>
<td>131.6</td>
<td>142%</td>
<td>79</td>
</tr>
<tr>
<td>4</td>
<td>Guitar, RE</td>
<td>109</td>
<td>92.6</td>
<td>128</td>
<td>131%</td>
<td>83</td>
</tr>
<tr>
<td>6</td>
<td>Extra Perc</td>
<td>92</td>
<td>93.4</td>
<td>134.6</td>
<td>133%</td>
<td>69</td>
</tr>
<tr>
<td>8</td>
<td>Alto Sax LE</td>
<td>94</td>
<td>91</td>
<td>122.4</td>
<td>100%</td>
<td>120</td>
</tr>
<tr>
<td>9</td>
<td>Tenor Sax LE</td>
<td>94</td>
<td>92.1</td>
<td>119.2</td>
<td>57%</td>
<td>93</td>
</tr>
<tr>
<td>10</td>
<td>Bari. Sax LE</td>
<td>97</td>
<td>89.6</td>
<td>121.8</td>
<td>58%</td>
<td>166</td>
</tr>
</tbody>
</table>

*using cowbell to beat time

3.1.2 Elder Conservatorium Symphony Orchestra

1600hrs, 3rd May 2012
Elder Hall
Standard set-up,
Repertoire: Scheherazade

<table>
<thead>
<tr>
<th>Run #</th>
<th>Instrument</th>
<th>Duration (mins)</th>
<th>dBALEQ</th>
<th>dBC Peak</th>
<th>% of daily noise dose during rehearsal</th>
<th>Minutes to exceed daily safe noise level at this LEQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Trombone 1 RE</td>
<td>86</td>
<td>92.2</td>
<td>123.6</td>
<td>94%</td>
<td>91</td>
</tr>
<tr>
<td>13</td>
<td>Percussion 1 RE</td>
<td>86</td>
<td>89.9</td>
<td>131.5</td>
<td>55%</td>
<td>155</td>
</tr>
<tr>
<td>14</td>
<td>Trumpet 1 LE</td>
<td>94</td>
<td>94.5</td>
<td>123</td>
<td>175%</td>
<td>53</td>
</tr>
<tr>
<td>16</td>
<td>Cello 3rd desk inside, RE</td>
<td>88</td>
<td>88.2</td>
<td>117.6</td>
<td>38%</td>
<td>229</td>
</tr>
<tr>
<td>18</td>
<td>Horn 1 RE</td>
<td>95</td>
<td>92.2</td>
<td>124.2</td>
<td>104%</td>
<td>91</td>
</tr>
<tr>
<td>19</td>
<td>Bassoon 2 LE</td>
<td>94</td>
<td>86.9</td>
<td>128.2</td>
<td>30%</td>
<td>309</td>
</tr>
<tr>
<td>20</td>
<td>Clarinet 1 RE</td>
<td>94</td>
<td>93.5</td>
<td>128.2</td>
<td>139%</td>
<td>67</td>
</tr>
</tbody>
</table>
3.1.3 Stage band

1600hrs, 3rd May 2012
Madley RSL
Circular configuration
Repertoire: Various

<table>
<thead>
<tr>
<th>Run #</th>
<th>Instrument</th>
<th>Duration (mins)</th>
<th>dBALEQ</th>
<th>dBC Peak</th>
<th>% of daily noise dose during rehearsal</th>
<th>Minutes to exceed daily safe noise level at this LEQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Kit</td>
<td>90</td>
<td>96.1</td>
<td>130</td>
<td>242%</td>
<td>37</td>
</tr>
<tr>
<td>17</td>
<td>Trumpet 1</td>
<td>90</td>
<td>97.8</td>
<td>124.6</td>
<td>357%</td>
<td>29</td>
</tr>
</tbody>
</table>

3.1.4 Elder Conservatorium Wind Orchestra

1100hrs, 4th May 2012
Madley RSL
Standard set-up
Repertoire: Various

<table>
<thead>
<tr>
<th>Run #</th>
<th>Instrument</th>
<th>Duration (mins)</th>
<th>dBALEQ</th>
<th>dBC Peak</th>
<th>% of daily noise dose during rehearsal</th>
<th>Minutes to exceed daily safe noise level at this LEQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>Director</td>
<td>60</td>
<td>90.2</td>
<td>123.3</td>
<td>41%</td>
<td>144</td>
</tr>
<tr>
<td>22</td>
<td>Trom 2 RE</td>
<td>60</td>
<td>90.1</td>
<td>124</td>
<td>63%</td>
<td>148</td>
</tr>
<tr>
<td>23</td>
<td>Trumpet 2 RE</td>
<td>54</td>
<td>92.5</td>
<td>128.4</td>
<td>63%</td>
<td>85</td>
</tr>
<tr>
<td>24</td>
<td>Flute 1 RE</td>
<td>54</td>
<td>89</td>
<td>123.8</td>
<td>28%</td>
<td>190</td>
</tr>
<tr>
<td>25</td>
<td>Alto Sax LE</td>
<td>61</td>
<td>92.2</td>
<td>122</td>
<td>67%</td>
<td>91</td>
</tr>
<tr>
<td>26</td>
<td>Tenor Sax RE</td>
<td>61</td>
<td>90.4</td>
<td>121.8</td>
<td>44%</td>
<td>138</td>
</tr>
<tr>
<td>27</td>
<td>Piano RE</td>
<td>61</td>
<td>84.8</td>
<td>115.9</td>
<td>12%</td>
<td>503</td>
</tr>
<tr>
<td>28</td>
<td>Tuba RE</td>
<td>53</td>
<td>90.9</td>
<td>124.6</td>
<td>43%</td>
<td>123</td>
</tr>
<tr>
<td>29</td>
<td>Clarinet RE</td>
<td>59</td>
<td>86.5</td>
<td>119.3</td>
<td>17%</td>
<td>339</td>
</tr>
<tr>
<td>30</td>
<td>Horn 1 RE</td>
<td>56</td>
<td>92</td>
<td>123.2</td>
<td>59%</td>
<td>95</td>
</tr>
</tbody>
</table>
3.1.5 Percussion Ensemble

1400hrs, 4th May 2012
Madley Percussion studios
Repertoire: Various
Two small groups (4) – 2pm-3pm, large group (8) 3-4pm.
Relatively quiet repertoire in one small group and in large group, moderately loud repertoire in the other small group.

<table>
<thead>
<tr>
<th>Run #</th>
<th>Instrument</th>
<th>Duration (mins)</th>
<th>dBAEQ</th>
<th>dBC Peak</th>
<th>% of daily noise dose during rehearsal</th>
<th>Minutes to exceed daily safe noise level at this LEQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>Director</td>
<td>118</td>
<td>83.5</td>
<td>122.8</td>
<td>17%</td>
<td>679</td>
</tr>
<tr>
<td>32</td>
<td>Group 1</td>
<td>114</td>
<td>84.2</td>
<td>134.4</td>
<td>20%</td>
<td>577</td>
</tr>
<tr>
<td>33</td>
<td>Group 1</td>
<td>116</td>
<td>81.8</td>
<td>122.7</td>
<td>12%</td>
<td>1005</td>
</tr>
<tr>
<td>34</td>
<td>Group 1</td>
<td>116</td>
<td>83.8</td>
<td>122.2</td>
<td>18%</td>
<td>633</td>
</tr>
<tr>
<td>35</td>
<td>Group 2</td>
<td>117</td>
<td>92.8</td>
<td>136</td>
<td>147%</td>
<td>79</td>
</tr>
<tr>
<td>36</td>
<td>Group 2</td>
<td>117</td>
<td>89.5</td>
<td>133.4</td>
<td>69%</td>
<td>170</td>
</tr>
<tr>
<td>37</td>
<td>Group 2</td>
<td>117</td>
<td>90.1</td>
<td>134</td>
<td>79%</td>
<td>148</td>
</tr>
</tbody>
</table>
3.2 Available controls and existing practices

3.2.1 Engineered Controls

Engineered controls may include the use of large acoustic screens, diffusive and/or absorptive materials and risers or staggered staging to assist in the vertical separation of musicians. Engineered controls also include the physical set-up of an ensemble in order to reduce exposure while still allowing easy communication and cohesive playing between the various elements of the ensemble/s.

The two venues in Madley (RSL and Percussion Studio) were appropriately designed for their purpose, with high ceilings and the use of diffusive material on the walls.

While there were risers in use in Elder Hall these were not used to maximum effect to reduce exposure from instruments to the rear. Risers were not evident elsewhere.

Setup of the various ensembles, particularly the Latin and Stage bands did not demonstrate prior considerations of noise exposure reduction.

3.2.2 Administrative Controls

Examples of administrative controls are the structuring of rehearsals in such a way as to reduce sound exposure either through repertoire choice, alternative activities, rotation of players out of high noise level areas to provide respite and/or sectional rehearsals. Often these controls may be achieved with typical physical respite activities common in many ensembles.

Although very few formal administrative controls were observed, several of the ensembles were incidentally reducing sound exposure using methods mentioned above. For instance the Latin Band spent some ten minutes on rhythmic drills using clapping alone, the ECSO rehearsed a heavy piece (Scheherazade) alongside a quieter piece for strings only, and the stage band viewed a DVD of a professional ensemble part-way through their rehearsal. Measurements taken of these ensembles include these relatively quiet periods in order to more accurately represent actual exposure on the day. If these periods were removed from, say, the first trumpet during the stage band rehearsal, then levels would have been very much higher. The following graph of the 1st trumpet’s exposure for this rehearsal illustrates this, with the DVD viewed between around 1645 and 1705hrs.
3.2.3 Personal Controls

Personal controls include personal acoustic screens and earplugs. The conservatorium has recently purchased fifteen wrap-around personal screens as used in many professional ensembles, although use of these is quite limited to date.

There was evidence of use of custom-moulded musicians’ plugs in some areas of the conservatorium. In particular the director of the percussion ensemble was very pro-active in insisting the students of this ensemble be fitted with such devices at the commencement of study. There was also some evidence of use of generic filtered musicians’ earplugs in various ensembles, however it was noted that attitudes to and use of hearing protection seemed to vary widely across the different ensembles.
3.2.4 Education

Education is a vital part of any approach to hearing conservation. The visit by Musicians’ Hearing Services and subsequent lectures were in themselves part of the conservatorium’s education component and are a good start to informing students and staff of ways to protect their hearing while working or studying in the music industry. A more structured delivery of this information using online learning – together with education on a range of health and safety issues for music students – has very recently been developed for inclusion in tertiary music curriculum throughout Australia. For further information on this contact Suzanne Wijsman (suzanne.wijsman@uwa.edu.au) or visit the Sound Performer’s website (www.soundperformers.com).

4. Discussion & Recommendations

It is important to point out that all recommendations presented below come from the observation of a single rehearsal only, and the various suggestions are given in order to initiate discussions between operational and artistic staff at the conservatorium to explore their viability and perhaps develop in-house solutions to problems identified.

4.1 Latin band

From sound level results, the highest exposed individual monitored was the director, which is an unusual result. It is expected that sound level was also quite high amongst the brass section, but only one trumpet was at this particular rehearsal and the sound level meter on this position failed to record due to operator error.

The setup of the band (surrounding the director on three sides) undoubtedly caused the director's exposure to be higher than it may otherwise have been if all the musicians were directly in front of him. The habit of using a cowbell to beat time was also seen to contribute to excessively high peak levels not generally seen amongst band and orchestra directors.

The use of a band riser in this ensemble would enable a setup with the brass to the rear but well above the sax players, with the percussion to one side. It is the habit of the brass to stand in this ensemble, so the riser would need to be no more than 300-400mm. If the brass were seated a higher riser should be considered.

This configuration would also enable the use of wrap-around screens for the sax players to shield from the brass behind and the ability to lessen exposure by incorporating some distance between the two rows. It is important that the brass have a clear line of sight to the director, but in this set-up the director could put extra distance between himself and these high level instruments.

The format of the rehearsal incorporated respite (rhythmic drills using only clapping, for example) and it is possible that this could be introduced in a more structured way throughout the rehearsal to
increase respite for the ears of those involved. Another control that may be considered is rehearsal at lower volumes to work on technically challenging aspects that do not require full fortissimo to achieve desired improvement and this was observed during this rehearsal.

Use of earplugs was noted in the rhythm section and further education, particularly of the brass, may increase the uptake of hearing protectors when necessary.

4.2 Elder Conservatorium Symphony Orchestra (ECSO)

This relatively short rehearsal of a loud piece, followed by a small orchestra rehearsal of a quieter piece was a good example of how planning repertoire rehearsal can have a significant impact on sound exposure. If the rehearsal had continued with the ‘loud’ repertoire for another hour, then noise dose percentages would have doubled. Recorded levels overall were typical of those seen in professional orchestras and it may be assumed that traditional orchestral 'hot-spots' are broadly replicated at the ECSO.

There were several observations regarding setup. The configuration of the orchestra led to a problem of the 1st trumpet’s bell being in extremely close proximity to the right ear of the inside rear desk viola player. While the violist was using a wrap-around screen, because the trumpet was on riser this screen could not be elevated to a useful level.

With existing infrastructure, problems such as these can be overcome. Most professional orchestras avoid double-ranking the brass based on the fact that the trumpets (typically the highest exposed group in an orchestra) then have lower brass directly to their rear, increasing their exposure. An extension of the 400mm riser in front of the percussion may allow the brass to sit in a single line.

It is also recommended that consideration be given to moving the clarinets and bassoons forward to the 200mm riser and the oboes/flutes to floor level, allowing horns to be configured in a single line possibly meeting with the brass. Use of wrap-around screens should then be trialed for the rear desk of the woodwinds.

Similar to the Latin Band, another control that may be considered is rehearsal at lower volumes to work on technically challenging aspects that do not require full fortissimo to achieve desired improvement.

Use of earplugs was noted in the percussion. Targeted education of brass and woodwind players (and their teachers) should have an impact on usage rates.

4.3 Stage Band

Although the investigator was unable to observe the rehearsal in person, reported setup seemed similar to the Latin band setup and similar considerations should be given to this ensemble, particularly the use of risers. As already stated, structuring rehearsals to include respite is an excellent idea, as is low-volume rehearsal when possible.
Further investigation of this band is required for fuller recommendations. The sound levels observed are considered to be extreme, and as such a comprehensive strategy to introduce hearing conservation into the culture of this ensemble is warranted.

4.4 Elder Conservatorium Wind Orchestra (ECWO)

This was a short rehearsal following sectional rehearsals, which is again an excellent way to control noise exposure. Those highest exposed were the brass, particularly the trumpets. This band sets up in a horseshoe shape, with several rows. All players were situated on the floor.

There is a significant need for risers to allow rear instruments to play over the heads of those in front and to allow those in front of brass and percussion to utilise wrap-around screens. This is currently unlikely to be possible due to sight-line problems that would be encountered.

In the short term the use of wrap-around screens between the brass and percussion should become part of the standard set-up to reduce high peak levels in the trumpet section. Players not using wrap-arounds should be encouraged to wear earplugs and further education is required to encourage a cultural shift in this direction.

4.5 Percussion Ensemble

The percussion ensemble rehearsal consisted of two small ensembles for the first hour, followed by the larger group.

Higher levels were seen in the group occupying the smaller room, which may have been a function of repertoire rather than a function of the room. Very high peaks, typical of percussion, were recorded in both rehearsal rooms.

In all, constant sound levels were not excessive, but there was a significant culture of hearing conservation in place due to the efforts of the director of this ensemble. This approach could serve as a template for the broader Conservatorium.

4.6 Popular Music and Creative Technologies (PMCT) & Centre for Aboriginal Studies in Music (CASM)

While the recording space itself at the PMACT studios has been designed to optimise recording outcomes, the control rooms at these studios were relatively untreated acoustically. Higher quality sound in these environments can often lead to less stress on the auditory system and ultimately lower required volumes to achieve mixing and balancing tasks, as well as reduce actual sound level exposure by reducing reflections, standing waves and other issues caused by parallel reflective walls.

Similarly, both the studios and control rooms at CASM are particularly small and reportedly often used for potentially high-level amplified music.
Engineered controls such as absorptive screens using high density acoustic foam should immediately be utilised to reduce reflections in both locations in the first instance. This can be achieved at relatively low cost (eg. http://www.foambymail.com/acoustical-wedge-foam.html). Ultimately further more permanent acoustic modifications could be considered using the services of acoustics engineers.

Students and staff involved in long recording sessions may often lose track of their exposure time and a reminder system is needed to alert students and staff of total exposure levels over time. As such an administrative control such as a highly visible warning indicator is also highly recommended (eg. http://www.burntechshop.com/extech-sound-level-noise-monitor-industrial-p-176.html) as discussed with staff during the inspections of these centres.

5. Conclusion

Hearing conservation measures in a music setting need to be ongoing and adaptive to change. When dealing with noise exposure from music no single solution or control measure will effectively create a 'safe' environment, however balancing the various available measures can maximise their effect and ultimately reduce the need for the use of earplugs, which should always be seen as a last resort before after all other measures have been implemented. In this way it is possible to merge the need to create high sound levels with a safe environment and avoid measures that are seen as prescriptive or that limit creative art in some way.

It is a broad recommendation that hearing conservation become a part of culture of the Conservatorium not only to manage sound exposure of students and staff, but also to encourage students to develop habits that they will use throughout their careers and hopefully pass on to their students in turn. The inclusion of content delivery via the Sound Performers website mentioned previously within the Conservatorium’s curriculum (particularly for first year students) is an excellent way to achieve this for a limited outlay.

A comprehensive strategic approach to the issue of hearing conservation and noise management is also recommended, including further training of staff and the formation of a working group on the issue. A good example of such an approach can be seen at the Royal College of Music in London (http://www.legacyweb.rcm.ac.uk/health/Hearing+Awareness).

In addition to this the presence of warning signs, indicators and reminders are a good way to keep the issue in the minds of those in any business/institution, and a regular visit from a group such Musicians’ Hearing Services offering hearing tests, musicians’ earplugs and educational talks is a good way to keep the issue relevant and controls active.

To ensure earplugs are usable by musicians and music students it is important that these personal protective devices be carefully selected and fitted by audiologists who fully understand the needs of musicians. Significant developments in technology surrounding these devices are currently occurring and we will keep the Conservatorium informed as these are released.
Musicians’ Hearing Services would be happy to return to Adelaide University at any time to provide hearing tests, fit earplugs to students and staff and to further train staff and students as needed. To discuss this or any aspect of this report further please contact Ian O’Brien at Musicians’ Hearing Services.
Reference