And in collaboration with

School of Public Health

Study of noise exposure assessment of racing car drivers and hearing protector evaluation.

Contributors

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Note: This version of the study has been condensed and amended by AIMSS to provide the reader an easier understanding of the key aspects of the study.

ABSTRACT

Race car personnel exposed to noise in the motor sport environment are potentially susceptible to excessive noise exposure above the recommended Australian Standard AS/NZS 1269.0: 2005. Noise Induced Hearing Loss through excessive noise pollution has become an epidemic, being the third most common illness worldwide. People involved in motor sports, such as within race car environments, are susceptible to hearing impairment due to this noise exposure.

This study aimed to measure the exposure to noise of selected racing car drivers, specifically within the cockpits of cars during motor racing events at the Wanneroo Raceway in Western Australia over a 3 day period. The effectiveness of currently used hearing protection devices were evaluated to determine the level of attenuation offered by the protectors and the protected exposure of the drivers.

Data was collected over the V8 Supercar 3 day weekend by placing noise dosimeters into the cars of drivers who had agreed to be monitored for noise during an event (partial noise dose). These levels were downloaded and partial noise exposure for particular drivers were converted to a LAeq.8hours to get an 8 hour equivalent of noise exposure. These results were analyzed to identify the degree of noise exposure and whether the noise exposure was above the Australian standard of 85 db(A). Most of the results proved that drivers are exposed to noise levels above this Standard.

The research results identified that most race car drivers were wearing hearing protection devices with the exception of saloon car category drivers. Hearing attenuation evaluation for hearing protection devices that drivers use across different classes of racing cars was conducted. Based on the amount of exposure, specific hearing protection is recommended. Research results overall suggest that the motor sport environment is one with excessive noise levels and that drivers are exposed to levels that require the correct selection and use of hearing protection to reduce the protected exposure to below 85dB(A) and preferably between 75-80dB(A) if practicable.

TABLE OF CONTENTS

ABBREVIATIONS

ARHL Age Related Hearing Loss

NIHL Noise Induced Hearing Loss

NIOSH National Institute for Occupational Safety & Health

NRR Noise Reduction Rating

SLC80 Sound Level Conversion

WHO World Health Organization

SEL Sound Exposure Level/Short-term exposure limit

DEFINITIONS

Eight-hour equivalent continuous A-weighted sound pressure level –"In decibels, is that steady sound pressure level which would in the course of an 8 h period deliver the same A-weighted sound energy as that due to the actual noise on any particular representative working day. (Symbol: LAeq,8h)" (Standards Australia, 2005b, p.5).

Equivalent continuous weight sound pressure level –"In decibels, is the value of the steady continuous frequency-weighted sound pressure level that, within a measurement time interval, T, has the same mean square sound pressure as the sound under consideration whose level varies with time during the interval T. The frequency weightings used shall be A, C or un-weighted as appropriate. (Symbol: LXeq,T)" (Standards Australia, 2005b, p.5).

Exposure to noise – "Exposure to noise is determined at the person's ear position without taking into account any protection that may be afforded by personal hearing protectors" (Standards Australia, 2005b, p.6).

Partial Noise Exposure–"The exposure of a person to noise over a specified time interval, typically the time spent at a specified workstation, or while performing a specified task" (Standards Australia, 2005b, p.6).

Peak sound pressure level –"In decibels, is 10 times the logarithm to the base 10, of the ratio of the square of the maximum instantaneous sound pressure to the square of the reference sound pressure (20 μPa). (Symbol: Lpeak)" (Standards Australia, 2005b, p.6).

Protected Exposure – "The presence of a person wearing hearing protectors at a point of emission" (Standards Australia, 2005a, p.5).

Sound Exposure Level/Short-term exposure limit – Sound exposure level abbreviated as SEL and L_{AE}, is the total noise energy produced from a single noise event. The Sound Exposure Level is a metric used to describe the amount of noise from an event. The Sound Exposure Level is the integration of all the acoustic energy contained within the event (DiracDelta, 2013).

Total daily noise exposure–"Is the total of a person's partial noise exposures over a working day" (Standards Australia, 2005b, p.7).

DETERMINING THE NEED & IDENTIFICATION OF THE LATEST TECHNOLOGY FOR APPROPRIATE HEARING PROTECTION FOR RACING CAR DRIVERS IN AUSTRALIA

1.0 INTRODUCTION

General Background

In 2013, 360 million people worldwide had disabling hearing loss. Worldwide 16 % of the disabling hearing loss in adults is attributed to occupational noise.

Damage from noise pollution is a serious issue for those involved in motor sports as they are exposed to an environment with excessive noise over long periods (average 8 hours a day) on a daily basis, whereas racing fans are occasionally exposed to such noise levels and are unlikely to develop permanent damage to their hearing (Rose, Ebert, Prazma & Pillsbury, 2008; Lindemann & Brusis, 1985). It is important for race personnel to know the consequences of excessive noise exposure and recommendation for using hearing protection devices (Scheinder, 2010).

Research Aim and Objectives

The aim of this study was to determine the noise level exposure of selected racing car drivers during a racing meeting, of the V8 Supercars Championship held at the Barbagallo Raceway in Wanneroo, Western Australia.

The objectives of the research were as follows:

1. To determine drivers' exposure to noise during a car racing event, specifically the noise levels within the cockpit of various types of cars.
2. Evaluate the level of attenuation provided by hearing protection devices used and available to drivers and calculate the protected exposure.
3. Provide recommendations for racing car driver regarding appropriate hearing protection management based on data from noise assessment, questionnaires and hearing protectors evaluated.

2.0 LITERATURE REVIEW

Race Car Driver Noise Exposure & Effects

In various race sport scenarios professional drivers, track officials, spectators and other personnel are exposed to noise levels ranging from 90 dB(A) to 140 dB(A) on a daily basis (Lindemann & Brusis, 1985;Van Campen et al., 2005; Rose, Ebert, Prazma & Pillsbury, 2008).

In America studies have been conducted on NASCAR tracks. Scientific research of NASCAR races in the USA have shown noise levels to be up to 900 times higher than the acceptable occupational daily noise dose of 85 decibels, reaching to a sound pressure of 140 decibels (Hear-it, 2010). NIOSH (National Institute for Occupational Safety & Health) took measurements from three different NASCAR tracks in 2010 and found that noise levels exceeded even the loudest of noises found in the industrial and occupational settings (Centers for Disease Control and Prevention, 2010; Rose, Ebert, Prazma & Pillsbury, 2008; Hear-it, 2010; Schneider, 2010).

In addition to permanent damage to the ear from noise induced hearing loss non-auditory effects of noise include physiologic changes, fatigue, increased reaction time, reduced concentration, and irritability (.Safe Work Australia, 2011). Due to these consequences having a psychological effect on individuals, improved noise reduction could result in improved performance and safer racing conditions. Louder noise can have a negative effect on performance in reading, attentiveness, problem solving, concentration and memory increasing the probability of accidents and injury occurring (WHO, 2001; Cantrell, 1974; CCOHS, 2008; Occupational Safety And Health Administration, 2012). Excessive or prolonged exposure to noise, in the community and at work, can also cause permanent medical conditions, such as hypertension and ischemic heart disease (Azizi, 2010).

The NIOSH's recommended exposure limit is 85db(A) as an average over an eight hour exposure period, the same as Australian Standards. The Bristol Motor Speedway was found to have noise levels exceeding the standard ranging from 96 dBA in the stands to 114 dBA for a driver inside a car during practice and greater during actual races in the pit area, found to have exceeded a peak noise level of over 130dB, a level of human hearing threshold often recognized for pain (Centers for Disease Control and Prevention, 2010; Schneider, 2010; Hear-it, 2010).

Hearing Protection Measures

Due to excessively loud noise in the motor sports environment, choice of hearing protection requires a background knowledge of hearing attenuation that the device will give when worn in any given environment where noise is a possible hazard. Hearing protection efficacy in shielding the inner ear from noise through laboratory testing has been proven. Hearing loss prevention effectiveness from excessive noise exposure depends mainly on the regular use of hearing protection in the situation of excessive noise exposure.

Studies have shown that if workers and other persons exposed to excessive noise do not wear hearing protection, it completely diminishes its effectiveness. In only wearing hearing protection 90% of the time around excessive noise, effectiveness of hearing protection is decreased to less than one-third, showing the importance of the need to wear hearing protection during these circumstances.

If ear muffs or mufflers are not able to be used to reduce noise from race cars to a recommended time-weighted average of 85 dB(A), then hearing protection devices such as ear plugs should be used by drivers and crew members, the main recommended type of ear plugs being custom-molded earplugs with built-in speakers, a type of protection currently available to drivers allowing for both protection against noise while being able to communicate with the pit crew, vital and very useful in motor sports for preventing drivers from taking off hearing protection due to miscommunication (Centers for Disease Control and Prevention, 2010; 2011; Workplace Health and Safety Queensland, 2011).

Hearing Protection & Its Significance

Each Hearing Protection device has an 'In-ear/Real-Ear' attenuation, which is defined as "the difference in decibels between the occluded-ear threshold of hearing and the open-ear threshold of hearing" by the AS/NZS 1270:2002 (Standards Australia, 2002, p.5). In selecting appropriate hearing protection, noise level exposure for participation in a loud activity, specifically for drivers in motor sports, must be known and the compatibility of the hearing protection device in the race environment and other protective or necessary equipment known and used.

Attenuation must be set to block out the excessive noise exposure but must not over protect to avoid feelings of isolation and cause communication problems that may lead to inconsistent wearing of the hearing protection. Reduction to an “in-ear” level of 70 dB(A) and below should be regarded as over-protection. Although the area between 80 and 85 dB(A) is of acceptable attenuation, because of uncertainties introduced by the “real world” ear protection, it could be regarded as potentially under-protecting. For good attenuation the “in-ear” noise level should generally be required to fall between 75 and 80 dB(A), while acceptable attenuation lies between 70 to 75 db(A) and 80 to 85 db(A) (Workplace Health and Safety Queensland, 2011; Cirrus Research, 2010).

A variety of methods exist to test hearing protection attenuation. The main methods documented by Australian Standards are the SLC80 method and the class method. The SLC80 method of the hearing protection indicates the difference between the measured C-weighted sound pressure level of the workplace noise outside the hearing protector and the A-weighted sound pressure level, attenuated by the hearing protector, under the hearing protector inside the ear canals. This requires a C-weighted sound pressure level average over a period of time, usually 8 hours represented by LCeq,8h.

Table 1. SLC80 rating to class method requirement AS/NZS 1269.3

(Workplace Health and Safety Queensland, 2011, p.2).

Class	$L_{Aeq.8h}$ dB(A)	SLC_{80} Range
1	Less than 90	10 to 13
2	90 to less than 95	14 to 17
3	95 to less than 100	18 to 21
4	100 to less than 105	22 to 25
5	105 to less than 110	26 or greater

If drivers and other personnel involved in motor sports are exposed to noise levels ranging from 90 dB(A) to 140 dB(A) on a daily basis, then a class 2-5 form of hearing protection is required depending on the category of car. Each type of hearing protection used has different hearing attenuation levels, so the driver must know the type of hearing protection suitable for the race and have knowledge of the noise levels they will be exposed to (Workplace Health and Safety Queensland, 2011a). A common hearing protection attenuation used in the United States is the Noise Reduction Rating (NRR), which ranges from 0-33 decibels in attenuation using different decibel frequencies at each value and a different calculation, but which has the same frequencies as the SLC80 with an addition of 3000 Hz and 6000 Hz (CCOHS, 2007; Centers for Disease Control and Prevention, 2012). The NRR method, although common in the United States, is not acceptable in Australia as the method of testing is different from the AS 1270 test method (Workplace Health and Safety Queensland, 2011a).

The types of hearing protection recognized by the AS/NZS 1269.3:2005 Standard include ear plugs (pre-molded ear plugs, user formable ear plugs, custom-molded earplugs, banded ear plugs) ear canal caps, acoustic helmets and other special type of hearing protectors (level-dependent protectors, active noise reduction protectors, communication hearing protectors) (Standards Australia, 2005d). Ear plugs (foam and molded gel inserts) are common hearing protection devices used by drivers.

The hearing protection must be compatible with the work being performed. Due to cars being confined spaces, movement of the car and the hot humid temperature expiated by the car engine, ear muffs are not recommended for drivers. The hearing protection must be comfortable for the environment being used and adhere to communication requirements to maintain voice and further communication, as communication between drivers and crew members is very important.

For effective protection personal characteristics (such as large ear canals) must be met when applying hearing protection. It is vital that hearing protection devices with attenuation levels suited to the racing activity are worn as failure to wear the hearing protector during the entire exposure will significantly decrease the effective protection of the hearing protector (Standards Australia, 2005c; 2005d; CCOHS, 2007). Although hearing attenuation is obtained through laboratory testing, the actual attenuation depends on the device fitting properly (Standards Australia, 2005c; 2005d). For example, the hearing protection may not fit properly if the person is wearing other equipment, such as glasses, has long hair or if other forms of protective equipment (helmet) are used at the same time. Age and condition of the hearing protector and the correct fitment are also a consideration.

3.0 METHODS

3.1 Data Collection

This research was conducted at the Barbagallo Raceway, in Western Australia during a round of the V8 Supercars. The research participants were ten racing car drivers across five categories that included Saloon Cars, Touring Car Masters, V8 Utes, V8 Supercars and Formula Fords. The drivers were monitored for noise exposure in the races qualifying and practice that they participated in over the 3 days.

Personal noise monitoring was conducted on 3 different race car drivers in 3 different vehicles classes per day for the first 2 days and 4 race car drivers on the third day (total 10 samples) A noise dosimeter was strapped to the roll cage in each driver's car and located within 300 mm of the driver's ear whist the driver was competing in a race, or practicing for a race. Vehicles in which the drivers were monitored are as follows.

Day 1. V8 Utes, Formula Fords, Touring Car Masters
Day 2. Saloon Cars, Touring Car Masters, Formula Fords
Day 3. Saloon Cars, Touring Car Masters, V8 Utes, V8 Super Cars, Formula Fords

Noise level measurements were used to determine the level of noise attenuation needed for each car category via the class method. All noise monitoring equipment used in the field was calibrated before and after use to ensure the reliability of the monitoring information obtained. The maximum deviation in calibration permitted was ± 0.5.

The participants included one Saloon car driver, three Formula Ford drivers, two V8 Ute drivers, two V8 supercar drivers and two Touring Car Masters drivers, a total of 10 drivers. Each participant had a noise dosimeter placed in the car 30-45 minutes before a race either on the roll cage inside the car, on the passenger seat next to the driver seat or to the side of the driver depending on the type of car, with the microphone being close to the ear of the driver without disturbing them during the race.

Examples of placement of noise dosimeters in some cars are shown in Figures 1 and 2.

Figure 1. Noise dosimeter placement - Formula Ford Driver 3.

Figure 1 shows the placement of a noise dosimeter secured in place on the roll cage of the Formula Ford Car for Driver 3 on Day 3. The microphone was taped along the side of the inside of the car so as to not disrupt the driver but still gain realistic levels of the noise that the driver was exposed to.

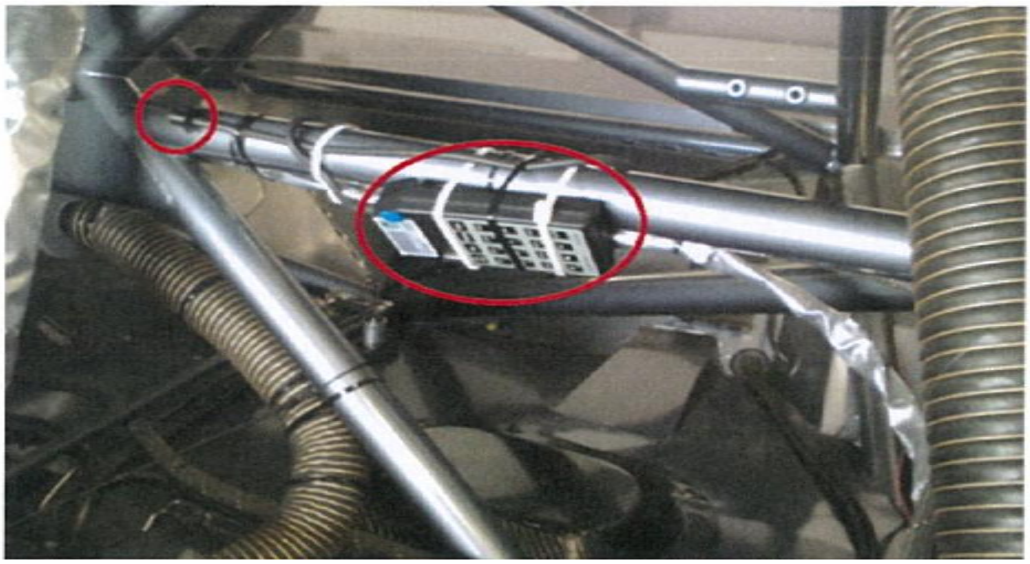

Figure 2. Noise dosimeter placement –V8 Supercar Driver 2.

Figure 2 shows the placement of a noise dosimeter on the top part of the roll cage of the V8 Supercar for Driver 2 on race Day 3. The microphone is placed facing the driver just behind the seat.

The levels that were collected from participating drivers included the following:

- LEq/LAvg: Average sound pressure level at C-weighting slow response but with an exchange rate set to 3.
- Max Level: Highest level sound sampled during the dosimeter run time allowing for the response that the unit in either fast or slow setting.
- Min Level: Smallest level sound sampled during the dosimeter run time allowing for the response that the unit in either fast or slow setting.
- Peak Level: the highest instantaneous level that the dosimeter detects via the microphone and is detected independently regardless of response setting.
- %Dose and %P Dose
- Pa^2H/ Pa^2H EXP
- Short-term exposure limit (SEL)

Hearing Protection Questionnaires

Hearing Protection questionnaires were provided to each category manager to be filled out by the drivers. The questionnaires asked questions about the types of hearing protection used, driver age and if the driver had ever had a hearing test/hearing loss.

The majority of questionnaires for Touring Car Masters and Formula Fords were unable to be collected resulting in a small sample size for these categories. A total of 121 questionnaires from drivers were collected.

Hearing Protection Attenuation Evaluation

Based on each type of hearing protection devices presented in the questionnaire, at least one of each type was evaluated, and a variety of others used in and out of the workplace were evaluated, to identify the suitability of hearing protection available for drivers, depending on car category. Those listed in the questionnaire that have been evaluated include custom fitted molded silicone/gel ear type inserts, quality Universal fit silicone/gel type ear moulds and simple foam, plastic or wax industrial type ear plugs.

3.2 Data Analysis

Noise Level Data Analysis

LEq/LAvg noise level readings corresponded to a time including before the race, during the race and after the race (partial noise exposure of drivers). Data was collected using the noise dosimeter and split into only the time of the race to obtain a realistic reading of the noise exposure from the cars and what the driver was exposed to. This reading was then converted to an LAeqT (time in minutes) specific to the time of the race, as well as an LAeqT including 10 minutes before and after the race to show the difference in Sound Level Exposure (SEL). The race had a higher noise exposure level than the 10 minutes before and after. The LAeqT race data over each of the 3 days was then converted to a LAeq,8h value for each driver for each day that they had been monitored for noise exposure. Peak levels across the three days were also reported and commented on. Each of these levels ignores protected exposure (presence of hearing protection devices worn) of drivers.

After LAeq,8h values were determined, class of hearing protector required was selected using the classification method for those values where LAeq,8h is less than 110 dB(A) while those that are 110db(A) or more may have the highest class to be sufficient but also requires SLC80 calculation or a Octave Band Method calculation listed in the AS/NZS 1269.3:2005 and AS/NZS 1270:2002. These methods are outside the scope of this research project due to frequencies of hearing protection devices specific to the drivers required for the calculation not being available.

Hearing Protection Attenuation Evaluation

Thirty Seven different hearing protection devices were evaluated. Each hearing protection device had either an SLC80 rating (Australian Standard for attenuation as stated in the AS/NZS 1269.3:2005 and AS/NZS 1270:2002 Standards) and an NRR (American Standard Noise Reduction Rating (NRR) Those devices that had an SLC80 were converted to a class method and based on LAeq,8hour level data the protection was calculated. Hearing protection was recommended for car categories depending on the degree of noise exposure for the category and ranged from Class 1-5 hearing protection. Any devices that only had an NRR were converted to an SLC80 rating and class equivalent, then made into recommendations for the car categories to be worn.

4.0 RESULTS

Questionnaires

Of the 121 completed questionnaires collected 38 were from Saloon Car drivers, 26 from V8 supercar drivers, 21 from Dunlop Series drivers, 3 from Formula Ford car drivers, 30 from V8 Ute drivers, 3 from Touring Car Masters.

Note: The majority of questionnaires for Touring Car Masters and Formula Ford were unable to be collected resulting in a small sample size for these categories.

The following charts show the total use of and types of hearing protection used for all drivers surveyed Chart1, and Chart 2, the types of hearing protection used by category.

Chart 1. Use of Hearing Protection and type for all Drivers

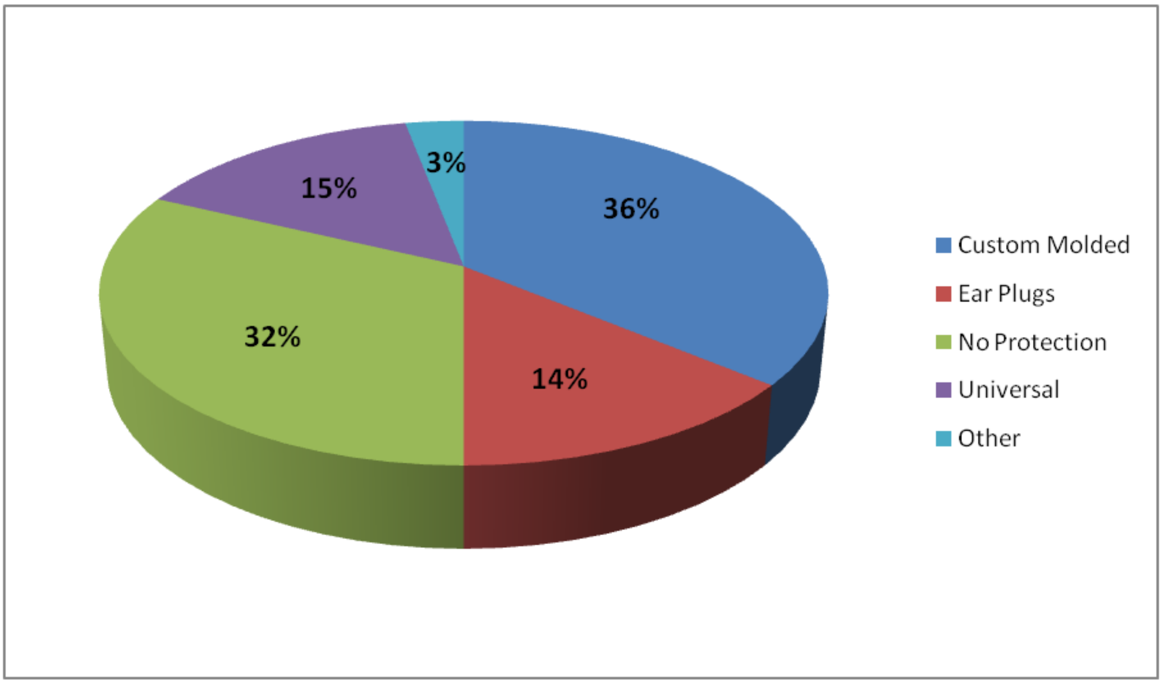

Chart1 shows the results for all drivers surveyed. Out of the 121 participants, 65% had worn transducers/speakers using either custom molded, universal or earplugs types. The most common type of hearing protection used by drivers, were custom molded ear plugs. These were used by 36% of participants. Alarmingly 32% of participants did not use any form of hearing protection.

Chart 2 - Types of Hearing Protection Used by Drivers per Category

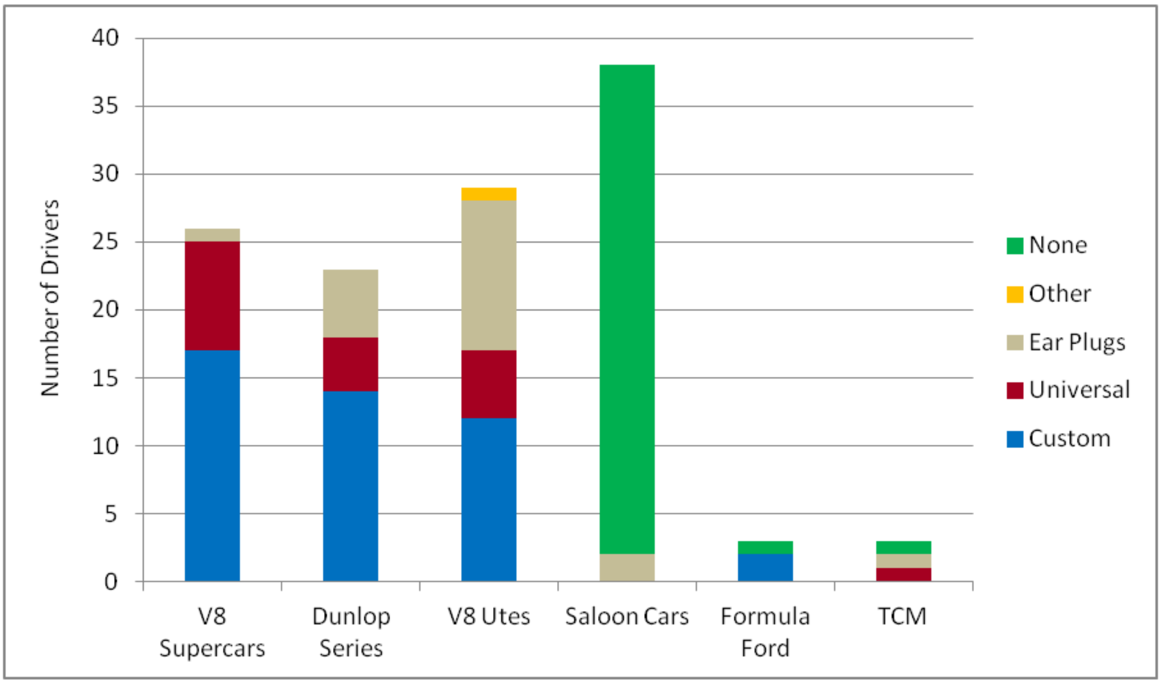

Chart 2, shows the types of hearing protection use by drivers for each category of racing, with Custom molded ear plugs the most popular. 39 of the 121 drivers surveyed or 32% stated they did not use any form of ear hearing protection, with Saloon cars drivers the highest non user of hearing protection at 94%, (36 of the 38 Saloon car competitors stating they did not use hearing protection).

Note: There was only a small sample of data for Formula Ford and TCM due to surveys not being returned.

Noise Level Exposure Assessment

Noise exposure data was recorded using dosimeters installed in cars of ten drivers, across five car categories, each time a driver participated and for the number of races or practices they had participated in during that day.

Every driver experienced a peak level of above 140 dB(C) in at least one race on one of the days.

Chart 3

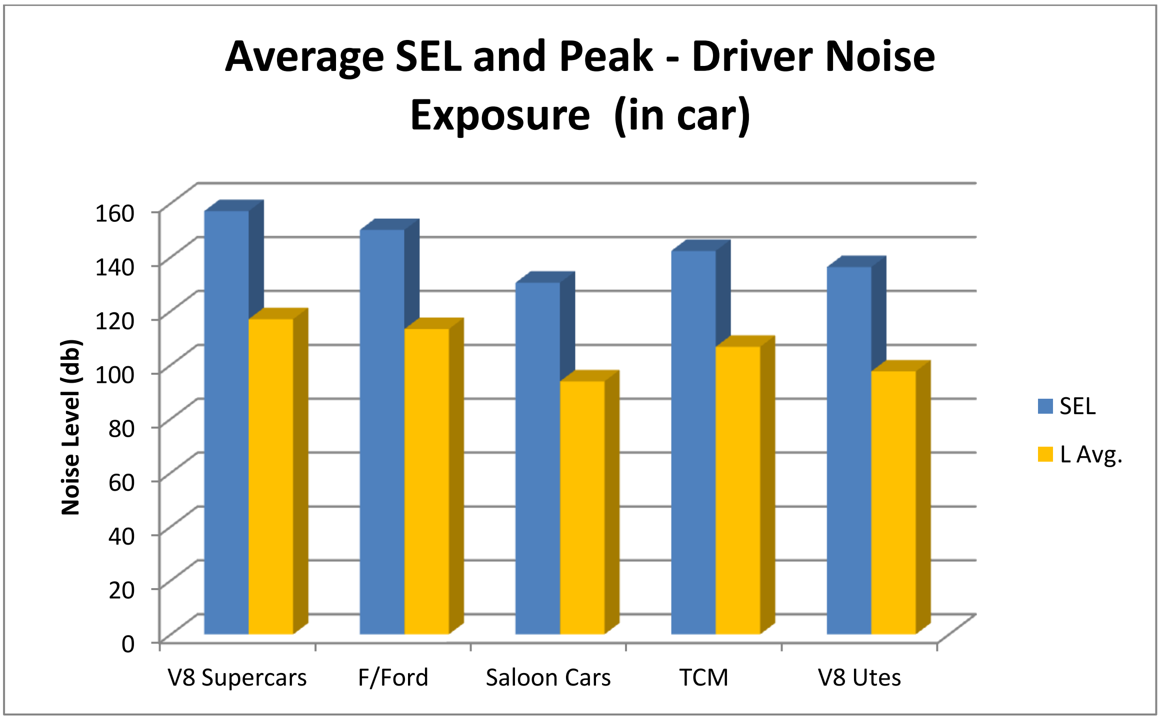

Chart 3, shows the Sound Exposure Level/Short-term exposure limit (SEL) in decibels used to calculate the approximate time the dosimeters were running for which includes the before the race, the time of the race and the race itself, all of which are included. The LAvg data for partial noise exposure presented are for the total duration time the noise dosimeter was running, including the Dose % and Pa²H. The P Dose % is a dose at an 8 hour equivalent.

Every driver reached a peak level of above 140 dB(C) in at least one race on one of the days according to the data obtained, even though on some days a peak above 140 dB(C) was not reached, such as for Touring Car Masters Driver 1 where a peak level of 127.2dB was reached on Day 1-Practice Race 1, but on Day 3- Race 3, a peak level for the same driver reached 145.0dB. A LaeqT for each race was calculated and a LAeq,T for all races occurring during that day. LAeq,T of races for all drivers on all days except for Saloon Cars Driver 1-Day 3 showed significant exposure levels exceeding an LAeq,8hr of 85dB(A). An example of this was V8 Ute Driver 1 and 2 monitored for 1 race on Day 3 (Race 3), the race being 20 minutes long, giving LAeq, 20min values of 105 dB(A) and 102 dB(A) respectively. This converted to a LAeq,8hr gave values of 91dB(A) and 88dB(A), above the 85dB(A) standard for a LAeq,8hr. Although the Saloon Car Driver 1 had not exceeded 85 dB(A) on Day 3, on Day 2 he had as he participated in 2 races equating to 35 minutes total, instead of just a 20 minute race which occurred on Day 3. Most drivers monitored had worn custom fitted molded ear silicone/gel type inserts and overall all drivers had worn hearing protection except for Saloon Car Driver 1.

Below is a table representing the hearing protection class required for each category monitored based on LAeq,8h levels collected.

Table 2 - Hearing Protection Class Requirement

Driver	**Day 1 LAeq,8h**	**Day 2 LAeq,8h**	**Day 3 LAeq,8h**	**Recommended Class of Hearing Protector Required**
V8 Ute Driver 1	88 db(A)	Not monitored	91 db(A)	Class 1 to Class 2
V8 Ute Driver 2	94 db(A)	Not monitored	88 db(A)	Class 1 to Class 2
Saloon Cars Driver 1	Not monitored	88 db(A)	83 db(A)	Class 1
Touring Car Masters Driver 1	97 db(A)	93 db(A)	97 db(A)	Class 2 to Class 3
Touring Car Masters Driver 2	Not monitored	91 db(A)	96 db(A)	Class 2 to Class 3
Formula Ford Driver 1	103 db(A)	Not monitored	Not monitored	Class 4
Formula Ford Driver 2	Not monitored	104 db(A)	Not monitored	Class 4
Formula Ford Driver 3	Not monitored	Not monitored	101 db(A)	Class 4
V8 Supercar Driver 1	Not monitored	Not monitored	112 db(A)	Class 5 and above, requires SLC80 or Octave Band Method calculation
V8 Supercar Driver 2	Not monitored	Not monitored	112 db(A)	Above Class 5, requires SLC80 or Octave Band Method calculation

Table 2 shows that all drivers exceed the standard of an LAeq,8h of 85db(A) at least once during the 3 days. Recommended hearing protection classes are made based on Table 1 - SLC80 rating to class method requirement AS/NZS 1269.3 (Workplace Health and Safety Queensland, 2011). Wearing hearing protection is needed to attenuate excessive noise that which can cause hearing loss/damage.

Hearing Protection Attenuation Evaluation

Tables 4 and 5 document the wide variety (37) of brands and types of hearing protection that were evaluated. All of the hearing protection devices attained were earplugs, mainly polyurethane foam earplugs. From the SLC80 rating or SLC80 rating equivalent attained from an NRR, a class of hearing protection was found for each device, ranging from class 2-5 depending on the rating. Most of the devices listed ranged from class 3-5 and were suitable for drivers exposed to noise levels above 95db(A). This included drivers of V8 Supercars, Touring Car Masters and Formula Fords.

Class 2 hearing protection types from table 5 are suited for drivers exposed to 90 to 95 db(A) or just less than 90 db(A), such as for drivers racing V8 Utes or Saloon Cars. Each driver can wear a range of classes within acceptable attenuation [to reduce noise levels to 70-75 db(A) or 80-85db(A)] to good attenuation [between 75 to 80db(A)]. Good attenuation is recommended over acceptable attenuation. Any further attenuation from hearing protection devices results in over and under attenuation. Refer to Table 2 for LAeq,8h levels that were used to make recommendations for drivers in what class they should use and the recommended classes. Refer to Table 4 and 5 for in depth results.

Examples of hearing protection devices

Custom molded with integrated transducers

Custom Molded

Common foam and plastic Earplugs

Appendix I – Hearing Protection Attenuation Evaluation SLC80 Rating & NRR to SLC80 Rating and Class Equivalent

Table 4 – Hearing Protection Attenuation Evaluation – SLC80 Rating

Brand	Name of Hearing Protection Device	Type	SLC80 Rating	Class	Category Recommendation
E-A-R	SofTouch	Polyurethane Foam Earplugs	28dB	Class 5	V8 Supercars Drivers
E-A-R (3M)	Push-Ins SofTouch Corded	Polyurethane Foam Earplugs with PVC cord	28dB	Class 5	V8 Supercars Drivers
E-A-R	Military Skull Screws Corded	Polyurethane Foam Earplugs with screw grip	27 dB	Class 5	V8 Supercars Drivers
E-A-R (3M)	Push-Ins	Vinyl/Slow recovery polymer foam Earplugs	23dB	Class 4	Formula Ford Drivers
E-A-R (3M)	Push-Ins Corded	Vinyl/Slow recovery polymer foam Earplugs	23dB	Class 4	Formula Ford Drivers
E-A-R (3M)	Push-Ins Uncorded with Grip Rings	Polyurethane Foam Earplugs	26dB	Class 5	V8 Supercars Drivers
E-A-R	Push-Ins Corded with Grip Rings	Polyurethane Foam Earplugs with PVC cord	26dB	Class 5	V8 Supercars Drivers
E-A-R (3M)	Express Pod Plugs	Polyurethane Foam Earplugs	19dB	Class 3	Touring Car Masters Drivers
E-A-R (3M)	Express Pod Plugs Corded	Polyurethane Foam Earplugs with PVC cord	19dB	Class 3	Touring Car Masters Drivers
E-A-R (3M)	EZ-Ins	PVC Earplugs	20dB	Class 3	Touring Car Masters Drivers
E-A-R (3M)	UltraFit	Elastomeric polymer Earplugs	18dB	Class 3	Touring Car Masters Drivers
Peltor (3M)	Next No-Touch	Polyurethane Foam Earplugs	25dB	Class 4	Formula Ford Drivers

Peltor (3M)	Next No-Touch Corded	Polyurethane Foam Earplugs with PVC cord	25dB	Class 4	Formula Ford Drivers
Peltor (3M)	Next Skull Screws	Polyurethane Foam Earplugs with screw grip	27dB	Class 5	V8 Supercars Drivers
Peltor (3M)	Next Skull Screws Corded	Polyurethane Foam Earplugs with screw grip	27dB	Class 5	V8 Supercars Drivers
Peltor (3M)	Tri-Flange	Polyurethane Foam Earplugs with PVC Cord	19dB	Class 3	Touring Car Masters Drivers
Howard Leight	Pilot	Polyurethane Foam Earplugs	23dB	Class 4	Formula Ford Drivers
Howard Leight	Quiet	Foam Earplugs	20dB	Class 3	Touring Car Masters Drivers
Howard Leight	Smart-Fit	CMT foam Earplugs with cord	20dB	Class 3	Touring Car Masters Drivers
Moldex	Rockets	Air Cushioned Ear Plugs	24dB	Class 4	Formula Ford Drivers
Moldex	Comets	Air Cushioned Ear Plugs	20dB	Class 3	Touring Car Masters Drivers
Moldex	Goin' Green Earplugs	Foam Earplugs	29dB	Class 5	V8 Supercars Drivers
Elvex	Quattro	Polymer Earplugs	20dB	Class 3	Touring Car Masters Drivers
GN ReSound	Solid Hearsavers	Universal Molded Earplugs	21dB	Class 4	Formula Ford Drivers
GN ReSound	Musician Hearsaver	Custom Molded Earplugs	21dB 25dB	Class 4 Class 5	Formula Ford Drivers V8 Supercars Drivers
GN ReSound	Hearsaver Moulds	Custom Molded Earplugs	21dB	Class 4	Formula Ford Drivers

Table 5 - Hearing Protection Attenuation Evaluation – NRR to SLC80 Rating and Class Equivalent

(The following devices have unattainable SLC80 ratings and have Noise Reduction Ratings (NRR) only, meeting American standards but not Australian Standards. Due to this, the NRR is converted to an estimated SLC80 range or class method it may correspond to.)

Brand	**Name of Hearing Protection Device**	**Type**	**NRR Rating**	**SLC80 Rating/Class Method Equivalent**	**Category Recommendation**
Radians	Snug Plug	Soft Earplugs with nylon cord	28dB	22dB-24dB Class 4	Formula Ford Drivers
Radians	Resistor 27	Synthetic rubber Earplugs	27dB	21-23dB Class 4	Formula Ford Drivers
Radians	Custom Molded Earplugs	Custom Molded Earplugs	26dB	20-23dB Class 4	Formula Ford Drivers
Tasco	Tri-Fit	Silicone Ear Inserts plus inserters	25dB	20-22dB Class 4	Formula Ford Drivers
HEAROS	Racing Ear Plugs with cord	Soft Foam Earplugs	33dB	26-29dB Class 5	V8 Supercars Drivers
MACK’s	Snore Mufflers	Silicone putty Earplugs	22dB	15-18dB Class 3	Touring Car Masters Drivers
iHear	Hocks – Darryl	Custom Molded Earplugs	19dB	13-16dB Class 2-3	V8 Utes, Touring Car Masters Drivers
iHear	Hocks - Starkey	Custom Molded Earplugs	19dB	13-16dB Class 2-3	V8 Utes, Touring Car Masters Drivers

5.0 DISCUSSION

This research was undertaken with the aim of identifying the noise level exposure of race car drivers in Australia as few studies have been conducted on the topic. Research conducted with racing car drivers in other countries had found that noise level exposure was excessive and above acceptable occupational health standards for the majority of race car drivers involved in motor sports. The following discussion compares the results gained from this study and what they mean, to either prove or disprove noise level exposure to be excessive. There is also a comparison between the frequency of the use of hearing protection devices, hearing tests and hearing loss amongst drivers.

Health Protection Questionnaire

Based on the findings from the questionnaires, a total of 82 drivers surveyed out of 121 (68.8%) had worn hearing protection, however 36 out of 38 drivers amongst the Saloon Cars category made up 36 out of the 39 drivers who had not worn hearing protection, while the other 3 drivers that had not worn hearing protection consisted of one driver from V8 Utes, one from Formula fords and one from Touring Car Masters. Custom fitted molded silicone/gel type inserts were found to be the most used type of hearing protection overall, being used by 45 out of 121 (37.2%) drivers who completed the questionnaire and 45 out of 82 drivers who had worn hearing protection or 54.9%. Ear plugs were found to be the second most used hearing protection amongst participants, used by 17 out of 121 total or 82 who had worn hearing protection, followed by quality universal fit silicone/gel type ear moulds used by 18 drivers and 4 other forms of hearing protection.

Noise Level Data

All drivers amongst all monitored car categories had experienced an LAeq,8h above the recommended exposure level of 85 db(A) over 8 hours. Not every race or practice for each day that a driver had participated in was monitored for noise due to lack of equipment available and spacing of time. This means that the 8 hour value would be higher than the results gained within this study adding to the severity of noise exposure amongst drivers in calculating the LAeq for the races and the 8 hour equivalent.

Reports of motor sport racing have recorded the sound pressure levels emitted by car engines to be around peak levels of 125 to 140 decibels in a single race. All races were above a peak level of 125dB with all the drivers reaching over 140dB in at least one race monitored. This is above the Australian and other peak noise level permissible standards of 140 dB(C) (Standard Australia, 2005a; Van Campen et al., 2005).

Although in some cases practice races were found to be less excessive in sound than actual races for some categories (such as V8 Utes), it is still shown that practice races are relatively harmful to noise exposure and still have an impact that leads to the standard of 85 db(A) for an LAeq,8h and 140 db(C) peak level being exceeded.

Amongst the categories, V8 Supercars had the highest LAeq,8h values, in both drivers having an LAeq,8h of 112db(A) on Day 3 in which they were monitored. The lowest LAeq,8h value was 83 dB for the Saloon Car driver on Day 3. This was the only value below the acceptable noise limit, however this was due to an exposure of 15 minutes and if further excessive noise exposure had occurred, the exposure level would be above the recommended limit. Saloon Car Driver 1 and Formula Ford Driver 3 both had not worn any form hearing protection despite the high levels of LAeq,8h and are recommended to wear hearing protection during their races.

The results have shown that all drivers exceed the standard of an LAeq,8h of 85db(A) at least once during the 3 days. Wearing hearing protection for drivers, during races is needed to attenuate excessive noise that can cause hearing loss/damage.

Hearing Protection Attenuation Evaluation

Based on the SLC80 rating and class of the hearing protection devices listed presented in Table 4 and 5, most range from Class 3-5. Most that are Class 3 are suitable for drivers involved in Touring Car Masters; Class 4 hearing protection devices suitable for drivers involved in the Formula Ford category, Class 5 is suitable for drivers involved in V8 Supercars. Drivers involved in V8 Utes and Saloon Cars require a minimum of Class 1-Class 2 and Class 2 respectively, so amongst these kinds of hearing protection,

6.0 CONCLUSIONS AND RECOMMENDATIONS

Recommendations

Drivers exposed to noise levels that exceed the Standards should be encouraged to have their noise exposure reduced by implementing cost effective hearing protection. Drivers have been proven to be exposed to excessive noise levels by being present around the cars during racing.

Areas to improve hearing protection could include as stated by the AS/NZS 1269.3 for the following (Standards Australia, 2005d):

- Management responsibility which would be managed by the raceways and separate categories;
- Proper usage of hearing protection, hearing protection usage and selection based on noise exposure, compatible with job requirements, personal characteristics and workplace, when hearing protection devices should be used and the correct fitting of hearing protection, comfort, meeting communication requirements, for both drivers and spectators. Regardless of class required for each category, all are recommended to wear some form of hearing protection of that required hearing protection class.
- In wearing hearing protection devices, attenuation requirements should be met, reaching at least between 70 dB to 85dB if not practicable to reach a good attenuation range of 75dB to 80dB. Anything below 70dB or above 85dB is hazardous due to over and under attenuation respectively.
- Correct cleaning, storage and maintenance of hearing protection devices.
- Inspection for defects of hearing protection devices.
- Knowing the noisiest areas in the raceway which are identified as hearing protector areas.
- A correct training program in the use of hearing protection devices for all personnel
- Ensuring continued effectiveness of the hearing protector program is implemented by monitoring noise levels, program auditing, and maintenance and user awareness.

Investigation of the attenuation levels of hearing protection specific to what drivers use will give greater indication to the suitability of hearing protection use amongst drivers.

Further research to what was conducted in this research report will prove useful in providing further evidence of excessive noise levels present in the motor sport environment. For future studies a larger sample group monitored for noise levels in the motor sport environment will provide better insight into the potential hazards all personnel attending motor sports are exposed to.

Conclusions

There have been few studies conducted within Australia in relation to motor sport noise exposure so this research has provided evidence about the noise levels that racing car drivers are exposed to over a 3 day car racing event. It is difficult to silence car engines and regulate noise levels to a degree that will reduce noise levels significantly due to the nature of racing. However, as long as effective hearing protection devices are used by all personnel that attend motor sports and an investigation is conducted to reduce noise levels via risk control programs; education provided on the effects of hearing loss, how hearing loss is dealt with and the reduction of noise at the source, the motor sport environment can become a place where hearing loss is easily preventable and no longer a hazard induced by motor sport racing.