Nova 3 Noise Attenuation Study

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Table of Contents

1.0 Introduction 3
1.1 Noise Attenuation Data 3
2.0 Limitations of the Procedure 4
3.0 Sandblasting Noise 4
4.0 Test Results 5
5.0 Noise inside the Nova 3 7
5.1 Bone Conduction 8
5.2 Additional Protection 9
6.0 Conclusions 10

1.0 Introduction

This report summarizes the noise attenuation characteristics of the Nova 3 Abrasive Blasting Helmet manufactured by RPB® Safety (Herein RPB, Where RPB is a registered trade mark of RPB USA Inc.).

Although the Nova 3 incorporates integrated noise attenuation by means of its molded polyurethane foam padding, RPB recommends users should always wear additional hearing protection whilst abrasive blasting due to the intrinsically high noise levels associated. This report utilizes theoretical calculations based upon field and laboratory tests to illustrate the combined noise attenuation of earplugs and the Nova 2000.

1.1 Noise Attenuation Data

Noise attenuation data of the Nova 3 and Nova 2000 was gathered from experiments conducted by Ben Scott and Mathew Bancroft at the University of Canterbury under the supervision of Dr. John Pearse. The University of Canterbury was commissioned to conduct several independent tests on the acoustical properties of the Nova 3 and Nova 2000 Abrasive Blasting Helmets. The data within this report has been extracted from their findings.

The sound pressure levels inside the Nova 3 and Nova 2000 were measured using RPB's own *Brüel & Kjær* Type 4100 Sound Quality Head and Torso Simulator and *Brüel & Kjær* PULSE 4100 Analyzer with Type7700 software analysis package. The helmet, complete with cape, was fitted to the simulator. The simulator was located in a reverberant chamber where the specialised loud speaker system was used to generate pink noise, which has equal sound power in each octave band. The sound pressures in the right and left ears of the Simulator were measured using Bruel & Kjaer Type 4189 microphones and a Bruel & Kjaer Type 4100 Pulse System. The equipment used is shown in Figure 1, below.

Figure 1 - Measuring Equipment

2.0 Limitations of the Procedure

The *Brüel & Kjær* Type 4100 Sound Quality Head and Torso Simulator is limited with a fixed head size. However, the Nova 3 pads are designed to provide a secure fit where the pads completely encompass the ear by contacting the head; creates a seal that prevents sound waves going around the foam. Therefore, it is not possible that all pad configurations would provide a perfect fit to the measuring equipment. As the measuring apparatus has a narrow head width, actual sound attenuation levels are likely to be higher than obtained during these tests.

Whilst preparing the laboratory for each test, the position of the measuring equipment may have undergone subtle displacements. Although it is possible this may have altered the datum (unobstructed) sound pressure levels for each test, it is assumed the laboratory acted as an ideal reverberation chamber.

3.0 Sandblasting Noise

A multitude of studies have been performed on the abrasive blasting industry, each collecting its own frequency response of the noise. Each study tests a different setup of basting equipment, abrasive material and blasting surface contributing the difference in frequency response from the tests. A selection of these is shown in Table 1, ordered loudest through quietest, whereas, a graphical representation is subsequently shown in Figure 2.

Table 1 - Sandblasting Noise Comparison [dBA]

Octave Band Centre Frequency (Hz)	63	125	250	500	1000	2000	4000	8000	Log Sum
1: Health and Safety Executive, 1997.	85	91	100	109	118	123	126	120	128.9
2: Patel & Irving 1999.	78	79	83	90	98	107	114	120	121.2
3: Pearse, RPB Study	52	63	74	87	98	108	115	119	120.7
4: Price and Whitaker, 1986.	98	97	101	101	106	112	115	116	119.8
5: Pearse, Unpublished	75	76	74	81	88	97	102	117	117.2
6: Environmental medicine unit report, 1998	73	82	89	97	107	111	111	107	115.5

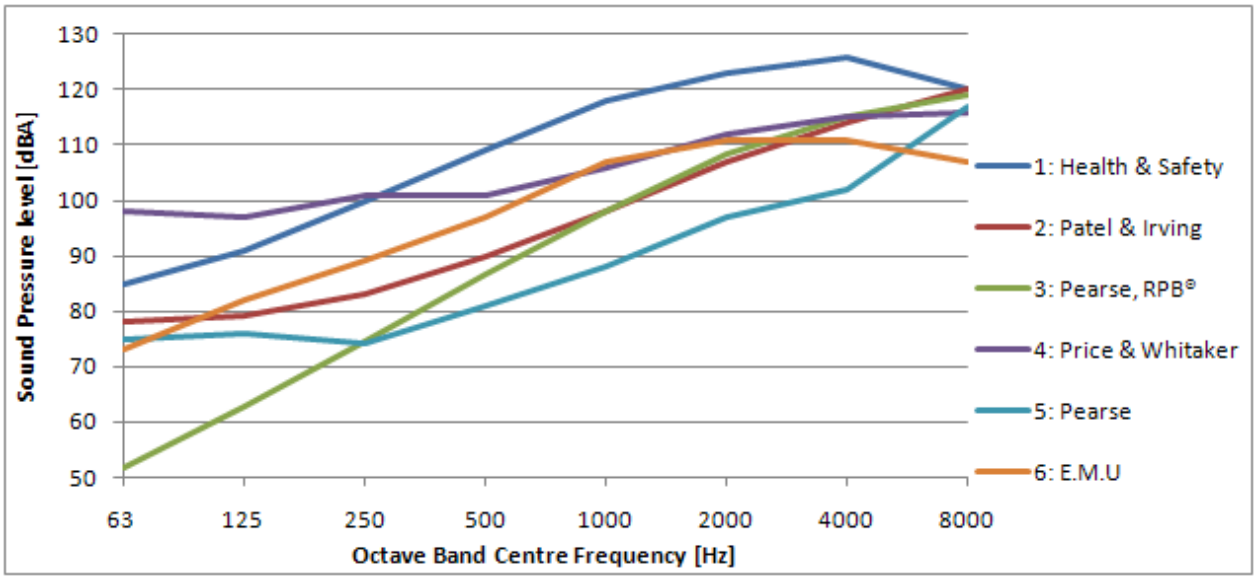

Figure 2 - Blasting noise recorded in various studies

4.0 Test Results

4.1 Consequences of Cape Selection

The Nova 3 was tested using standard A10 side pads and using a sample of the cape options:

- NV3-750, Standard Nylon Cape
- NV3-752, Leather Cape.
- NV3-754, Nylon Blast Jacket

As expected, tests quickly proved the NV3-754 performed nearly identically to the NV3-750. This is because the noise passes through the Nylon around the neck of the helmet and does not come up the cape in any way.
Similarly, the NV3-752 leather cape provided superior noise attenuation characteristics when compared with the Nylon alternatives.

Table 2, and Figure 3 below show the resultant the noise attenuation characteristics of the Nova 3 when compared with the Nova 2000.

Table 2 – RPB Nova Noise Attenuation Results

Octave Band Centre Frequency	125	250	500	1000	2000	4000	8000
NV3-750-A10 (dB)	-1.7	1.0	5.2	9.6	19.5	35.0	49.4
NV3-752-A10 (dB)	-2.2	2.8	6.9	13.4	22.7	38.1	51.6
NV2000 (dB)	-1.0	2.8	4.8	9.2	18.3	31.6	41.0

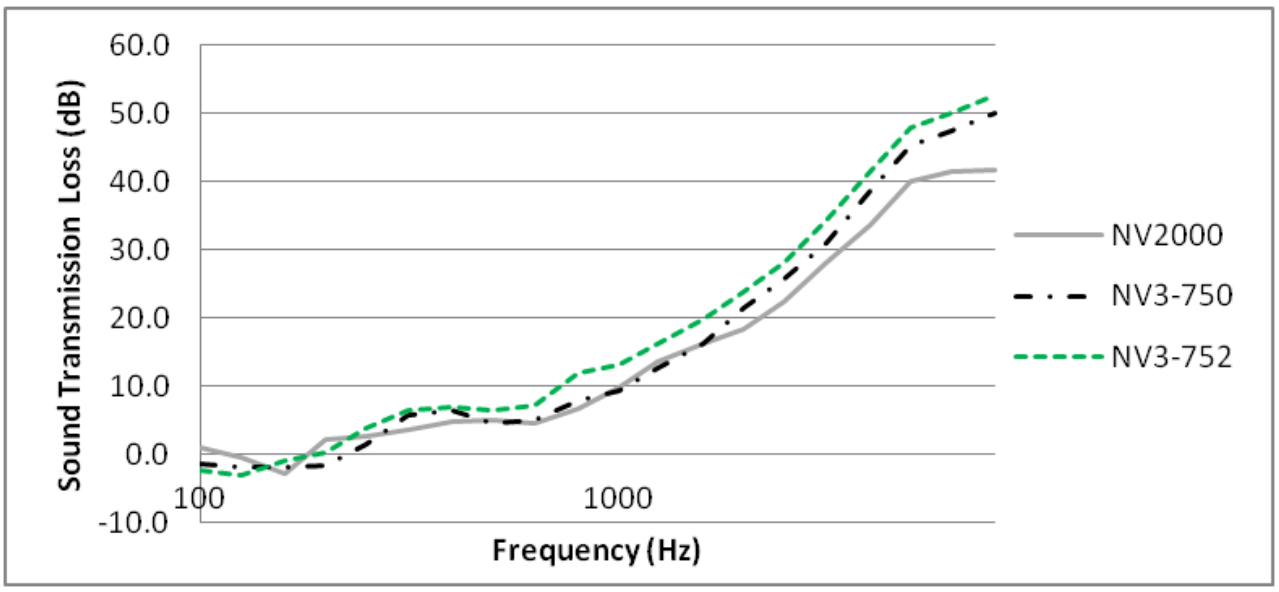

Figure 3 – Sound Attenuation Levels of Nova Respirator Helmets

4.2 Consequences of Pad Thickness

The noise attenuation was also measured to compare the effect of the various side pads. These tests were performed using the NV3-750, standard nylon cape. The pad variations tested were:

- NV3-732-A10: Side Padding Foam, Type A, Size 10 (for large heads)
- NV3-732-A15: Side Padding Foam, Type A, Size 15 (for medium heads)
- NV3-732-A20: Side Padding Foam, Type A, Size 20 (for small heads)
- No Pads: To show the attenuation inherently provided by the bare respirator.

Table 3 & Figure 4 show the noise attenuation profile for each configuration of side pad.

Table 3 – Nova 3 Noise Attenuation for various pad sizes

Octave Band Centre Frequency	125	250	500	1000	2000	4000	8000
NV3-A10	-1.7	1.0	5.2	9.6	19.5	35.0	49.4
NV3-A15	-1.9	1.3	4.9	9.7	19.6	35.3	51.5
NV3-A20	-2.0	3.2	5.8	11.9	22.8	38.3	53.7
NV3-No Pads	-1.9	0.2	4.8	9.0	13.8	23.7	29.1

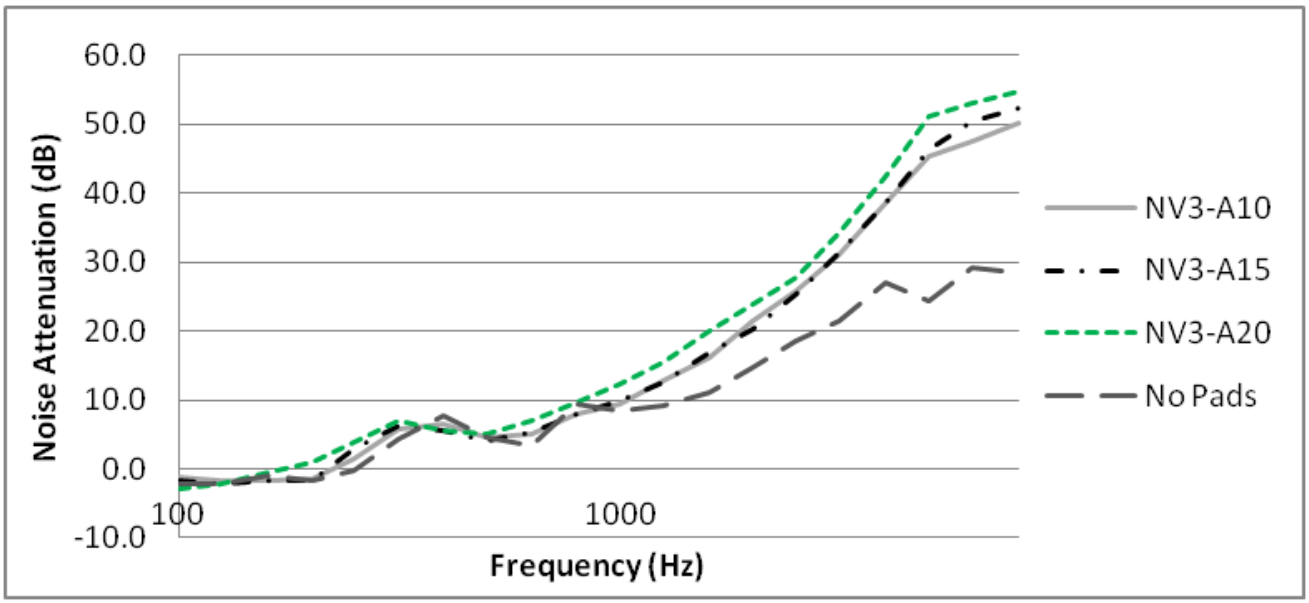

Figure 4 – Sound Attenuation Levels of Nova 3 Side Pads

5.0 Noise inside the Nova 3

By combining the attained noise attenuation of the helmets with a known abrasive blasting sound profile, we can calculate the resultant noise inside the Nova 3.

Table 4 and Figure 5 below show the resultant sound experienced inside the Nova 3 & Nova 2000 when exposed to the environmental noise obtained by the Pearse Study of abrasive blasting noise.

Table 4 - Sound Pressure Levels

Octave Band Centre Frequency (Hz)	125	250	500	1000	2000	4000	8000	Log Sum
Pearse, RPB Study	63.0	74.0	87.0	98.0	108.0	115.0	119.0	120.7
NV3-750-A10	64.7	73.0	81.8	88.4	88.5	80.0	69.6	92.3
NV3-752-A10-Leather	65.2	71.2	80.1	84.6	85.3	76.9	67.4	89.0
NV3-750-No Pads	64.9	73.8	82.2	89.0	94.2	91.3	89.9	97.7
NV2000	64.0	71.2	82.2	88.8	89.7	83.4	78.0	93.3

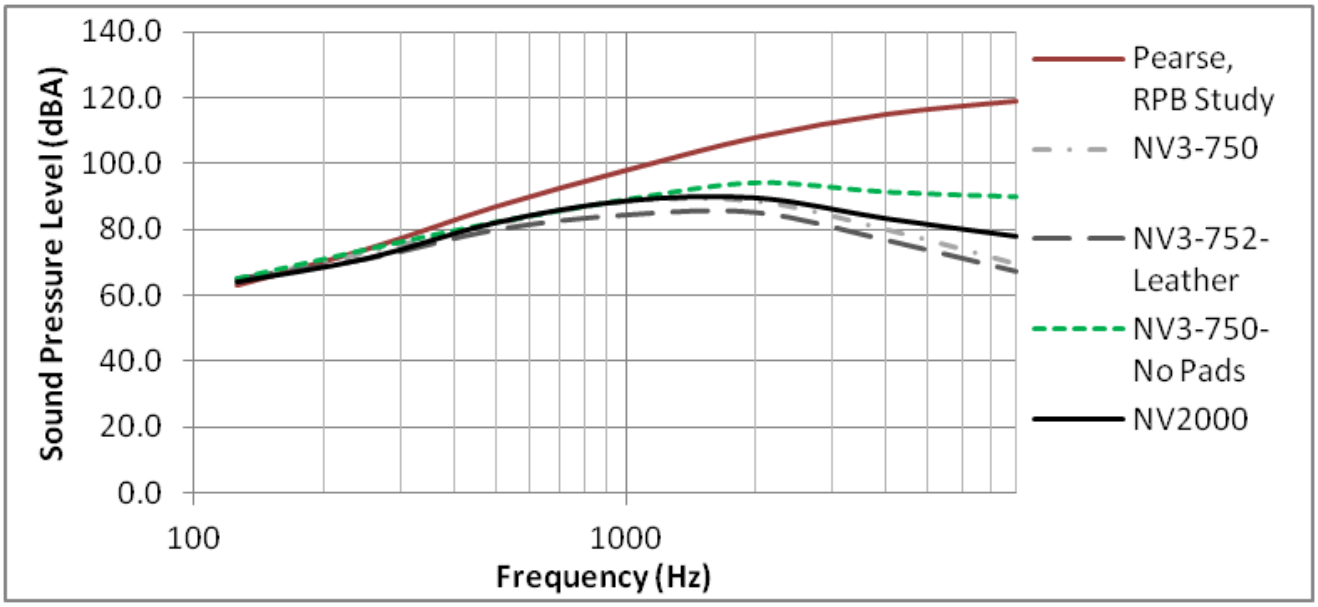

Figure 5 - Sound Pressure Level whilst exposed to Abrasive blasting noise (Pearse, RPB Study)

Similarly, Table 5 and Figure 6, below, show the noise experienced inside the base level Nova 3 with no additional hearing protection. This is determined by applying the attenuation of the Nova 3 to the data shown in Table 1, on page 4.

Table 5 - Attenuation provided by Nova 3

Study	Initial Volume [dBA]	Attenuated Volume [dBA]	Attenuation [dBA]
1: Health and Safety Executive, 1997.	128.9	111.1	17.8
2: Patel & Irving 1999.	121.2	93.0	28.2
3: Pearse, RPB® Study	120.7	92.3	28.3
4: Price and Whitaker, 1986.	119.8	105.4	14.4
5: Pearse, Unpublished	117.2	84.6	32.6
6: Environmental medicine unit report, 1998	115.5	99.7	15.8
Average	120.5	97.7	22.8

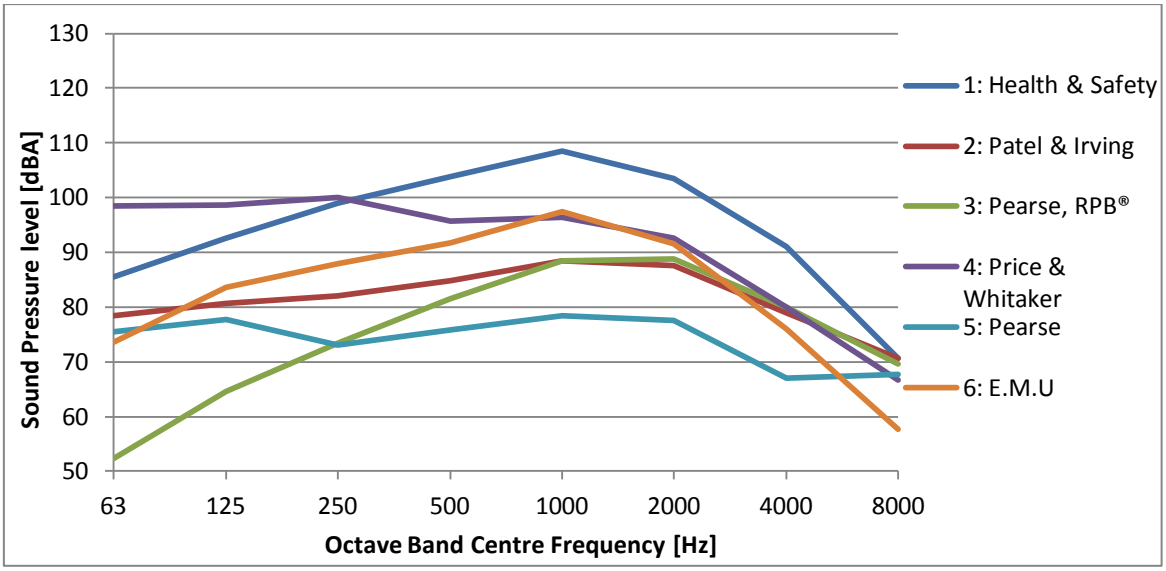

Figure 6 - Noise level inside Nova 3 for the various input cases.

5.1 Bone Conduction

The effect of bone conduction (noise transmitted through the skull to the ears) performs a significant role in the effectiveness of hearing protection. It is hypothesized that the Nova 3 adds further noise attenuation over alternative products by reducing bone conduction. Although yet to be scientifically proven, this is achieved because no rigid connections are formed between the helmet shell and the user's skull. Instead, the user is insulated by foam or polystyrene at all contact points. Conversely, alternatives products rigidly connect the wearer's skull to the helmet shell in the form of a plastic head harness.

5.2 Additional Protection

Although the Nova 3 provides significant hearing protection from sandblasting noise, this is still insufficient to protect users from hearing damage. Therefore, RPB recommends operators should always wear additional hearing protection. Foam earplugs are recommended because they:

- Provide the highest attenuation
- Fit comfortably next to the Nova 3's pads
- Readily available
- Relatively cost effective compared with ear defenders and custom ear plugs.

It should be noted, the individual attenuations of hearing protection products cannot be combined using simple addition. The process to determine the combined protection is outside the scope of this document. To gain truly accurate results requires complicated experimentation that considers the effects of bone conduction.

Two examples of suitable ear plugs are:

"Max" by Howard Leight

Octave Band Centre Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Mean Attenuation [dBA]	34.6	37.1	37.4	38.8	38.2	37.9	47.3	44.8
Standard Deviation [dBA]	3.0	4.5	4.3	3.7	3.5	4.0	3.5	7.2
Assumed Protection (98%) [dBA]	28.6	28.1	28.8	31.4	31.2	29.9	40.3	30.4

"Soft FX" by E.A.R

Octave Band Centre Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Mean Attenuation [dBA]	34.6	37.5	38.5	40.4	38.6	39.6	48.9	47.8
Standard Deviation [dBA]	5.7	6.0	5.4	5.0	4.2	2.5	3.8	3.9
Assumed Protection (98%) [dBA]	23.2	25.5	27.7	30.4	30.2	34.6	41.3	40.0

Table 6 shows the average attenuation provided by the earplugs alone. Because the blasting noise varies across all the studies, the earplugs are compared to the mean sound pressure level volume of each study shown in Table 1 on page 4 across each octave band.

Table 6 - Attenuation provided by sample earplugs only

Octave Band Centre Frequency (Hz)	63	125	250	500	1000	2000	4000	8000	Log Sum
Average Sandblasting Noise [dBA]	77	81	87	94	103	110	114	116	119
Noise with Howard Leight, Max [dBA]	48	53	58	63	71	80	74	86	87
Noise with E.A.R, Soft FX [dBA]	54	56	59	64	72	75	73	76	81

Note: RPB Safety is in no way affiliated with E.A.R or Howard Leight.

6.0 Conclusions

The noise produced by the process of sandblasting is well in excess of that safe for human exposure, as it reaches levels in excess of 120 dBA. Even when a user is wearing earplugs, the exposure can still be in excess of 85 dBA, the maximum recommended 8 hour exposure level in most countries including (Europe, Australia and New Zealand). Thus additional hearing protection is always required. However when a user is wearing earplugs in countries such as USA and Canada, who adopt a 90 dBA maximum recommended 8 hour exposure limit, suitable earplugs are likely to reduce the noise to below the 8 hour exposure level (for the noise levels outlined in this report).

Upon inspection of the Octave band frequency response, additional protection is required predominantly against frequencies greater than 1 kHz. Coincidently, the Nova 3 provides its greatest protection to these frequencies. Because not all operators obey safety instructions, supervisors can be assured of at least 15 to 33 dB of protection provided by the Nova 3 alone.

The results outlined in this report infer that the optimum system for assuring the best sound protection would be to use the Nova 3 shell with NV3-732-A20 side pads and a NV3-752 Leather blast jacket. This system would be likely to give between 16 to 35 dB of noise protection. The use of side pads in the Nova 3 and Nova 2000 provides approximately 9 dB noise attenuation.

RPB Safety intends to perform future calculations and testing of the protection provided by the Nova 3 combined with suitable ear plugs. It is expected that these tests will conclude the resulting sound pressure will be well below 85 dBA.

APPENDIX A: Permissible Daily Exposure (OSHA, USA)

The permissible noise exposure can be quantified using Figure 7 which shows the allowable daily exposure time for the corresponding sound pressure level of the work place. Referencing values from Tables 4 and 5 will give the corresponding permissible noise exposure time.

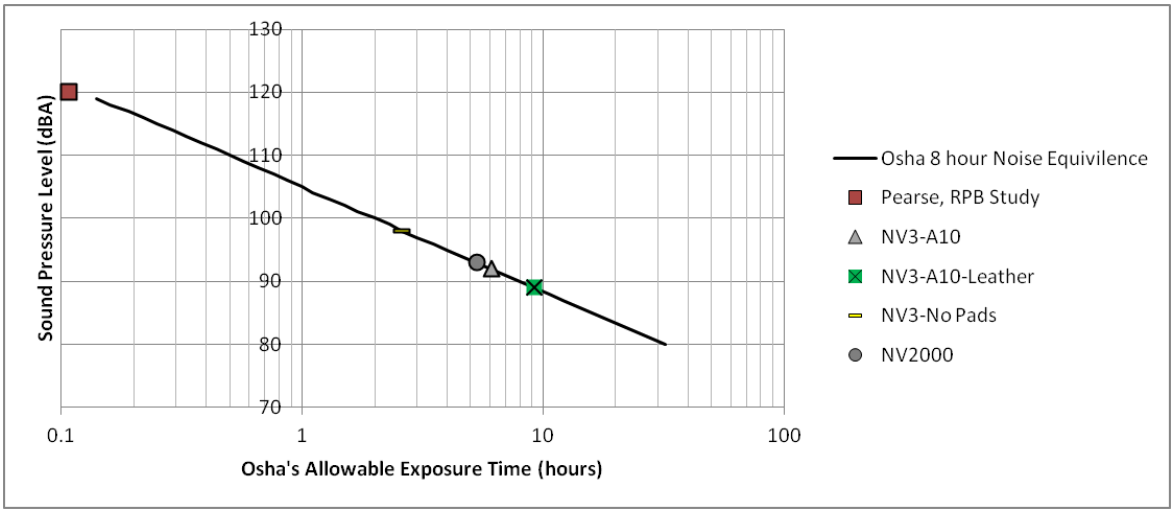

Figure 7 - OSHA Permissible Daily Exposure

The Osha allowable exposure time is likely to change depending on the specific noise environment. This can be observed in Table 5 and Figure 6 where there are large fluctuations in total noise for the same helmet. Hence the allowable exposure time must be quantified for specific sandblasting application.