

Noise Levels in Cinemas

Non-refereed

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Abstract

Over the last couple of years there have been numerous media reports about the potential risk posed to personal hearing from watching movies in cinemas. The reports often describe noise levels that patrons are exposed to as “ear shattering” and in excess of the recommended levels for the workplace resulting in potentially serious damage to hearing.

The aim of this project was to measure sound levels of a number of movies in order to determine what level of noise an ordinary cinema goer may be exposed to during the course of a movie. Noise levels of movie trailers have not been measured or considered and are outside the scope of this project.

A Brief History Of Cinema Sound

The acoustic requirements of a cinema are intended to maximise the quality of the reproduction and movie-going experience. George Lucas has been quoted as saying “sound is 50% of the motion picture experience” [1]. Special effects are used to improve the movie going experience both visually and aurally, as well as lend authenticity and “realism” to the story line. The use of surround sound speaker systems and the ability to reproduce sound at higher levels without distortion,

has meant that the aural special effects are being used increasingly to “enhance” movies, particularly those which utilise action packed scenes for example James Bond, Star Wars etc. Criticism in the media about excessive noise levels occurs from time to time. However, the noise levels quoted are vague at best, and the use of acoustic terms often misleading.

Standards And Guidelines

There are no existing standards relating to the level of sound an audience can be exposed to from the replay of movie soundtracks in cinemas.

As an aside, the competitive nature of commercials and trailers means there has been a trend to record the sound level as high as possible [8]. Thus, when the advertisement is replayed to an audience before the main feature it is subjectively considered as “too loud” and “earshattering”. When the main feature is played it can seem quieter than it is, due to the audiences’ previous exposure to noise. When a cinema manager receives a complaint from patrons about an excessive or uncomfortable level of sound from trailers and advertisements, there is a temptation to lower the replay level by using the fader control in the projection room. If the fader control is not reset to the “calibrated” position after the

trailers and advertisements have concluded then when the main feature is played, some of the quieter sections containing speech for example, may be lost, as they were originally mixed assuming the “calibrated” replay level within the cinema.

A considerable amount of research has been done and is currently in progress into environmental noise and its impact upon communities. None, however, has been carried out in terms of damage caused, or annoyance as a result of watching movies at cinemas. This may be because people can choose whether or not to attend a movie. Of course this argument applies to any leisure activity where the individual has the control in terms of exposure level and duration.

It is widely accepted that a daily exposure of 80-85 dBA (L_{eq}) for an 8-hour day over an individual’s working life is the upper limit before permanent damage will occur and hearing protection is required. For instantaneous noise, up to 200 Pascal (140 dB Linear) is acceptable.

The World Health Organisation (WHO) [11] recommends a 24 hour L_{Aeq} of 70 dB or lower to avoid hearing impairment from “industrial, commercial shopping and traffic areas, indoors and outdoors”. Impulse noises for adults should not exceed 140 dB (Linear) and 120 dB for children. Clearly it would be difficult to measure a person for 24 hours and

obtain meaningful data. For instance, there could be a large number of possible noise sources that may vary from day to day. The WHO Guideline does go on to say that hearing impairment is not expected to occur where the 8 hour L_{Aeq} is lower than 75 dB.

In summary, there are no specific standards or guidelines that relate to noise levels in cinemas from the replay of movie soundtracks. In attempting to anticipate what constitutes “high” or “dangerous” levels of noise, guidance should perhaps be taken from industrial noise legislation [15] and recommendations from the World Health Organisation [11].

Noise Measurements

Two different types of equipment were used to measure the acoustic parameters of interest. Initially a Larson Davies 705 Noisebadge was used, however a Bruel & Kjaer 2260 integrating sound level meter replaced this after the first nine measurements. The microphone

for both instruments was handheld at forearm's length above the armrest of the chair.

Measurements were taken of 17 movie soundtracks replayed within different cinemas throughout London owned by various operators including Cineworld, Warners, UCI, Odeon and Virgin. Several movies were measured twice, at different cinemas to enable a comparison of results for the same soundtrack.

The types of movie chosen were designed to be representative of the range available to consumers at multiplex cinemas and generally were “new releases” at the time of the survey. Of the 14 different movie soundtracks measured (3 soundtracks were measured twice) 7 were action movies, 4 suspense, 2 comedy and 1 music. Consent of the cinema operators was not sought, as anonymity was required so that measurements could be made as an ordinary cinemagoer.

Each movie duration was different but generally ranged between 1.5

and 2.25 hours. Fantasia 2000 was the exception, lasting just over 1 hour.

Results of the movies have been recorded in terms of L_{Aeq} , L_{max} (dBA) and L_{peak} (dB Linear). Time history plots for each movie showing the three acoustic parameters of interest (L_{Aeq} , L_{Amax} and L_{peak}) were completed, with two examples shown as Figures 1 and 2. Table 1 below summarises the measured levels for each movie in overall terms as well as the type of soundtrack and an indication of the size of the cinema and approximate percentage of seats occupied. Also included is a predicted $L_{ep,D}$ (8hr) and the number of minutes during which the L_{Aeq} was above 90 dB.

Similar surveys have been carried out by Fiumicelli [6] and Ferguson et al [7] have expressed the measured $L_{Aeq}(t)$ for each movie as an 8 hour L_{Aeq} in order to make comparison with the Noise at Work Regulations 1989 [15].

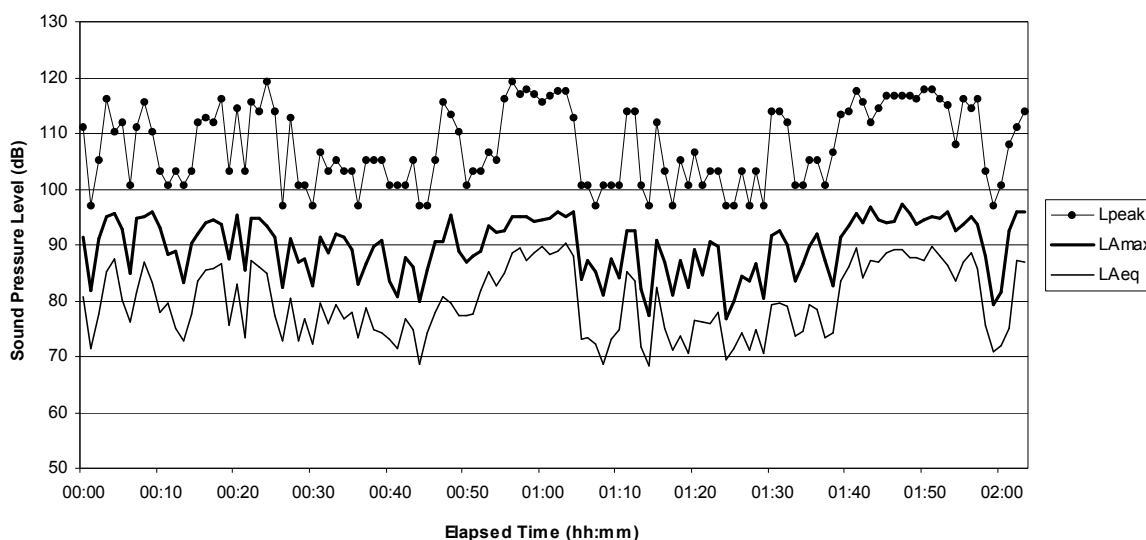
The results show that the measured

Name of movie	Duration (min)	L_{Aeq} (dB)	L_{Amax} (dB)	L_{Peak} (dB)	Predicted $L_{ep,D}$ L_{Aeq} (8 hr)	Cinema Size / % full ²	Number of minutes $L_{Aeq} > 90dB$
James Bond 007 – World is not enough	120	75	88	107	69	M / 100	NIL
Star Wars Episode 1: The Phantom Menace	125	77	92	115	71	M / 100	NIL
Star Wars Episode 1: The Phantom Menace (2)	125	84	97	119	78	L / 5	1
The Mummy	116	78	98	>140	72	M / 100	NIL
The Matrix	114	78	101	131	72	M / 100	0.5
Southpark	72	79	95	118	71	M / 10	NIL
The Blair Witch Project	75	69	91	132	61	M / 100	NIL
Cruel Intentions	90	61	84	107	54	S / 100	NIL
Austin Powers - The Spy Who Shagged Me	84	72	87	107	64	M / 100	NIL
Deep Blue Sea	93	82	107	117	75	M / 25	NIL
Gladiator	143	84	99	103 ¹	79	L / 10	12
Gladiator (2)	143	77	92	109	72	M / 100	NIL
Final Destination	88	81	100	103 ¹	74	M / 100	1
Final Destination (2)	88	72	90	114	65	M / 75	NIL
Scream 3	108	79	99	103 ¹	73	M / 100	NIL
Fantasia 2000	66	73	86	120	64	M / 50	NIL
U-571	105	78	96	122	71	M / 100	NIL

Note: 1 Measurement not considered representative as incorrect full scale deflection setting on sound level meter
 2 S=small (<1,000m³), M=medium (1,000-10,000m³), L=large (>10,000m³)

Table 1: Summary of acoustic measurements for each movie

Figure 1: Star Wars—Episode 1 The Phantom Menace (2)



overall L_{Aeq} ranged between 61-84 dB. The L_{Amax} was between 84-107 dB and L_{peak} measurements indicated values between 103-140 dB. Five movies had L_{peak} values of 120 dB or greater, with the remainder being below 120 dB.

For most movies the L_{Aeq} did not exceed 90 dB for more than a minute. The exception was *Gladiator*, which exceeded 90 dB L_{Aeq} for a total of 12 minutes or 8% of the total movie time.

Three movies were measured on two different occasions. Different cinemas were used for the repeat measurements and all showed a difference in the measured noise levels from the soundtrack replay. The range of measured level variation in L_{Aeq} was 7-9 dB, L_{Amax} 5-10 dB and L_{peak} 4-11 dB.

Discussion

The time history plots show fluctuations in sound pressure level throughout each movie. As would be expected the L_{Aeq} rises and falls for all movies and generally fluctuates by more than 10-15 dB. The exceptions to this were *James Bond*, *Austin Powers*, *Blair Witch Project*, *Cruel Intentions*, *Scream 3* and *Southpark* which

demonstrated a smaller dynamic range.

In figure 1, the plot shows the almost consistent rise and fall of the L_{Aeq} with dialogue and action/effects used throughout. At around the 50 minute mark, the build up to the “pod race” can be seen and lasts approximately 15 minutes. Similarly, towards the end of the movie, another sustained period of action before the denouement.

The plot for *Austin Powers—The Spy Who Shagged Me*, shows a much smaller dynamic range and is a reflection of the high dialogue content. The limitation of the Larson Davis 705 Noisebadge is evident in this plot, with the L_{peak} trace showing a noise floor of just under 100 dB (Linear).

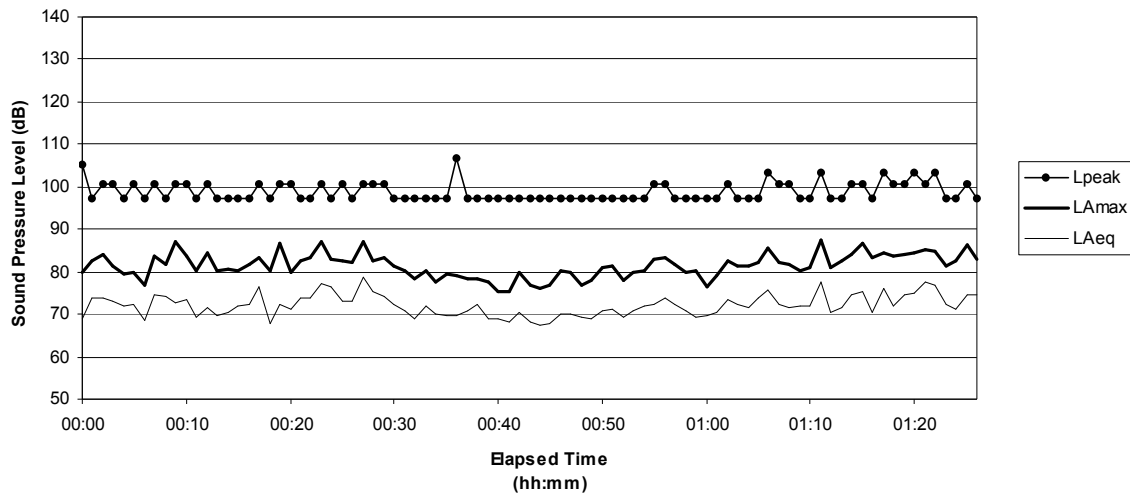
In movies such as *Blair Witch Project* and *Cruel Intentions*, this may be expected given the long quiet periods used to build tension between action scenes, which themselves are over relatively quickly. For movies such as *James Bond*, *Austin Powers* and *Southpark* the action scenes are interspersed with speech, which is at such a level that it does not particularly raise the L_{Aeq} and by

definition is punctuated with pauses.

The remainder of the movies show a much more fluctuating L_{Aeq} from period to period across their time history plots. This may perhaps be due to their action/adventure style. The occurrence of numerous high noise events (fighting, killing, and pod racing) at regular intervals is typically greater than for the suspense thrillers described above. The exception is *Fantasia 2000* which displays a wide dynamic range but has a relatively low overall L_{Aeq} of 73 dB. Nonetheless it was one of the few movies measured with a peak noise level of 120 dB or higher. The soundtrack of *Fantasia 2000* consisted of pieces of classical music interspersed with speech introduction before each piece.

Measured differences between repeat screenings indicate that the acoustic performance within one or both of the cinemas showing the movie was not ideal. In theory, whether or not one cinema is much larger than another, the acoustics of the cinemas (and sound system/fader control) should be set so that the reproduction of the soundtrack is optimised and as intended by the director.

Figure 2: Austin Powers—The Spy Who Shagged Me



Higher levels seem to occur where there are fewer people in the audience suggesting that the audience absorption is not accounted for in setting playback levels.

The results of similar surveys carried out by Inhe et al [5], Fiumicelli [6] and Ferguson et al [7] measured L_{Aeq} values of 73-85 dB. These values are consistent with the results of this project. Interestingly, none of the surveys measured any movie with an overall L_{Aeq} above 85 dB.

Given that no individual movie L_{Aeq} exceeded 85 dB (ranged between 61-84 dB, L_{Aeq}), the corresponding 8-hour L_{eq} ($L_{ep,D}$) for each ranged from 54-79 dB, significantly below the first action level of the United Kingdom Noise at Work Regulations [15]. Peak noise levels greater than 120 dB were exceeded during 11 of the one-minute measurement samples in 4 movies. Note, however, that it is possible that 120 dB was exceeded on more than one occasion during a one-minute sample.

The movie U-571 accounted for 8 of the 11 one-minute intervals where 120 dB(lin) was exceeded, however the highest peak measurement was 122 dB. Only a single measurement period exceeded 140 dB, which was in the final scene of The Mummy.

Conclusions

Despite claims in media reports, measured noise levels in 17 separate screenings show that even for the duration of the movie, 85 dBA L_{eq} is not exceeded. As an 8-hour exposure, levels are less than 80 dBA L_{Aeq} . One event over 140 dB (peak) were recorded, with other results generally well below the threshold at which hearing damage is likely to occur

In conclusion, it is considered that going to the cinema is unlikely to cause irreparable damage to hearing, nor is it likely to result in short term damage.

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Standards News

Wind Farm Noise

Standards Australia have recently announced their intention to set up a technical committee to deal with methods for the measurement of wind turbine noise.

The committee will also participate in the work of International Technical Committees, Sub-

Committees and Working Groups including IEC/TC 88 (Wind Turbine Systems).

Terms of reference for the committee; Standardization in the methodology of the measurement of wind farm noise, including methods for assessing noise from wind turbine installations and wind farms, but excluding

community acceptability criteria.

The first meeting was reportedly being held in Sydney during June 2002.

Further information can be obtained from Suzanne Wellham (61-2) 8206 6821

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