Noise Exposures

Assessing an NCAA Basketball Arena on Game Day

By Gary A. Morris, Bassam H. Atieh and Randal J. Keller

NCAA Division 1 men's basketball is a major collegiate sport with more than 330 teams nationwide. Approximately 25 million people attend games each year, with an average attendance of 5,000 spectators per game (NCAA, 2012). In addition to spectators, many event support staff are employed, such as public safety employees, concessionaires, media personnel, university officials, coaches and referees.

Despite the popularity of college basketball and the large numbers of spectators and employees who attend these events, few published reports address noise levels in college basketball arenas. A report by Shepherd, Hambric, Evans, et al. (2011), estimates the noise potential in 10 college basketball arenas selected by asking announcers and journalists which arenas they perceived to be the loudest. The report suggests that factors other than seating capacity, including seating geometries, materials and reverberant contributions, all play an important role in contributing to noise levels.

Decibel levels have been estimated in some major collegiate basketball arenas to be as high as 118 dBA (University of New Mexico, 2012). In an environment where noise is generated by avid spectators, bands and public address systems, the potential for overexposure to noise exists. Yet, noise dose estimates have not been determined for attendees at these events.

Noise exposures at other athletic events have been the subject of several publications. Engard, Sandfort, Gotshall, et al. (2010), studied noise exposure at three football stadiums and reported measurements that exceeded OSHA's action level of 85 dB that would require enrollment in a hearing conservation program. Rose, Ebert, Prazma, et al. (2008), report a range of sound pressure levels from 96.5 to 109 dBA at stock car racing events, an exposure that the authors speculate could cause a temporary threshold shift. A significant deterioration of postmatch hearing thresholds was reported by Swanepoel and Hall (2010) for spectators following a Fédération Internationale de Football Association World Cup soccer match, where sound pressure levels average 131 dBA.

Although many exposures reported at athletic events are below the OSHA permissible exposure limit (PEL) and cause only temporary hearing impairment, the effects of noise-induced hearing loss (NIHL) are potentially serious. As Kujawa and Liberman (2009) report, the acoustic overexposures causing moderate threshold elevation have "progressive consequences that are considerably more widespread than are revealed by conventional threshold testing" due to nerve degeneration. Therefore, spectators and employees at events such as NCAA basketball games are at an increased risk for NIHL.

IN BRIEF

- **Research suggests that spectators and employees at indoor athletic events could have an increased risk for noise-induced hearing loss.**
- **Little empirical data has been gathered on indoor basketball game noise exposure.**
- **Emphasizing the concepts of identifying, evaluating and controlling hazards in a practical setting, Murray State University faculty conducted a study with students to assess the potential noise hazard at an indoor basketball game that illustrates the need for future research.**

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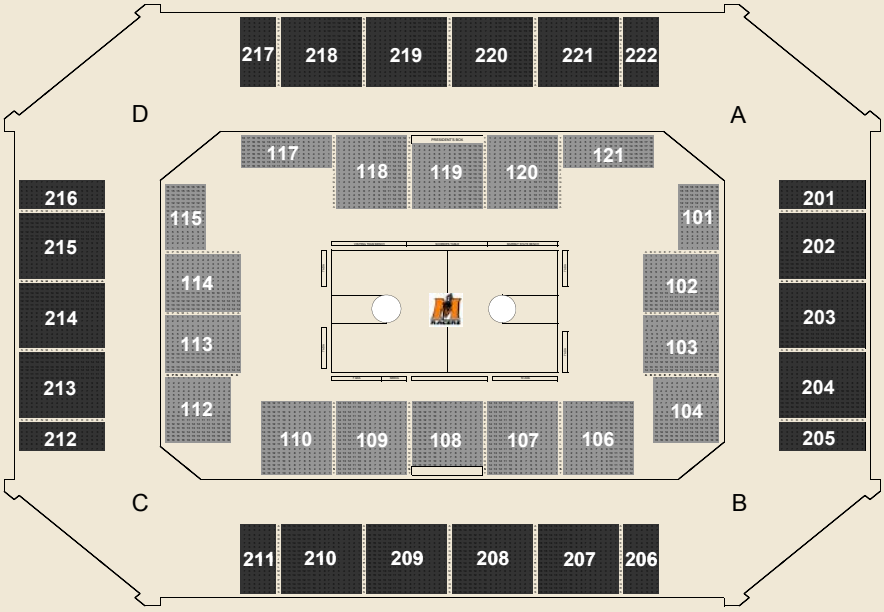
Figure 1
Diagram of CFSB Center



The Study: Purpose, Methods & Results

During the 2011-12 NCAA basketball season, the Murray State Racers men's basketball team was undefeated midway through February, making it the last undefeated team in the country. The Racers had never sold out the arena before that season. However, the team's success and national ranking increased attendance. The arena was loud. The question was, how loud?

This study aimed to measure noise exposures for attendees (employees and spectators) at a midsize basketball arena and to determine whether these noise exposures were within acceptable limits. The study resulted from a unique opportunity to observe the arena at its full capacity. As noted, until 2011-12, the CSFB Center at Murray State University in Murray, KY, had not sold out a game in its more than 10-year history. It should be noted that the study was limited in that the researchers had restricted access to the facility due to the high demand for tickets and press passes at these games.

The authors attempted to obtain representative samples from each area of the arena. This included sampling in proximity to the court, as well as most other areas of the arena. However, since the arena was sold out, measurements could not be equally distributed throughout the event. That said, all major sections were included in the sampling. Two studies, Engard, et al. (2010), and Cranston, Brazile, Sandfort, et al. (2013), use similar sampling strategies to obtain a representative sample of a venue. Figure 1 presents a diagram of locations within the CSFB Center where measurements were obtained.

Personal noise monitoring was conducted on 15 attendees during three home basketball games. Five individuals wore audio dosimeters at each game. Monitors were placed on patrons upon arrival at the arena and removed as they exited.

At the first two games (Feb. 9, 2012, and Feb. 11, 2012), participants chosen to wear audio dosimeters were seated on the arena's first level, ranging from 23 to 75 ft (7 to 23 m) from the basketball court. Dosimeters were evenly distributed, with monitored patrons located on both sides and ends of the court.

At the third game (Feb. 18, 2012), more excitement was expected for a nationally televised game. Fans selected to wear audio dosimeters were located on the second level of the arena. Dosimeters were evenly distributed around the arena, at distances ranging from 82 to 164 ft (25 to more than 50 m) from the court.

Dosimetry results from game one (Table 1) indicate that two of the five individuals monitored were exposed to noise above the OSHA action level, 8-hour time-weighted average (TWA; 50% noise dose, $\geq$ 85 dBA, 5 dB exchange rate). The Lavg readings (average sound level for the dosimeters' run time) ranged from 89.57 to 95.15 dBA. Peak levels obtained ranged from 120 to 130.8 dBA.

Table 2 presents dosimetry results from game two. None of the five individuals monitored were exposed to noise above the OSHA action level 8-hour average. The Lavg readings ranged from 87.75 to 92.2 dBA, and peak levels ranged from 115.1 to 131.2 dBA.

Results from game three (Table 3) indicate that three of the five individuals monitored were exposed to noise above the OSHA action level 8-hour average. The Lavg readings ranged from 92.36 to 98.33 dBA, and peak levels ranged from 127.5 to 138.3 dBA.

Discussion

This study had several goals. The first was to determine whether noise levels at a Murray State basketball game reached potentially hazardous levels. Second, the project allowed faculty and students to partner on an occupational safety and health issue that put classroom theories into practice and reinforced learning. Third, the project illustrated to students that the SH&E profession can identify interesting safety and health problems and enlighten the public about unexpected hazards. The opportunity to add to the body of knowledge while working with students and increasing interest in the SH&E profession was a win-win for all.

Athletic events are popular and have a huge fan base. Exposure to high noise levels, whether on the job, at home or at an athletic event, can affect an individual's health. The limited study aimed to determine whether noise levels reached at a mid-level NCAA arena were within acceptable limits. Although the risk to fans may seem minimal due to exposure occurring infrequently and for only a few hours at a time, extremely high levels and routine exposure could be unacceptable. Measurements revealed that peak levels of noise reached 138 dBA at one game and exceeded 130 dBA at several random

sites during the three games studied. Of the 15 samples taken during the three games, five samples exceeded the 85 dBA OSHA action limit that would require entry into a workplace hearing conservation program.

Another interesting data point was that 12 of the 15 samples exceeded the TWA-PEL when just calculating the dosimeters' run time. This suggests that for tournament settings the possibility of exceeding the PEL is significantly higher.

During conference and NCAA tournaments, several games are played consecutively in the same arena, which can double or triple exposure time. Tournament games also are typically nationally televised and have a "win or go home" consequence, creating more excitement and possibly an increased level of noise intensity.

Although this project was limited to one arena and three games, the data suggest the need for future studies. CFSB Center's capacity is approximately 8,700, classifying it as a midmajor college facility. The top three NCAA men's basketball attendance leaders are University of Kentucky, Syracuse University and University of Louisville, all of which average more than 21,000 attendees (NCAA, 2012). To date, the highest documented noise level recorded at an indoor basketball arena is a 138 dBA at a Murray State game. The possibility of exposure to hazardous levels of noise is significant and could affect millions of individuals.

Preventing fans from attending events or providing PPE does not seem realistic. However, educating attendees of such events might be a step in the right direction. More empirical data and additional studies might influence arena design, leading to use of better noise-absorbing material, thereby reducing the hazard and better protecting occupants.

Conclusion

This study illustrates high noise levels and potential hazards at a midlevel NCAA basketball event. Although Shepherd, et al. (2011), discuss potential acoustic levels, empirical studies do not exist to validate their conclusions. Future studies should be conducted to specifically identify the risk of high levels of noise to different groups at NCAA basketball events. **PS**

Table 1
Audio Dosimetry Results, Game 1

Dosimeter No.	Measured time (hours)	8-hour % dose		8-hour TWA (dBA)		Lavg (dBA)	Peak level (dBA)
		Lt(80)	Lt(90)	Lt(80)	Lt(90)	Lt(80)	
D1	2.72	69.72	61.77	87.44	86.56	95.15	130.8
D5	2.67	37.52	26.90	82.98	80.60	90.85	120.7
D6	2.71	59.53	49.60	86.28	85.00	94.06	130.8
D7	2.78	32.83	20.99	82.01	78.78	89.57	120.0
D10	2.81	43.37	31.44	84.02	81.71	91.50	124.1

Note. *Audio dosimetry results, game 1, Feb. 9, 2012.*

Table 2
Audio Dosimetry Results, Game 2

Dosimeter No.	Measured time (hours)	8-hour % dose		8-hour TWA (dBA)		Lavg (dBA)	Peak level (dBA)
		Lt(80)	Lt(90)	Lt(80)	Lt(90)	Lt(80)	
D1	2.6	35.30	23.77	82.53	79.68	90.62	115.1
D5	2.58	43.90	33.98	84.12	82.26	92.2	117.7
D6	2.68	43.06	31.81	83.98	81.79	91.77	125.6
D7	2.65	24.26	12.29	79.84	74.94	87.75	117.3
D10	2.80	30.89	20.86	81.58	78.75	89.06	131.2

Note. *Audio dosimetry results, game 2, Feb. 11, 2012.*

Table 3
Audio Dosimetry Results, Game 3

Dosimeter No.	Measured time (hours)	8-hour % dose		8-hour TWA (dBA)		Lavg (dBA)	Peak level (dBA)
		Lt(80)	Lt(90)	Lt(80)	Lt(90)	Lt(80)	
D1	2.18	57.98	49.76	86.11	85.01	95.42	129.3
D5	2.33	92.61	84.49	89.49	88.84	98.33	132.3
D6	1.96	45.74	38.50	84.41	83.22	94.51	127.5
D7	2.51	43.41	32.58	84.02	81.97	92.36	138.3
D10	2.2	84.47	76.17	88.84	88.08	98.10	133.8

Note. *Audio dosimetry results, game 3, Feb. 18, 2012.*

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