



# Johns Manville

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Steve,

The following document is in conjunction with Contract Report 500-2350 (A2003-091) “Sound Power Measurements of a Nightstar® Flashlight”. The purpose of this document is to display the perceived A-weighted sound pressure levels (SPLs) from the Nightstar® Flashlight depending on the listener’s distance from the point source in a free field environment. An A-weighted SPL is a single number rating of loudness determined through the application and summation of frequency discriminatory constants to all SPLs in the measured sound spectrum (in this case 100-10,000 Hz, 1/3 octave band). A free-field environment refers to a medium without obstructions to impede the progress of sound emitted from a source. In this case, a free field environment is used to model an open, outdoor space. The flashlight is assumed to be a point source, or a single, noise emitting device that radiates noise spherically. Table 1 and Graph 1 display the A-weighted SPLs of the Nightstar® Flashlight while it is shaken “side-to-side” (found to be the worst case noise emitting scenario) depending on distance of listener from the flashlight(s). The “side-to-side” shake is meant to simulate emitted noise while a person is running with the flashlight. In addition, the A-weighted SPLs of several common noise sources at close range are documented as a reference guide. The equation used to convert emitted sound power levels to sound pressure levels, in free-field environment, is as follows:

$$L_p = L_w + 10 \log_{10}(Q) - 20 \log_{10}(r) - 11 \text{ dB re: } 20 \mu\text{Pa}$$

where:

$L_p$  = sound pressure level, dB re: 20  $\mu$ Pa

$L_w$  = sound power level, dB re: 10 pW

$Q$  = source directivity factor, assumed to equal 1

$r$  = distance from noise source to listener

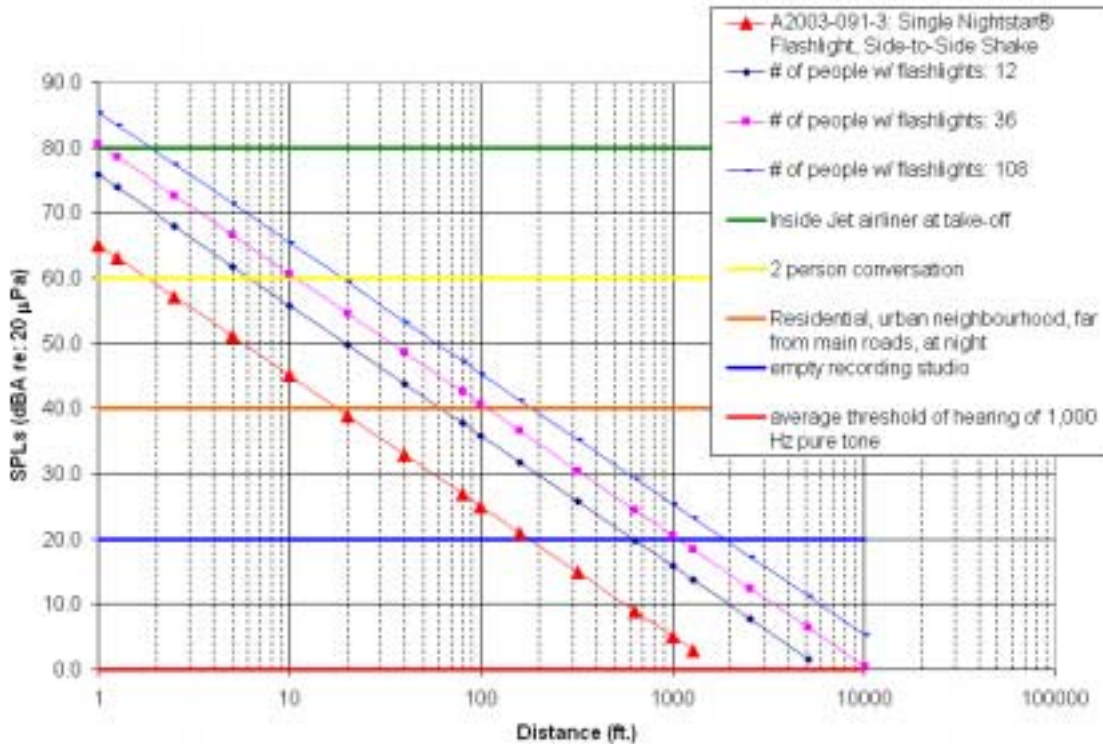
**Table 1. Predicted A-Weighted Sound Pressure Levels of 1, 12, 36, and 108 Nightstar® Flashlights at Various Distances**

A-Weighted SPL (dBA re: 20 $\mu$ Pa)	Distance from Nightstar® Flashlight(s) (ft.)				
	1	10	100	1,000	10,000
1 Nightstar® Flashlight	65	45	25	5	0
12 Nightstar® Flashlights (Squad)	76	56	36	16	0
36 Nightstar® Flashlights (Platoon)	81	61	41	21	1
108 Nightstar® Flashlights (Company)	86	66	46	26	6

**Table 2. Common A-Weighted Sound Pressure Levels**

	SPL (dBA re: 20 $\mu$ Pa)
Inside a jet airliner at take-off	80
2 person conversation	60
Residential, urban neighborhood, far from main roads, at night	40
Empty recording studio	20
Average threshold of hearing of 1,000 Hz pure tone	0

**Graph 1. Predicted A-Weighted Sound Pressure Levels of 1, 12, 36, and 108 Nightstar® Flashlights at Various Distances**



The SPLs of the flashlight no longer contribute to the overall ambient noise once the flashlight’s SPLs are 10 or more dBA below ambient noise. Assuming 40 dBA represents ambient outdoor noise, a single flashlight would no longer contribute to the ambient noise perceived by the listener at distances greater than ~55 ft. away from the flashlight noise source. SPLs of 12, 36, and 108 flashlights would fall 10 dBA below ambient noise at ~200, ~300, and ~600 ft. away from the noise source, respectively. Please contact me if you have additional questions.

Sincerely,

Parker Stone  
 Research Engineer  
 Acoustical Research & Testing  
 Johns Manville Technical Center

## REFERENCES

1. Beranek, L. L. and Ver, I. L. (1992) *Noise and Vibration Control Engineering*. John Wiley & Sons, Inc., New York.
2. Fahy, F. (2001) *Foundations of Engineering Acoustics*. Academic Press, San Diego.