45.3 Four identical fans produce a combined sound pressure level of $90dBA$ as measured at a point that is equidistant from each fan. What is the sound pressure level if three fans are shut down?

A. $70dB$

B. $80dB$

C. $84dB$

D. $87dB$

Refer to the table for Combining Two Sound Levels and note that when the difference between two source's sound levels is $0dB$, the number of decibels to be added to the highest level is 3dB. In this situation, sources are being removed as fans are shut down, but the same principle applies in reverse. To be clear, the table does not offer a way to add 3 or more sources together directly, therefore it is necessary to find an approach that allows adding the sources in pairs only.

First, imagine shutting 2 of the 4 fans down. One pair of fans may be treated as one source and the other pair treated as a second source. The sound pressure level will be reduced by $3dB$ when have the sources are removed. This reasoning can be confirmed by imagining re-enabling the 2 fans, thereby combining two pairs of sources, and adding back the $3dB$.

$$90dB - 3dB = 87dB$$

Next imagine shutting down one of the two remaining fans, thereby removing half the sources. By the same reasoning, another $3dB$ reduction will be observed.

$$87dB - 3dB = 84dB$$

Again, sense check this answer by adding two $84dB$ sources together to get $87dB$, then adding the two pair of sources to get back to $90dB$.

Answer C

45.4 The background noise in a factory prior to any equipment turning on has a sound pressure level of $40dB$. Once the equipment is operating, the sound pressure level is $46dB$. What is the sound pressure level attributable to the machinery only?

A. $6dB$

B. $41dB$

C. $43dB$

D. $45dB$

Refer to the table for Combining Two Sound Levels. The process for combining sound levels involves adding up to $3dB$ to the *highest* source, depending on the difference in sound level between the two sources. In this case, it is not immediately clear whether the background noise or the machinery is the louder source. Since the most that could be added to arrive at the combined sound pressure level

is $3dB$, it can be inferred that the background noise is not as loud at the machinery, as combining two $40dB$ sources would result in a combined level of only $43dB$. Therefore, the machinery must be louder.

Test values for the machinery between $41dB$ and $45dB$.

$$SPL_{machinery} = 41dB \rightarrow Difference = 1dB \rightarrow Combined\,SPL = 41dB + 3dB = 44dB \neq 46dB$$

$$SPL_{machinery} = 42dB \rightarrow Difference = 2dB \rightarrow Combined\,SPL = 42dB + 2dB = 44dB \neq 46dB$$

$$SPL_{machinery} = 43dB \rightarrow Difference = 3dB \rightarrow Combined\,SPL = 43dB + 2dB = 45dB \neq 46dB$$

$$SPL_{machinery} = 44dB \rightarrow Difference = 4dB \rightarrow Combined\,SPL = 44dB + 2dB = 46dB = 46dB$$

$$SPL_{machinery} = 45dB \rightarrow Difference = 5dB \rightarrow Combined\,SPL = 45dB + 1dB = 46dB = 46dB$$

Note there are two viable answer choices, $44dB$ and $45dB$. However, only $45dB$ is an answer choice.

Answer D

45.5 The octave band measurements of a fan are: $63Hz$, $64dB$; $125Hz$, $67dB$; $250Hz$, $63dB$; $500Hz$, $63dB$; $1000Hz$, $59dB$; $2000Hz$, $54dB$; $4000Hz$, $50dB$; $8000Hz$, $46dB$. What is the NC rating?

A. NC-45

B. NC-50

C. NC-55

D. NC-60

Refer to the Noise Criteria curves and use the figure to plot the sound pressure level in dB for each octave band frequency. The NC rating is the lowest curve which all measured values fall below.