## APPENDIX G—ALTERNATIVES FOR EVALUATING BENEFITS AND COSTS OF NOISE CONTROL

*Several sources have offered more detailed methods for evaluating the costs of noise and benefits of noise control. These methods involve diverse interpretations of how the costs of noise exposure are calculated, based on the individual needs of the organization for which the method was developed. They also include various additional steps and tools to help refine the organization's priorities or to help standardize the process. Section V.C—Economic Feasibility of Noise-Control Engineering presents one method for evaluating the feasibility of noise engineering controls, published by OSHA Region III. This appendix reviews four alternatives for evaluating the benefits and costs of noise control:*

- *American Industrial Hygiene Association (AIHA)—Benefits and Costs of Noise Control. In: The Noise Manual (AIHA, 2003; or latest edition); in the 2003 edition, see Chapter 9, "Noise Control Engineering"*
- *Additional detail: Driscoll, "The Economics of Noise Control Engineering Versus the Hearing Conservation Program"*
- *Example: Colgate-Palmolive, winner, 2012 Safe-in-Sound award*
- *National Aeronautics and Space Administration (NASA)—Buy-Quiet Roadmap*

### *G.1 AIHA—Benefits and Costs of Noise Control*

*In The Noise Manual, Chapter 9, AIHA outlines a procedure for comparing the benefits and costs of noise control (Driscoll and Royster, 2003).*

#### *G.1.1 The Noise Manual*

*The AIHA chapter recognizes that employers wonder:*

> *"What magnitude of noise reduction in the employees' TWA is possible, and is it worth doing?" That is, if an employee's TWA can be reduced by 3 dBA using noise control, should it be achieved?*

*The chapter encourages the reader to consider the potential magnitude of noise reduction and then prioritize efforts using a series of steps.*

*The first step is identifying realistic short- and long-term goals. A short-term goal could be to reduce the noise exposure of the most highly exposed workers to a level that makes it easier to protect them (e.g., with administrative controls or personal protective equipment). A long-term goal could be to reduce all noise exposure to nonhazardous levels, which can result in cost savings by eliminating the need for hearing conservation programs and additional worker*

> ***General Guidelines:***
>
> *General guideline 1: Most organizations will find that hearing conservation program costs average $350 to $400 per program participant per year.*
>
> *General guideline 2: Workers' compensation costs for hearing loss average about 0.2% of payroll. (Workers' compensation averages about 2% of payroll; 10% percent of that is associated with hearing loss compensation.)*
>
> *General guideline 3: Reducing compressed air pressure and volume used can reduce noise levels substantially and can also save on energy costs. It is almost always cost-effective. Other good opportunities for noise reduction are associated with routine maintenance and machine guarding (why not build in noise reduction at the same time?).*
>
> *General guideline 4: "As a criteria for an acoustical maintenance program, each machine should typically operate within 2 dBA of the minimum sound level of which it is optimally capable."*
>
> *Sources: Driscoll, 2010, 2012.*

*compensation expenses.*

*To set priorities, AIHA suggests that important considerations include:*

- *The number of workers affected by the noise source or sources.*
- *The potential for the noise to significantly damage their hearing.*
- *The characteristics of the noise, which can affect the control options. (Is it a pure tone? Impulse noise?)*
- *How likely it is that the intervention will succeed in meeting the organization's goals.*
- *Whether the control method will increase, decrease, or have a neutral effect on productivity.*
- *The estimated cost of the control, including purchase, installation, and maintenance.*

*Promoting a systematic evaluation, AIHA offers various factors that an employer can assign to these considerations and then process using an equation that divides the product of these factors by the estimated cost.*

### *G.1.2 Additional Detail: Driscoll—The Economics of Noise Control Engineering Versus the Hearing Conservation Program*

*One of the authors of The Noise Manual (AIHA, 2003, or latest edition) chapter, Dennis Driscoll, has outlined a method for determining the cost of a hearing conservation program in more detail. This method considers 18 costs in the annual hearing conservation program cost:*

- *Number of participants in the hearing conservation program*
- *Hearing protection devices*
- *Noise surveys*
- *Audiometric testing*
- *Audiometric follow-up and retests*
- *Recordability determination*
- *Worker training materials*
- *Calibration of acoustical instrumentation*
- *Calibration of audiometers*
- *Worker training time*
- *Worker hearing test time*
- *Hearing conservation program administrative time*
- *Maintenance of acoustical instrumentation*
- *Lost production*
- *Space allocation*
- *Expense to certify CAOHC (Council for Accreditation in Occupational Hearing Conservation) technicians*

***General guidelines provided by AIHA:***

*General guideline 1: Whenever possible, include noise control at the design phase (equipment or facilities). Considering noise exposure only at a later stage and then retrofitting existing equipment can cost more than 10 times as much as designing the noise control before construction begins. The cost of purchasing new production equipment comes into play somewhere between the two.*

*General guideline 2: Include maintenance expenses in the cost estimate—unless more specific information is available, assume that these can run about 5% per year (e.g., for 10 years).*

*Source: Driscoll and Royster, 2003.*

- *Medical record retention*
- *Workers' compensation*

*Using this method, the cost of the hearing conservation program does not include machinery (present or future).*

*In 2010 and 2011, approximately 100 professional industrial hygienists were given an opportunity to complete a worksheet on the costs of the HCP at their organizations. This exercise was part of a workshop on the economics of noise control engineering versus the hearing conservation program (Driscoll, 2010).*

*The worksheet results were quite consistent in showing that, using these 18 points as cost criteria, the majority of organizations spent $350 to $400 per year per worker in the hearing conservation program. Results for a few organizations, however, were substantially higher. The highest costs tended to be associated with fixed daily fees for services provided at multiple remote locations where few workers were employed (the highest hearing conservation program cost reported was $1,800 per worker per year). Costs were lower when these fixed fees, such as for audiometry van service to remote facilities, could be averaged over a larger number of workers. However, in general, the total hearing conservation program cost was not notably different for small organizations compared with large organizations.*

*In its next edition (estimated in 2013), AIHA's The Noise Manual will be updated to include some of these points.*

### *G.1.3 Example: Colgate-Palmolive—Winner of the 2012 Safe-In-Sound Award*

*NIOSH has partnered with the National Hearing Conservation Association (NHCA) to create an award for excellence in hearing loss prevention. This award is called the Safe-In-Sound award. Colgate-Palmolive won the 2012 Safe-In-Sound award through an extensive effort to reduce noise exposure in its facilities around the world (NIOSH, 2012).*

*With the assistance of a noise-control engineer and following the general principles outlined by AIHA, Colgate-Palmolive identified and prioritized noise sources. The process revealed that compressed air accounted for approximately 30% of the noise at production facilities and required approximately 15% of the energy. To help solve both problems, the company created "Noise, Energy & Maintenance" teams to help the company optimize system operation, minimize leaks, and assist workers in using compressed air appropriately. They planned to execute two noise reduction projects per year at many sites.*

*As of 2012, the company had completed 250 noise reduction projects across 60 facilities, investing $2 million. The results averaged approximately 6 dBA noise reduction per project (and up to 22 dBA for some projects). Noise exposure was reduced for more than 5,000 workers through these projects (the math suggests that this equates to an average cost of $400 per worker). Many of these projects also resulted in energy savings, cleaner facilities, and improved equipment life. One of Colgate-Palmolive's goals is to create a "Zero Hearing Protection" site. Because the company uses the ACGIH-TLV criteria (i.e., 85 dBA with 3 dBA doubling rate) or the local*

> ***General guidelines:***
>
> *General guideline 1: Plan to complete two noise-control projects per year.*
>
> *General guideline 2: Noise reduction projects often have additional benefits, such as reduced energy requirements, cleaner facilities, and improved machinery performance or service life.*
>
> *Sources: Driscoll, 2010, 2012. Colgate-Palmolive, 2012.*

*regulation, whichever is more stringent, this goal will reduce worker noise exposure to levels well below OSHA's permissible exposure limit (PEL) and action level (AL).*

*In an online presentation, Colgate-Palmolive provides a photojournal of noise-control projects and reports on the dBA levels before and after modifications. View this presentation at http://www.safeinsound.us/swf/colgate/index.html.*

## *G.2 NASA—Buy-Quiet Roadmap*

*NASA developed a comprehensive program to guide quieter equipment purchases. This program, termed the "Buy-Quiet Process Roadmap," is part of the NASA EARLAB Auditory Demonstration Laboratory website.*

*The Roadmap includes a simple spreadsheet application to help calculate the cost/benefit ratio for potential noise reduction projects. A white paper explains the approach used to determine the costs of exposing a person to noise for the length of a career (Nelson, 2012).*

*This method uses the following factors to estimate the cost of noise exposure:*

- *The TWA noise exposure (presumed constant over time).*
- *The net present value (NPV) of potential disability claims at the end of 30 years.*
- *The NPV of hearing aids and batteries that might be needed after retirement.*
- *The NPV of the hearing conservation program and personal protective equipment during the career.*

> ***General guidelines:***
>
> *General guideline 1: The cost of a dual-ear, full-disability claim across the United States reported in The Noise Manual (Berger et al., 2003) averages approximately $66,000 in 2011 dollars (assuming a long-term average of 4.2% inflation).*
>
> *General guideline 2: The net present value of the hearing conservation program and personal protective equipment (hearing-protective devices) may be set to $0 for TWAs below the AL.*
>
> *Source: Nelson, 2012*

*The white paper offers the following note about use of the NPV:*

> *The economic benefit of noise control is estimated by comparing the reduction of the net present value of noise exposure to the cost of the corresponding noise-control effort.*
>
> *For purposes of this paper, the discount rate for the NPV calculation is assumed to be 0% (inflation neutral). The NPV is then just the sum of the expected expenditures in today's dollars. This assumption translates in practice to the expectation that all inflated future costs will be paid with equally-inflated future dollars out of available cash accounts.*

*The white paper cites a 2006 study commissioned by the U.S. Navy titled Long-term Cost Benefit of Noise Control on Ships (Bowes et al., 2006). Extrapolating the cost per year and adjusting for inflation, the NPV of the hearing conservation program was determined to be $1,300 per year, or $38,000 for 30 years. This value is incorporated into NASA's cost/benefit calculations for noise-control projects.*

## *G.3 References*


*Berger et al. 2003. Hearing Loss Statutes in the United States and Canada. Chapter 18, Table 18.1, in The Noise Manual. 5th Edition. American Industrial Hygiene Association. pp. 692-696.*

*Bowes et al. 2006. Long-Term Cost Benefit of Noise Control on Ships. Document Number CRM D0014732.A2/Final. CNA Corporation. http://www.public.navy.mil/navsafecen/Documents/Studies/D0014732_A2.pdf.*

*Colgate-Palmolive. 2012. Presentation: Safe-In-Sound Excellence Award. http://www.safeinsound.us/swf/colgate/index.html.*

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*National Aeronautics and Space Administration. Buy-Quiet Process Roadmap. http://buyquietroadmap.com/buy-quiet-purchasing/buy-quiet-process-roadmap/.*

*Nelson, D. A. 2012. The Long-Term Cost of Noise Exposure. http://buyquietroadmap.com/wp-content/uploads/2010/02/Long-Term-Cost-of-Noise-Exposure.pdf.*

*NIOSH. 2012. NIOSH Update: NIOSH and NHCA present 2012 Safe-In-Sound Excellence in Hearing Loss Prevention Awards™. NIOSH Web page. http://www.cdc.gov/niosh/updates/upd-02-23-12.html. February 23.*