

What Causes Quiet Products to Come to Market?

Edgar Olvera, Robert D. Bruce, Adam Young, Arno Bommer and Isaac Harwell, CSTI acoustics, Houston, Texas

This article reviews why companies bring quiet products to the market. Is it due to laws limiting the sound at property lines, regulations limiting the noise emissions, lawsuits, union requirements, adverse publicity, market demand, or a host of other reasons? We will review the effects of laws at the federal level limiting noise emissions. Employee lawsuits relating to occupational exposure will be investigated along with lawsuits between neighbors. An example of how an employee lawsuit resulted in a manufacturer developing a quiet product will be reviewed. We will also review how corporate “buy-quiet” requirements have resulted in quieter equipment without a regulatory requirement.

It is always exciting for those of us in noise control engineering to see quieter products come to market – whether they are improvements of existing technologies or newly created quieter products. So what causes quiet products to come to market? It seems that in order for a manufacturer to build a quiet version of its product, certain external forces are required:

- Regulations – In their own country or in countries in which they wish to sell
- Law suits – Community annoyance or hearing loss due to workplace noise
- Worker’s compensation
- Third-party
- Corporate buy-quiet programs
- Market forces

Transportation

Aircraft. When jet aircraft began to fly into airports in about 1955, complaints and law-suits followed. The following quote from Technology for a Quieter America summarizes the situation succinctly:

“Complaints about aviation noise have a long history. In an introduction to a review of current activities by the Federal Aviation Administration (FAA) related to aircraft noise, Burlson points out that 2003 was the 100th anniversary of flight and the 92nd anniversary of the first editorial complaining about aircraft noise. The most serious problems arose in the late 1950s, when commercial jet aircraft came into service.

“In the past 50 years, considerable progress has been made in reducing noise emissions from aircraft – mainly through the introduction of high-bypass-ratio engines, which were driven by a desire to reduce noise emissions and increase fuel efficiency. A 2001 U.S. Government Accountability Office (GAO) report stated:

‘We currently estimate that the airlines’ costs directly attributable to complying with the transition to quieter aircraft noise standards ranged from \$3.8 billion to \$4.9 billion in 2000.’

The transition, over a period of 35 years, led to a 95% reduction in the number of people impacted by aircraft noise in the United States.

“Despite this progress, there are still noise issues around most of the nation’s commercial airports. In a report to Congress in 2000, a survey of the nation’s 50 busiest commercial airports indicated that noise was the number-one concern for 33 airports and was of some degree of concern in areas around 49 of the 50 airports”¹

And today, there are still concerns about noise around airports. Future aircraft (SAX-40 Concept Design) are expected to be quieter

This article has been adapted from the NOISE-CON 2016 submitted paper of the same name. It has been updated for publication in Sound & Vibration to include some data from a related paper that was presented at NOISE-CON 2016. These data were added as Figure 4.

by 25 dB and 25% more fuel efficient².

Vehicles. Both manufacturers and consumers want lower noise levels inside vehicles and in homes near highways. Rolls Royce named its cars with connotations of silence: Phantom, Shadow, Spirit, and Ghost. In the 1960s, Rolls advertised that the Silver Cloud (another silent name) was so quiet that the electric clock made the most noise.³ As a result of the Rolls Royce advertisement, Ford Motor Company retained Bolt Beranek & Newman to measure the sound level inside three 1965 Ford LTDs and two Rolls Royces. A Ford was quieter.⁴

Reducing the noise, vibration and harshness inside a car is still of interest to manufacturers and that also makes them interested in reducing the noise of tires and pavements. At speeds from 50-130 km/hr, the A-weighted sound level at 15 meters for light vehicles is dominated by tire noise, which is about 1 dB less than the overall noise.⁵ Better tires can reduce the A-weighted noise level by about 2 dB; better pavements can reduce the noise by 10-12 dB.⁶ Walls or barriers can provide greater noise reduction but at considerable expense.

Electric cars can significantly reduce traffic noise. On start-up, when stationary, and at low speeds (less than 18 mph), electric cars are quieter than engine-powered ones. So noise may have to be added to alert and orient people who might unknowingly try to cross in front of them. This will be a formidable challenge to standardize the sounds.⁷

Industry Equipment

There has been improvement in the noise environments of the industrial workplaces, but nowhere near the remarkable progress in noise control with aircraft or even traffic noise. OSHA regulates the noise exposure of workers, but no federal agency has regulated the noise emissions of industrial machinery. Lawsuits have been filed against employers on behalf of employees who have experienced hearing loss. Railroad, refinery, and paper mill workers, among others, have been compensated for hearing loss, but no machinery has been quieted as a direct result of such lawsuits. Third-party suits in which the individual with hearing loss sues

Table 1. FHWA roadway construction noise limits.

Limit, dBA	Equipment Description
55	Pickup truck
70	Generator (25 KVA or less)
73	Welder
77	Pumps
78	Slurry plant
80	Backhoe, bar bender, boring-jack power unit, compactor (ground), compressor (air), front-end loader, horizontal-boring hydraulic jack, soil-mix drill rig, vacuum street sweeper, vibratory concrete mixer
82	Concrete pump, generator (more than 25 KVA), slurry-trenching machine
83	Concrete batch plant
84	Flat-bed truck, dump truck, on-site soil-sampling rig, tractor
85	Auger drill rig, chain saw, concrete-mixer truck, crane (mobile or stationary), dozer, excavator, Gradall, grader, jackhammer, paver, pneumatic tools, rock drill, scraper, vacuum excavator (vac-truck)
90	Concrete saw, hydra-break ram, mounted impact hammer (hoe ram)
93	Clam shovel
94	Blasting
95	Impact pile driver (diesel or drop), vibratory pile driver

not his employer, but the manufacturer of the machinery, were unsuccessful in convincing most manufacturers to make quieter products. The only suit that may have impacted the noise of the product is a Mississippi suit against manufacturers of pneumatic tools in the 1980s.

Construction Equipment. The New York City Department of Environmental Protection incorporated the noise level limits from the FHWA Roadway Construction Noise Model 2 as the maximum allowable levels for construction equipment in NYC. Table 1 summarizes these levels. The limit is the A-weighted L_{max} noise level at 50 feet with slow time weighting. The limit for all other equipment with more than 5 hp is 85 dB at 50 ft.⁸

Manufacturing. In 1969-70, the National Machine Tool Builders Association developed a simple, uniform procedure for limiting the noise of machinery. In 1979-84, 80 dBA became the default sound level limit at 1 meter for the automotive industry to protect employee hearing. Anderson summarized that significant progress has been made, but a few things are still needed, including the “development of a uniform noise emission labeling system” as well as demonstrating the “case for added value of low-noise product.”⁹

Process Industry. The process industry has been dealing with noise issues since the 1950s. Many companies had hearing conservation programs before the creation of OSHA. In addition to hearing conservation, some of these companies have recently implemented programs to purchase quieter equipment with a limit of 80 dBA at 1 m.

Compressors. Dresser Rand saw an opportunity to sell significant single-speed compressors if there were a way to reduce the annoyance to nearby residents. The duct resonator array was the product that was developed; it can provide 10 dBA of noise reduction.¹⁰

Valves. Valves are ubiquitous in process facilities, and they

Table 2. Noise levels of home appliances adjusted for location of exposure (dBA in 1972).

Noise Source	Operator Exposure	Exposure to Others
Group I: Quiet Major Equipment and Appliances		
Refrigerator	40	32
Freezer	41	33
Electric heater	44	37
Humidifier	50	43
Floor fan	51	44
Dehumidifier	52	45
Window fan	54	47
Clothes dryer	55	48
Air conditioner	55	48
Group II: Quiet Equipment and Small Appliances		
Hair clipper	60	40
Clothes washer	60	52
Stove hood exhaust fan	61	53
Electric toothbrush	62	42
Water closet	62	54
Dishwasher	64	56
Electric can opener	64	56
Food mixer	65	57
Hair dryer	66	51
Faucet	66	51
Vacuum cleaner	67	60
Electric knife	68	60
Group III: Noisy Small Appliances		
Electric knife sharpener	70	62
Sewing machine	70	62
Oral lavage	72	62
Food blender	73	65
Electric shaver	75	52
Electric lawn mower	75	55
Food disposal (grinder)	76	68
Group IV: Noisy Electric Tools		
Electric edger and trimmer	81	61
Hedge clippers	84	64
Home shop tools	85	75



Figure 1. This 2011 ad by Bosch touts its German engineering of quiet dishwashers.

always come with specifications that list sound levels. Sound level data are routinely available from manufacturers of motors, compressors, gears, coolers, etc. In the 1960s, the steam emission valves on U.S. Navy submarines were very noisy and could be detected by enemy submarines. They also interfered with the ship’s sonar. Dick Self and a colleague left NASA and designed the drag valve, opened their own business, Controlled Components, Inc., and went to Navy Labs, which provided testing facilities. Additional incentives for producing quiet valves included both OSHA requirements and community ordinances. Today, all three major valve companies sell quiet valves and routinely report the data to their customers.¹¹

Pneumatic Tools. A 10-year law suit in Mississippi may have spurred pneumatic tool manufacturers to develop quieter pneumatic hand tools. The expense of these legal cases may have had a stronger influence than the corporations buying the tools. Pneumatic tool manufacturers were aware of the noise issues since they began measuring noise using a CAGI-PNEUROP test code since the early 1970s. The tool manufacturers might have even envisioned putting noise labels and/or vibration labels on tools, but the companies purchasing the tools might not have wanted the labels, because they would have identified the problems (noise-induced hearing loss and vibration-induced Raynaud’s disease).¹²

Home Appliances and Equipment

In the 1972 Report to the President and Congress on Noise,¹³ a table was given with typical noise levels of operator exposure for various home appliances; it is shown in Table 2.

Dishwashers. Bosch’s claim to have produced one of the quietest dishwashers (see Figure 1) seemed to have stirred interest among manufacturers in developing quieter dishwashers and in consumers to purchase them.¹⁴

Figure 2 presents screenshots from the websites of four retailers who sell dishwashers. In each, the consumer can sort the products by their decibel ratings.¹⁵⁻¹⁸

Figure 3 is a plot of the cost of various dishwasher models as a function of the sound level given by manufacturers.¹⁹ The noise level can be estimated from the price, using the following equation:

$$SLR = 120 - 23.9 * \log(USD) \quad (1)$$

where SLR is the sound level rating in dBA and USD is the cost in U.S. dollars.

Immediately following my presentation of this report at the NOISE-CON 2016 conference in Providence, RI, Kevin Herreman of Owens Corning Science and Technology presented on this specific topic based on his paper, “Market Effect on Sound Ratings for Dishwashers.”²⁰ In his paper, he also plotted a similar graph with the reported sound level ratings vs. the advertised retail price of a number of dishwashers from 2015. Figure 4 combines his points with ours from Figure 3 and presents a new noise-level estimating plot.

The sound level of the combined data points can be predicted with the following new equation:

$$SLR_{new} = 124 - 25.8 * \log(USD) \quad (2)$$

So why has there been such a push for quiet dishwashers re-

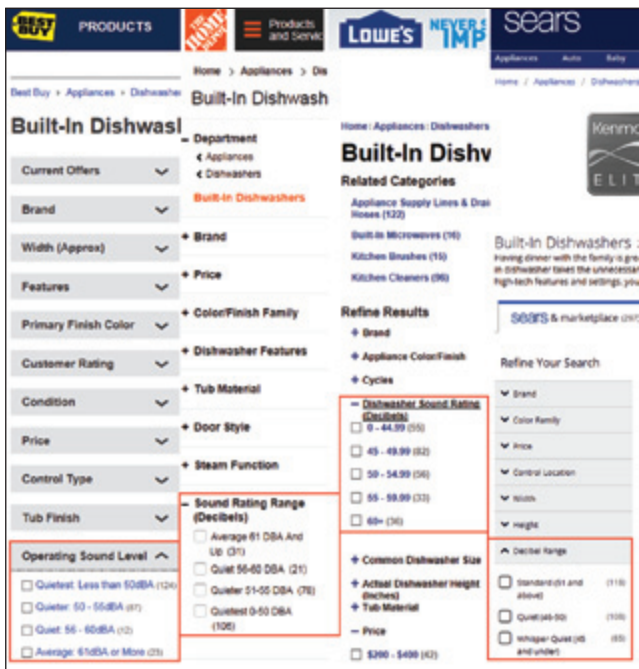


Figure 2. Screenshots from four different retailers allow sorting dishwashers by sound level.

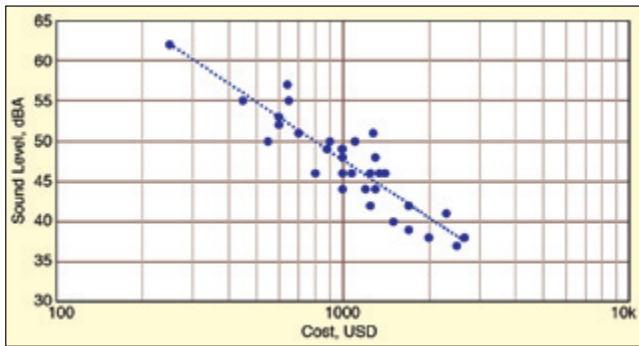


Figure 3. Cost in U.S. dollars of dishwashers with different sound level ratings in dBA.

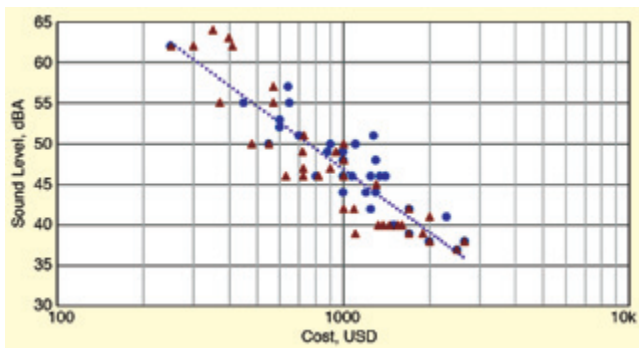


Figure 4. Cost in U.S. dollars of dishwashers with different sound level ratings in dBA.

cently? Some of this could be attributed to a rise in popularity of food culture (hundreds of cooking shows, eating organic, etc.). With this boom in cooking, people may wish to upgrade their kitchens or make them more “fashionable.” They’ve got to have the top-of-the-line equipment, especially one that helps with the most boring part of cooking: the cleaning.

In recent times, home layout has also been changing. Modern kitchens tend to be less closed off from the living or dining rooms, as homes seem to trend toward the idea of the open kitchen. This means that a larger area is affected by the noise generated by a dishwasher.

Another reason could be that since dishwashers run over long periods of time, people occupy themselves with other things during

Commitment | SoundTruth | How? | Guarantee | Next

The truth lies in the numbers. At least at Miele.

When soiling was introduced (simulating a true, at-home application), a leading manufacturer, who aggressively promotes low sound levels, recorded an increase of 6 decibel levels as compared to advertised sound levels. A significant and audible difference, given that noise levels double with every 3 dBs. Miele, however, measured up to the same, no matter whether the load was clean or soiled. No increase in decibel levels was reported, despite the performance requirement changes necessary to successfully handle the cleaning task at hand.

What was heard? The SoundTruth™ of a Miele dishwasher.

	Advised Claim™	Dirty Dishes
Miele® Diamond with Extra Quiet Program	37dBA	37dBA
Miele® Diamond®	42dBA	41dBA
Other Brand®	39dBA	42dBA

Miele® Crystal	46dBA	45dBA
Other Brand®	42dBA	46dBA

Miele® Classic	46dBA	46dBA
Other Brand®	44dBA	49dBA

The audible sound you hear doubles with every 3 additional decibels.

Based on independent lab testing conducted from 2013-2015. Units are tested installed in an enclosure, meeting the requirements described in Section 5.5.5 of IEC 60704-2-3 with the electricalhouse and area sealed with Acoustic 102 Quiet Seal.

1) Denotes model tested with Normal Program.
2) Brand claiming to offer the quietest dishwasher in the U.S.
3) Competitor claim based on cleaning a full load of unsoiled dishes.

Figure 5. Miele ad showing the “truth” behind the purported dBA numbers of its competitors.

this time. They could do so by watching TV, reading a book, conversing with others, etc. The noise from a loud dishwasher would certainly be disruptive to some of these activities. By comparison, a blender can be very loud but is usually manned by the person using it, focusing his or her attention entirely on the blending process instead of other things that could be disrupted by noise.

The last reason listed above for dishwashers could also be said about washers and dryers. In fact, there are a variety of “quiet” options for these appliances as well. But again, dishwashers seem to enjoy this push for quiet significantly more, which could be attributed to the fact that washers and dryers tend to be tucked away in a separate room that’s not as open to the rest of the home, even in modern designs.

Many people attribute the emergence of quiet dishwashers in the U.S. to Bosch and its advertisements. Having a line of quiet dishwashers for its European market, the company targeted the American market for quiet dishwashers and began an “arms race,” of sorts, among competing manufacturers. Nowadays, dishwasher manufacturers are fighting to beat their competitors by 1 or 2 dBA in the 37-39 dBA range. Ads can be seen attacking competitors over 1 or 2 dB, as shown in Figure 5.²¹ At levels this low, it arguably doesn’t matter much anymore. After all, noise levels for dishwashers have come a long way from a typical value of 64 dBA in 1972,

Table 3. Summary of factors affecting noise control.

Forcing Function	Aircraft	Highway	Autos	Construction	DRA	Valves	Pneumatic Tools	Dishwashers
Complaints	x	x		x				x
Lawsuits	x	x		x			x	
Regulations, USA	x	x						
Regulations, other				x	x	x	x	
Buy quiet								
Advertising			x			x		x
Opportunity			x		x	x	x	x

Summary

Almost all noise control efforts began because a select group of people complained about the sounds. In many cases, this effort led to legal actions that usually brought some localized relief (compensation). But in select instances, it resulted in regulations and laws requiring noise control to specified limits, so we have quieter airports, highways, and construction sites.


Interestingly, some noise control came about because the manufacturers saw opportunities to solve a problem and to be handsomely compensated. Table 3 is a brief summary of the progress of noise control from complaints to quiet products.

All of this progress in quieting home appliances raises the question of what will be the next noisy home appliance or tool to get the silent treatment? Manufacturers of clothes washers and dryers have already begun offering quieter options. We anticipate that the continued discussions of how noisy leaf blowers are will result in their being banned or their hours of operation being restricted, which may be the impetus for a quieter solution. Other appliances and tools that may be ripe for innovation are:

- Vent hoods
- Vacuums
- Oven heat distribution fans
- Home air compressors

The one area of home appliances where market forces have not had much effect is those noisy devices that bother the neighbor more than the user. This includes lawn mowers, leaf blowers, string trimmers, exterior air-conditioning equipment, and pool pumps.

References

1. *Technology for a Quieter America*, The National Academies Press, Washington, D.C., p.6, 2010.
2. *Ibid.*, p. 63.
3. "Shhh! Why Silence is Today's Most Precious Commodity," 2010, <http://nypost.com/2010/05/02/shhh-why-silence-is-todays-most-precious-commodity/>
4. 1965 Ford LTD TV Ad: Quieter than a Rolls Royce (online video), Daily Motion, <http://www.dailymotion.com/video/x2p6pci>, 2015
5. *Technology for a Quieter America*, The National Academies Press, Washington, D.C., p. 68, 2010.
6. *Ibid.*, p. 69
7. Don Norman, *The Design of Everyday Things: Revised and Expanded Edition*, 2014, Robert R. Anderson, "Application of Sound Level Specifications for Industrial Equipment" National Academy of Engineering "Engineering Responses to Hazardous Noise Exposures" August 14-15, 2008.
8. E. Thalheimer and C. Shamoan, "New York City's New and Improved Construction Noise Regulation," NOISE-CON 2007, Reno, NV, 2007.
9. Robert R. Anderson, "Application of Sound Level Specifications for Industrial Equipment" National Academy of Engineering, Engineering Responses to Hazardous Noise Exposures, August 14-15, 2008.
10. Bruce, Robert D., *Engineering Controls for Reducing Workplace Noise, The Bridge*, National Academy of Engineering, 2007.
11. Bruce, Robert D., "Engineering for Noise Control in Manufacturing, Progress and Failures in U.S. Manufacturing Noise Reduction, NAE Workshop, 2014.
12. Wasserman, D., "Vibration White Finger Disease in U.S. Workers Using Pneumatic Chipping and Grinding Hand Tools," *I: Epidemiology*, <http://www.cdc.gov/niosh/nioshtic-2/00171557.html>, September 1982
13. *Report to the President and Congress on Noise, Report of the Administrator of the Environmental Protection Agency in compliance with Title IV of Public Law 91-604*, The Clean Air Act Amendments of 1970, U.S. Government Printing Office, Washington, p. 2-124, 1972.
14. Bosch Ad, http://www.bosch-home.ca/Files/Bosch/ca/ca_en/Pagelimages/Promotions/1348_2011_Bosch_Dish%20Web%20PDF_ENG_WU3.pdf
15. Best Buy Image, <http://www.bestbuy.com/site/dishwashers/built-in-dishwashers/abcat0905001.c?id=abcat0905001>
16. The Home Depot Image <http://www.homedepot.com/b/Appliances-Dishwashers-Built-In-Dishwashers/N-5vc1vZc3nj>
17. Lowes.com (n.d.), <http://www.lowes.com/Appliances/Dishwashers/Built-In-Dishwashers/ /N-1z11pl0/pl#>
18. Sears.com. (n.d.), <http://www.sears.com/appliances-dishwashers-built-in-dishwashers/b-1020283>
19. Sheinkopf, S., "Quietest Dishwasher By Decibel Rating (Reviews/Prices)" Yale Appliance Lighting, June 2014, <http://blog.yaleappliance.com/bid/90427/Quietest-Dishwasher-By-Decibel-Rating-Reviews-Prices>
20. Herreman, Kevin, "Market Effect on Sound Ratings for Dishwashers," NOISE-CON 2016, Providence, RI, June13-15, 2016.
21. Mieleiframe.com (n.d.), <http://www.mieleiframe.com/Default.aspx?ID=137&PageID=301>. 

The author can be reached at: edgar@cstiacoustics.com.