

Now You Hear It ... Now You Don't



Airline passengers using noise reduction headsets can experience a new "zone of silence".

Noise cancellation technology has played a role in aviation for many years. It has been used in the cockpits of military aircraft since the early 1980's and subsequently found its way into the cockpits of commercial airplanes, helicopters, and private aircraft. In recent years noise cancellation headsets have also become popular additions in passenger cabins. Several airlines are now using them in conjunction with their IFE programming. Individual, travel-wise audiophiles carry them in their brief cases for use during flights. Nowadays, it's not uncommon to see an airline passenger wearing a noise-canceling headset and listening to ... nothing. While reading a book or magazine, sleeping, or just gazing out the window, the passenger hears almost nothing at all.

The term "noise canceling" headset is actually a misnomer. More correctly, it should be "noise reduction". What is it and how does it work? The term is creeping more and more into our industry, but not too many are familiar with what it's all about.

NOT A NEW THING

Noise reduction technology isn't new. It has been around since the dawn of man and it comes in two forms: passive and active. One demonstration of passive noise reduction is placing your hands over your ears. Passive noise reduction is simply keeping sound out of the ear canal. In its modern form in the IFE industry, it's embodied in the foam cushions that surround pneumatic and electronic headsets or in the plastic inserts that surround the tips of an in-the-ear headset.

The most marvelous form of active noise reduction technology that we experience emanates from that marvelous super computer called the human brain. The normal range of audibility for man covers about 10-1/2 octaves, from a lower limit of about 15 cycles per second to an upper limit of somewhat more than 20,000 cycles. Tones below the lower limit affect the human ear, but they give noisy effects and not distinct pitches. Tones above the upper limit are altogether inaudible. Generally speaking, two tones of equal volume but different frequency will not seem equally loud; this is true because the ear's sensitivity varies over its range. In the animal kingdom, the hearing range of humans is good, but far from the best. Animals, like cats and dogs for example, have a hearing range comparable to man's in the lower ranges but much greater in the higher ranges. They respond to tones of at least 60,000 cycles per second.

SOUNDS AROUND

We hear many sounds ... but that many can often be too many. Our brains have a marvelous way of "canceling out" many of those sounds and allowing us to hear selectively. If that weren't so, we'd probably go crazy. A mechanic can cancel out the sounds around him and concentrate on a specific sound in an engine. A mother's ear can be attuned to a baby's cry and sleep obliviously through other noises. Our brains have the fantastic capability of allowing us to concentrate on specific

sounds and cancel out other background noises. There is a limit, however, and there is a fatigue factor to be considered, especially at the noise levels today. One source said recently that the noise levels to which we're exposed have multiplied ten fold in as many years. We insulate our homes and offices, use acoustical tiles, close windows, etc. (passive noise cancellation), but we still hear many noises. Today, our hearing is almost constantly bombarded by the sounds of automobiles, lawn mowers, machinery, and a thousand whooshes, whirrs, beeps and chatters. Unless you've ever been enclosed in a totally sound-proofed area, you're always hearing noises (in that sound-proof room you'll still hear your heart and your breathing). Listen ... what do you hear? An air conditioner or fan, perhaps a highway or train in the distance, perhaps a computer. We take those sounds for granted and cancel them out. That's also true in an airplane cabin. Those sounds, primarily low frequency vibrations like the sound of the jet engines, can be annoying.

THE NEW TECHNOLOGY

Modern active noise reduction principles have been recognized since the 1930's. The first major patent was registered by RCA (Olson) in the 1950's for a headphone system with vacuum tube amplifiers. Personal noise cancellation devices became practical in the 1980's with the development of integrated circuit technology. Much of today's technology is a product of German engineering with names like Sennheiser and Bose at the forefront. Since the 1980's, there have been several thousand patents granted - many of them overlapping. The advent of digital signal processing capabilities and piezo ceramic actuators have led to an explosion of research and development. There are many exciting applications of this new science that have been and are being developed. The principle of this technology is based on a theory of what might be called noise and "anti-noise." It's been described as a kind of "Ying and Yang."

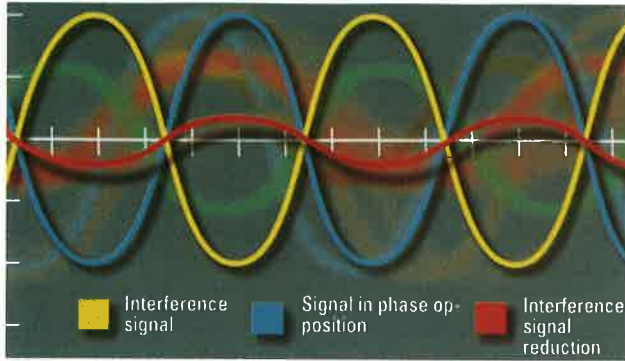
What we hear comes to our ears in the form of sound waves. The lower register sounds have waves spaced further apart, and higher register sound waves are closer together. Think of an oscilloscope. Sound waves also have loudness and timbre but we won't get into that here.



Noise reduction headsets are finding their way into many high noise environments. (Photo courtesy of Recoton)

That sound wave or cycle with its peaks and valleys forms a pattern that can be simple when it comes from a pure tone in a laboratory, but when it comes to us in its usual form, it is a complicated array of many waves and cycles. Noise cancellation technology "listens" to those sound waves, analyzes them, and

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In noise cancellation technology, original frequency and manufactured opposing frequencies collide and cancel each other out. (Diagram Courtesy of Sennheiser)

then produces sounds or waves that are 180 degrees opposed. That's the noise and "anti-noise", the "Ying and Yang." The opposing waves that are produced aren't heard by the ear. They cancel out the original waves, and, in theory, we hear nothing. Actually, we still hear some background noise, but we hear much less. The noise cancellation produces a "zone of silence." The headsets are generally programmed to address the low and mid-range frequencies because they are the prime offenders of background noise.

HEADSET VARIETIES

Noise cancellation or noise reduction headsets (the terms are used interchangeably) come in a variety of forms. In their simplest form, they have a speaker or driver in the earpiece just like a standard electronic headset. Unlike a standard headset, the earpiece also contains a tiny microphone. The microphone "hears" the sound near the ear, kicks it to a microprocessor that converts it to digital, analyzes it, produces the opposing sound, and sends it back to the speaker or driver, and we hear that "zone of silence". It all happens in a fraction of a second. Some noise cancellation headsets are of a "feedforward" type, some of a "feedback" type, and some incorporate a combination of both. The feedforward

models analyze the sound from a microphone located near the exterior of the earpiece and the feedback types analyze the sound inside the earpiece closer to the ear canal.

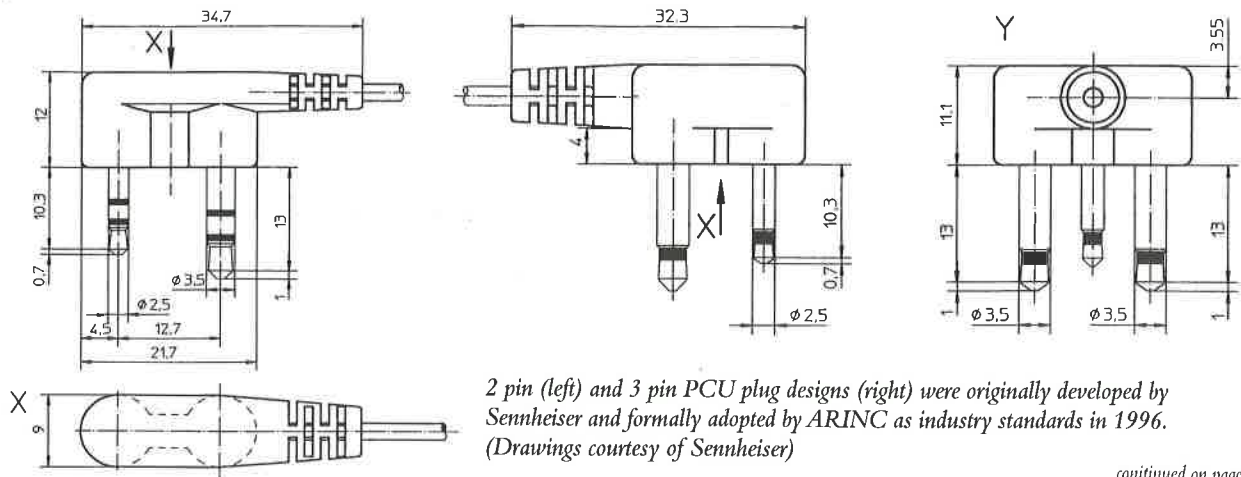
Of course, that all requires power. The power for some headsets being marketed to the airlines involves a "power-pack" that utilizes a 9 volt battery, a single AA battery, or two AAA batteries. Since battery power is consumed to make the headset function, batteries must be occasionally replaced. Noise cancellation headsets for airlines also come with plugs or connectors that not only pick up their audio signal from the PCU (Passenger Control Unit), but also pick up power from the seat. These specialized PCU's with power are available in two and three pin formats and are currently being produced by BE and Matsushita. The PCU's are also compatible with standard audio mini plugs or double/twin plugs. The ARINC standards for these PCU's were adopted by the AEEC and ARINC in 1996 as the result of needs for noise cancellation headset power requirements and are part of the ARINC 628 headphone specification (a follow-through of Sennheiser's original design).

One system of noise cancellation headsets not only depends upon its power from the PCU in the passenger seat arm rest, but also incorporates the noise cancellation microprocessor or integrated circuit board (ICB) in the arm rest. This makes for a less fragile and less expensive headset unit and a more durable system.

"At the beginning of 1995, Finnair put Sennheiser's noise canceling headsets into use, with the purpose of providing optimal listening comfort for our MD-11 Business Class passengers. We have used them on our Japan routes, and now that we have passed that initial phase, we are deliberating the option of adding noise canceling headsets to all long-haul flights. At the moment, we are out of stock, and they are not now in use while we source other manufacturers and examine our cost options. Our passengers have found noise canceling headsets to be very useful in reaching good levels of listening comfort. I can say that noise canceling headsets have given our Business Class passengers an additional value."
Tero Lohimäki - Finnair

FIVE SUPPLIERS

Five manufacturers are now courting the IFE industry with their noise cancellation headsets: Long-Prosper, Recoton, T Q Tradex, Sennheiser, and Sony. Sennheiser introduced its sophisticated NoiseGard® headsets at the 1988 WAEA Conference in Miami. Theirs was the first active headphone available as a series product. Previous to that, they had made strong inroads into the corporate jet and commercial jet cockpit market (boomsets). Their first customer for commercial airline passenger use was Air France in 1995. Finnair followed, and, last year, Sabena became a Sennheiser customer. Sennheiser is currently in "close discussion" with several major carriers in the US, Europe, and the Far East. Singapore Airlines also opted to go the noise cancellation route in 1996 and chose Recoton as its supplier. Just announced, United Airlines has recently selected Long Prosper as its noise cancellation headset supplier.



2 pin (left) and 3 pin PCU plug designs (right) were originally developed by Sennheiser and formally adopted by ARINC as industry standards in 1996. (Drawings courtesy of Sennheiser)

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Long Prosper's
NoiseBuster™ Headset
(Photo courtesy of NCT)



Recoton's Discwasher®
Headset, now in use on
Singapore Airlines



Sennheiser's HDC 45
NoiseGard® Headset, now in use
on Air France, Finnair, & Sabena
(Photo courtesy of Sennheiser)

Sony's MDR 5711 Headset
(Photo courtesy of Sony)



Long Prosper

The Long Prosper headsets are manufactured under a license issued to them by Noise Cancellation Technologies, Inc. (NCT). NCT's NoiseBuster™ technology has been promoted in the retail market, and the majority of headsets purchased by audiophiles in the US who use noise cancellation headsets for home and personal listening devices use NoiseBusters. This retail product, now listed at US \$69 is sold through The Sharper Image Stores and a number of mail order catalogs. NCT has extensive expertise in high-performance active noise reduction and active wave management for a variety of consumer, commercial, and industrial applications. One interesting application is manufacturing specialized NR (noise reduction) headsets for the medical market. Patients having to submit to Magnetic Resonance Imaging for diagnosis can find themselves in extremely noisy and claustrophobic confinement. Music played to them through noise reduction headsets can considerably ease their discomfort. Long Prosper has just introduced a new line of NR headsets (see Turntable). Their recent contract with United Airlines involves their LPE-40NC model, a fully integrated headset using a 2 pin plug, with the integrated circuitry contained in the passenger seat PCU.

Recoton

Recoton is a large, multi-national firm headquartered in the US with an extensive global operation and a host of well known subsidiary names in the audio business including Ross™, Jensen®, Calibron®, Parsec®, Discwasher®, and over a dozen more. They are primarily known for their large product line of consumer electronic accessories as well as home and automotive sound products. Their CD cleaner

"Noise Canceling headsets within Sabena were introduced in September, 1996, for our First Class passenger's comfort, but limited to our A340-200 fleet, currently operating North Atlantic and East African routes. The product has been described by our customers as a "mini-revolution" within the life onboard context. Now that we are planning to retrofit our wide-body aircraft into a two class configuration of Business and Coach, extension of such product to our Business Class passengers is under scrutiny for the coming months. The idea is still on a project status for our new coming fleet (A340-200/300 & A330-200/300) but, of course criteria such as the high cost to cover the extended Business Class cabins will be carefully taken into consideration before any decision in that respect is made."
Phillippe Falize - Sabena

Discwasher is a well known product, and that rather unconventional name for an airline item is also attached to the NR headset now being marketed to the IFE industry. They also market their headsets to manufacturing corporations who provide them to employees working in high noise environments and to the consumer market (one of their publicity photos shows a home owner wearing a Discwasher headset while mowing the lawn). Singapore's purchase of the Recoton Discwasher headset was announced in December of 1996 and that airline is now using it in their First Class cabin. The Recoton headset can feed power from a 9 volt battery in a power pack (an advertised 35 hour life) or, as in the case with Singapore Airlines, their NRH 200 model has been modified with a polarized plug for use in a PCU. The NRH 200 employs two microphones in each earcup to sense constant environmental noise in a specified band of low to mid frequencies. Singapore is the only airline currently using the PCU as a power source for its headsets.

T Q Tradex

T Q Tradex previewed their NR headset for the airline industry in its prototype form at the 1996 WAEA Conference and is now actively marketing their TQT - 3000 models. Their technology emanates from a well established noise reduction firm in Australia that carries the recently registered name of QuietTech®. T Q manufactures the

"Customised to our requirement, our ANR headset is unique in design and exceeds the expectations of many of our passengers in enhancing sound quality. Its effectiveness in reducing background noise is such that a few passengers actually use it to sleep."
-Singapore Airlines

TQT - 3000 under a licensing arrangement that grants them exclusive rights for world-wide marketing and distribution. Their headset, incorporating both feed-forward and feedback technology, is symmetrical (no left and right side) and

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available in two formats. Both using a single-side wire with electronics contained in the headband, one format utilizes a power pack with a standard 9 volt battery and the other feeds power and the audio signal from a standard 3 pin plug. For airlines, a headset that pulls power from a PCU has one definite advantage. The "walk-off" factor (that wonderfully euphemistic term for "theft") is greatly reduced. TQ also touts another advantage for airlines in the non-availability of their headset in a format that depends upon integrated circuit boards (ICB's) in the passenger's armrest. They feel it is a benefit to not ask an airline to commit to the considerable capitol expense of converting their PCU's to an ICB format in view of today's rapidly changing technology.

Sennheiser

Sennheiser, a company originally founded in 1945, has been a leader in audio technology for years. Their microphones are omnipresent on sound and theatrical stages around the world, and the number of Sennheiser headsets sold runs into many millions. They've amassed a large collection of awards including an Academy of Motion Picture Arts & Sciences Scientific and Engineering award. Their entry into the airline headset arena began in 1980 when Swissair became their first airline customer. Since then, they've added several dozen international carriers. Their concentration on excellence carries over into noise cancellation headsets (they call it "active noise compensation"), and they were the first to introduce them to the IFE industry in 1988 when they previewed a prototype at a WAEA Conference. They were also the first company to sell them to an airline. Air France, Finnair, and Sabena passengers have all purchased Sennheiser's NR headsets. The Sennheiser 2 pin and 3 pin PCU plug designs for both power and audio signals were also adopted as the industry standards. The Sennheiser HDC 45 NoiseGard® headset features a single-sided cable and is available in 2 pin and 3 pin version. They also supply the HDC 45 with a power pack that holds two AA batteries. The HDC 45 has excellent frequency response. It's light, rugged, and comfortable.

Sony

Sony's reputation for excellence in the consumer audio and video markets carries through in their headset line. Sony's noise canceling headsets are used by the thousands in cockpits of commercial and private aircraft throughout the world. They're designed to withstand the rigors of daily use in the cockpit and feature advanced ergonomic design for long hours of extended use. Sony introduced its noise canceling headsets to the IFE industry in 1996. They now offer two models: MDR 5711 and MDR 5720 to airlines. Both models have been available with a power pack that uses one AA battery (50 hour estimated battery life) with standard audio mini plugs or double/twin plugs. At the WAEA Orlando Conference, they will be introducing their new 2 pin and 3 pin plug models that pull power from the PCU. They use feed-forward noise canceling architecture on both models. The difference between the two is that the premium MDR 5711 model has somewhat larger ear cushions for superior passive reduction and a 40mm driver. The MDR 5720 has a 30mm driver.

COST

Noise Reduction headsets are "relatively" expensive when compared with standard pneumatic or electronic headsets ... or even some of the high end electronic models available. The old adage "You get what you pay for" is appropriate here because what you get is a far cry from pneumatic or standard electronic headsets. They remain a premium class passenger amenity, and it's a fairly safe bet that it will be quite a few years before they'll be appearing system-wide in Coach. It's also a bit unfair to tie down the NR suppliers to a cost figure appearing in an article such as this. There are wide fluctuations in pricing ... primarily dependent upon quantities quoted. A high end price quote could reflect the cost of one and a low end quote could be for many thousands. That fact notwithstanding, when AVION asked for figures, they came out like this:

Long Prosper....."US \$20. - \$50."
Recoton....."not disclosed"
T Q Tradex....."US \$30. - \$100."
Sennheiser....."US \$80. - \$95."
Sony....."US \$55. - \$87."

If those costs seem high, consider the cost of the headset manufactured by NCT for the medical field and magnetic resonance imaging noise compensation. That system runs into several thousand dollars,

but it is also very specialized and must be manufactured with non-ferrous components. The flip side is the prediction of Mr. Chris Todter from QuietTech®, "Airline noise reduction headsets have the long term potential of costing under \$10." That "long term potential" is based on greatly increased usage by the airline industry; usage that will definitely increase as more airlines jump on the Noise Reduction band wagon. They will surely do that as competition drives usage up and prices down.

IN THE FUTURE

Doubtless, you will be hearing more (or should that be "less?") as noise reduction technology becomes more commonplace. The President of the United States can now sit in a "zone of silence" onboard Air Force One as he makes or receives telephone calls. Los Angeles is testing "anti-noise" on some of its freeways. There are tests now being conducted on automobiles involving the replacement of mufflers with noise reduction microphones and speakers adjacent to tail

pipes with microprocessors built into the cars' electronic systems. NCT is currently supplying large power generating plants with noise reduction systems that attach to dynamos and substantially reduce the tremendous low frequency noise being generated. Irene Lebovics, Sr. Vice President at NCT says, "We can envision a day when the entire passenger cabin of an airplane will be equipped with a noise reduction system. It will generate a remarkable new quiet and a new level of airline passenger comfort."

The proof is in the trying and AVION suggests that you visit the noise reduction headset suppliers in Orlando for a demonstration and "listen" to the quiet.

"United Airlines is constantly searching for new ways to improve service for its worldwide customers. In support of this goal, beginning this fall, noise cancellation technology will begin to be offered in First and Connoisseur Classes on international aircraft. This will include all of United's 747-400's, 767-300's, and 777 long range aircraft. United is working in conjunction with B/E Aerospace and Noise Cancellation Technologies, Inc. to create a system which has noise reducing electronics included in the passenger seat. This system will be paired with specially designed Long Prosper headsets enabling customers to better enjoy the video and audio programming or simply block out the ambient noise. United is the first airline to implement this type of integrated technology. The noise canceling system is being installed concurrently with the BE2000M distributed video system. Installation begins this fall on the 767-300 and 747-400 fleet and will be complete on all three fleets by early 1999."
Mary Rogozinski - United Airlines

