

Tips & Tools

for Fitting and Using E-A-R™ Foam Earplugs



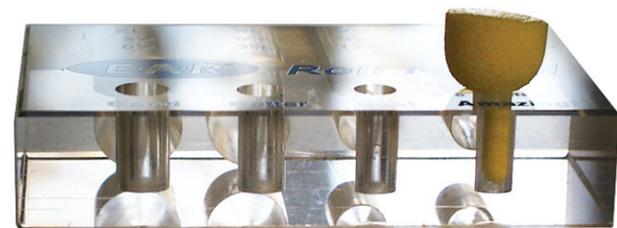
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Introduction

E-A-R™ employees invented foam earplugs. Since its introduction in 1972, the E-A-R™ Classic™ vinyl (PVC) one-sized foam earplug has come to be regarded as one of the most comfortable and effective hearing protectors available. 3M also offers a variety of other foam earplugs such as two-sized versions, as well as polyurethane (PU) foam earplugs (typically a shaped product with a smooth surface texture) for those who prefer the style and features of such earplugs. This booklet primarily pertains to E-A-R PVC foam earplugs, but is also largely applicable to all types of foam plugs. Certain key functional differences between PVC and PU plugs will be indicated as appropriate.

Even though foam earplugs are among the most forgiving of products when insertion techniques are less than adequate, proper fitting is still essential to obtain the best results. Through years of experience we have learned much about user education and training, and the problems that may occur in practice, and have devised tools (the Roll Model demonstrator/trainer and the Eargage™ fitting device) to aid in the training process. This booklet will assist you by providing a comprehensive step-by-step guide to E-A-R foam earplug utilization, as well as information on the Roll Model demonstrator and Eargage device, and how they can be incorporated into the educational process.



The Roll Down: Preparing a Foam Earplug for Insertion

Hands and plugs should be clean prior to use. Begin by rolling the plug into a very thin crease free cylinder. The cylinder should be as small in diameter as possible, that is, as tightly compressed as you can make it. Do not worry about hurting the plug — it is designed to be compressed in this way.

Crease-free rolling is accomplished by squeezing lightly as you begin rolling, then applying progressively greater pressure as the plug becomes more tightly compressed. Make sure you roll (not twist), the plug into a cylinder rather than any other shape such as a cone or a ball.

The plug is best rolled between the fingertips. One method is illustrated in Figures 1 and 2, with an alternative in Figure 3. Another option, for those with less finger strength, is to use the thumbs and forefingers of both hands as shown in Figure 4.

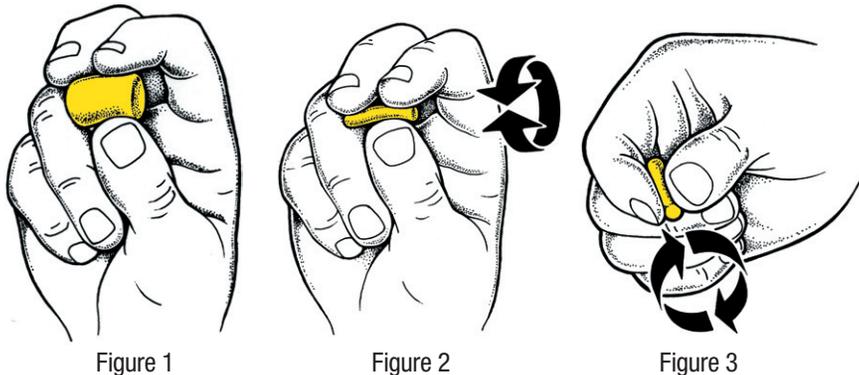


Figure 1

Figure 2

Figure 3

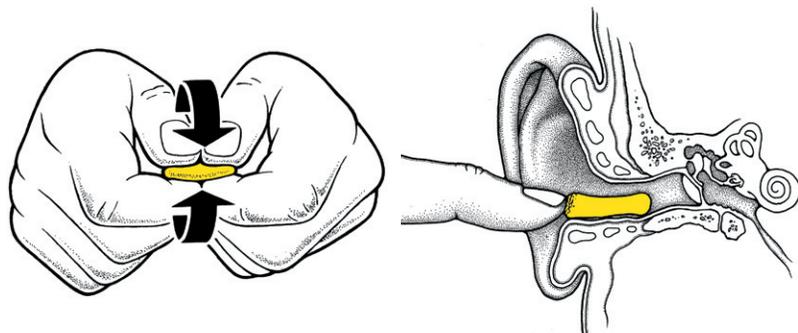


Figure 4

Figure 5

Inserting Foam Earplugs

Once an E-A-R plug has been properly rolled and compressed, immediately insert it well into the ear canal. The importance of compressing the plug tightly is that insertion into the ear canal can only be achieved when the plug's diameter is less than the canal's.

The plug then slides easily into place (Figure 5). As with all earplugs, fitting is easier if the ear canal is straightened and enlarged by pulling the outer ear (pinna) outward and upward during insertion (see Figure 6). Pull the pinna firmly, usually in the direction the ear extends from the head. Don't just press it flat against the skull.



Special Pinna Tip

A correct pinna pull is especially helpful. If the plug doesn't slide into the canal, keep trying to insert it as you continuously change the direction of pinna pull (up, out, back, etc.), until the plug slides into place.

Plugs should be inserted into the right ear using the right hand and into the left ear with the left hand. The pinna should be pulled with the opposite hand by reaching behind or over the head. This allows the hand inserting the plug to have the best line of approach for proper fitting.

After insertion, it may be necessary to hold the plug in place with a fingertip for a few moments until it begins to expand and block the noise. This is not intended to keep the plug from backing out of the ear canal, since properly inserted E-A-R plugs do not in fact exhibit such a tendency, but rather is to assure that the plug does not slip or dislodge prior to enlarging enough to hold itself in place.

Once a plug has begun to expand, neither pushing nor twisting it will improve its fit. If the initial fit is inadequate, remove the plug, reroll it, and try again.

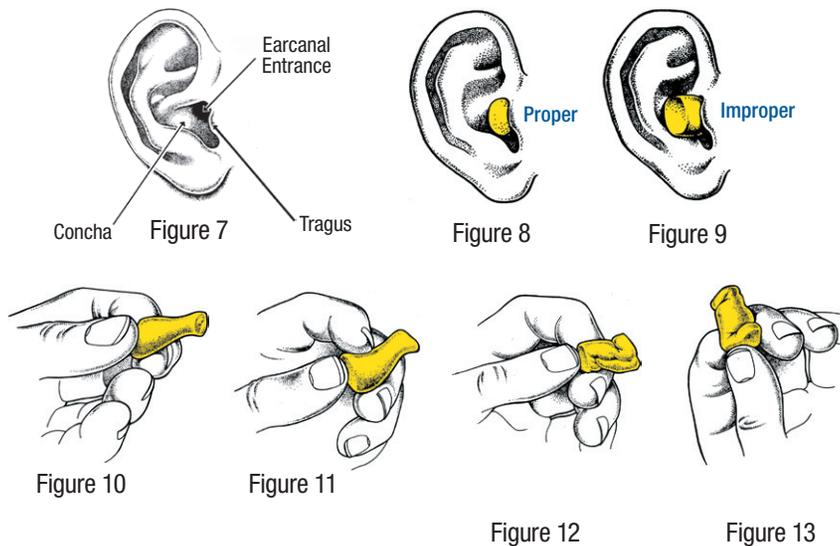
Occasionally when a foam plug is first inserted, it may be slightly uncomfortable if fitted deeply. Because a rolled-down plug is longer than an uncompressed plug (which is easily demonstrated by placing rolled-down and uncompressed plugs side by side in the palm of your hand), it will shorten as it expands and withdraw from portions of the ear canal upon which it initially may have impinged. Therefore, instead of reacting by immediately withdrawing a deeply fitted plug, it is better to wait 30 seconds or so for it to expand to see if the discomfort subsides; if not, withdraw the plug slightly.

Assessing the Fit

The fit of an E-A-R foam plug can be assessed in three ways. The most simple, but least accurate method, is to visually (for the fitter) or with fingertips (for the wearer), check whether the end of the plug is resting beyond the tragus and in the concha (Figure 7). If the outer end of the plug is flush with or slightly inside the tragus, this generally indicates that at least half of it is in the canal and the fit is proper (Figure 8). If most of the plug projects out of the concha, the fit is probably improper (Figure 9). Since the length of various foam earplugs as well as tragus-to-ear-canal dimensions can vary substantially, this check is not a foolproof indicator.

Another test that either the wearer or the fitter can perform is to remove an earplug after it has expanded in the ear for about a minute. For a few seconds the plug will maintain the shape of the ear canal. This will be easier to see for plugs fitted in smaller ear canals; in larger ear canals, or with small-size foam plugs in medium or larger ear canals, the impression on the withdrawn plug will be less noticeable. Examination of the “molded” plug should show that at least one-half of it was in the ear canal and that it was neither squashed, creased, nor wrinkled. This indicates a good fit as illustrated in Figures 10 and 11. By contrast, Figures 12 and 13 depict creases and fold-overs that indicate the plugs have been improperly inserted.

Finally, the plugs' noise reduction can be tested subjectively by pressing firmly cupped hands over the ears while listening to a steady noise. With properly fitted plugs the noise levels should seem nearly the same whether or not the ears are covered.

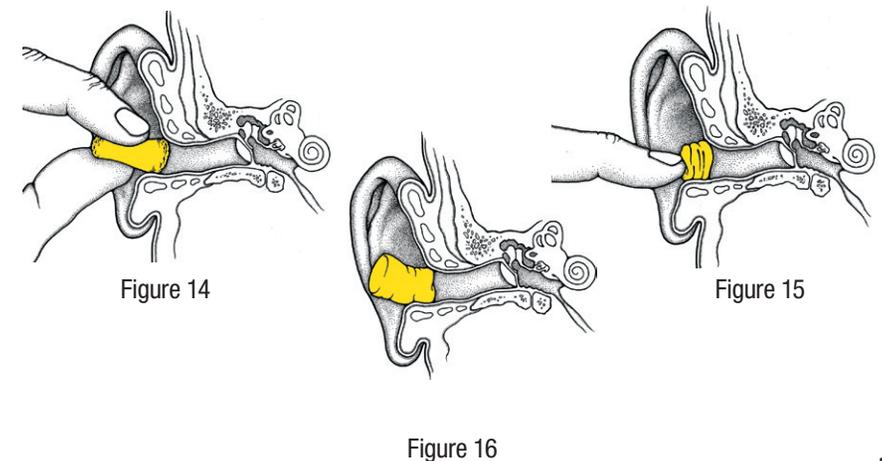


Problems Fitting Earplugs

The primary causes of poorly fitted E-A-R plugs are inadequate roll-downs, and/or too much delay between roll-down and insertion. The Roll Model (see next section) helps to overcome this by providing a means to demonstrate and practice rolling and compression. However, actual fitting is required to become adept at properly pulling the pinna and aiming the plugs in the correct direction for insertion.

If one attempts to push in an improperly rolled down or already partially expanded plug, it will likely be squashed flat at the entrance of the ear canal (Figure 14, 15). As it expands it will appear to back out of the canal (Figure 16). In fact, the portion in the entrance to the canal stays in place as the plug's outer end expands to regain its initial length. Remove the plug, re-compress it, and try again. This type of insertion problem is less likely to occur with vinyl (PVC) than with polyurethane (PU) foam earplugs, since PVC plugs have a more suitable stiffness when fully compressed and a more well-controlled recovery characteristic; PU plugs are sometimes too soft, and in high humidity can expand too rapidly for proper insertion.

Occasionally, wearers with larger ear canals may push a foam plug in so forcefully and quickly that it becomes difficult to grasp and remove. This may be uncomfortable and inconvenient, but it is not dangerous. Simply have a member of the medical staff or a designated person use a small tool such as tweezers to carefully grip the end of the plug and slowly withdraw it. Next time, the plug should not be pushed in as quickly or deeply and it should be held more carefully as it is inserted, or it should be rolled into the shape of a golf tee to provide a specific stopping point for the insertion. Another alternative is to purchase corded foam earplugs.



The Roll Model: Improving Your Roll Down

The Roll Model is both a training aid and a product demonstration device (Figure 17). For instruction, the *Practice Holes* in the front face of the Roll Model (labeled *Good*, *Better*, *Best*, and *Amazing!*) serve as a gauge to evaluate a plug roll down. We have found that not only the wearers of foam earplugs, but hearing conservationists and hearing protection issuers as well, are often surprised at how small and tightly an earplug can be rolled and compressed. So too, they are often unaware of how important a tight and crease-free roll down is for proper insertion and maximum protection.

For purposes of illustration, the *Demonstrator Holes* in the top of the Roll Model (labeled XL+, XL, XS, and XS-) which correspond to extra-large and extra-small earcanals, are useful to compare the sizes of earplugs that are being considered for purchase. This can be particularly illuminating when comparing various one-size products on the market today. See the section titled *Using the Earcanal Demonstrator Holes in the Roll Model*.

Using the Roll Model for Training and Practice

Roll down an E-A-R plug and, while it is still tightly compressed, try to insert it into one of the four Practice Holes **until it touches the bottom**. If it does not fit on your first attempt, you will need to re-roll the plug and try again.

For most wearers the plug will need to be rolled tightly enough to fit into at least the *Good* hole for them to be able to insert it properly into their earcanal. In most cases, compressions that allow insertion into the *Better* and *Best* holes will increase the likelihood of easily and correctly fitting real earcanals for optimum protection. The hole labeled *Amazing!* has been

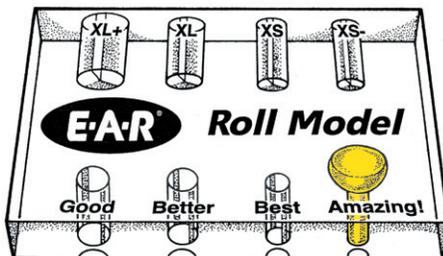


Figure 17

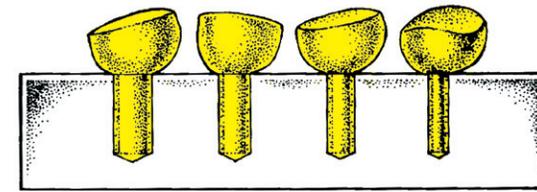


Figure 18

included for those who appreciate a challenge. A roll-down this small is usually not necessary for insertion. However, such a roll-down does not hurt properly designed foam earplugs, and it can ease insertion for especially small or difficult-to-fit earcanals.

A correct insertion into the Roll Model, as in a real earcanal, will be characterized by a plug compressed tightly enough that it will slide easily into place. Once inserted, it will be free of creases and wrinkles as shown in Figure 18.

Additional Roll Model Details

The diameters of the Practice Holes in the Roll Model vary from 0.26" to 0.20" as shown in Figure 19. By comparison, the diameter of the average adult earcanal is 0.35" (9 mm), the diameter of the E-A-R Classic and Classic Plus foam earplugs is 0.54" (13.7 mm), and the more diminutive Classic Small foam earplug is sized at 0.50" (12.7 mm). The Practice Holes are drawn life-size in Figure 19, so that in the absence of an actual Roll Model the user can still have a means of comparing his or her roll-downs to the recommended dimensions.

○	○	○	○
Good 0.26" (6.5mm)	Better 0.24" (6.0mm)	Best 0.22" (5.5mm)	Amazing! 0.20" (5.0mm)

Figure 19: Dimensions of the practice holes

The depth of the Roll Model Practice Holes is 0.48" (12 mm), or about 1/2 the length of the typical adult earcanal. Placing an E-A-R plug into one of the holes so that it bottoms out represents the depth of insertion in real earcanals that is normally achieved by experienced subjects in our laboratory. Stated in another way, laboratory-rated protection is usually only attained when a crease-and wrinkle-free E-A-R Classic Plug is inserted so that at least one-half of its length resides in the earcanal. The closer a wearer's insertion approaches or exceeds this ideal, the greater the likelihood of obtaining optimum protection.

Using the Earcanal Demonstrator Holes in the Roll Model

Many factors, such as materials, shape, and dimensions, influence the success of an earplug in comfortably fitting and protecting a wide range of adults. In particular, with one-size-fits-most earplugs like many of the foam earplugs sold today, development and design of the proper size is important. In an attempt to make plugs seem more comfortable, the manufacturer can undersize the diameter, the liability being that those with larger earcanals may receive inadequate attenuation. When using PU foams, which feel softer in the hand but are actually more dense than their PVC counterparts, the plugs may not be able to be sufficiently rolled down for easy and proper insertion in the smaller and/or more convoluted earcanals. The Roll Model block can be used to examine these possibilities.

In addition to the four Practice Holes on the front face, the block includes four Demonstrator Holes on its top face. Those holes, with size designations XL+, XL, XS, and XS-, represent the dimensions of earcanals from their entrance up to and including about 1/3" (9 mm) inside that point. The values, drawn from a study of nearly 600 adults examined in the E-A-RCAL acoustical laboratory, are tabulated in Table 1. Following the table, examples of inferences that can be drawn from use of the Roll Model are provided.

Table 1:
Percentage of population with earcanal sizes corresponding to the Demonstrator Holes

Hole Designation and diameter (mm)	Male (%)	Female (%)
XS- (7.2)	1	5
XS (7.7)	8	13
XL (11.4)	9	3
XL+ (11.9)	2	0

Example 1: E-A-R Classic foam earplug

The very largest earcanals are represented by XL+ (2% of males), or XL (9+2=11% of males). Note how a modest roll down of the Classic foam plug allows it to fit those holes. Once expanded, it is snug and seals properly as shown in Figure 20.

Roll the Classic as tightly as you can and note that it is possible to insert it in the *Best* and for many people, the *Amazing!* holes, indicating the plug's ability to also properly fit the tiniest of earcanals. Compare the *Amazing!* hole to the canal size hole labeled XS (5% of females), and note that although the *Amazing!* hole is somewhat smaller, such a diminutive diameter for a rolled-down plug will be useful, perhaps necessary, to fit very small and/or tortuously shaped earcanals.

This example of the use of the E-A-R Classic in the Roll Model block demonstrates the plug's excellent ability to fully, safely, and comfortably fit the widest possible range of earcanal sizes with a single-sized product. Although a smaller single-sized plug could have provided marginally better comfort in the smallest of earcanals, the protection that would have been lost for those with larger earcanals was deemed unacceptable. Hence, the current optimized dimensions of the original one-sized Classic product. Today, however, we offer a slightly smaller version, not suitable for a XL earcanal, which is called the Classic Small earplug.

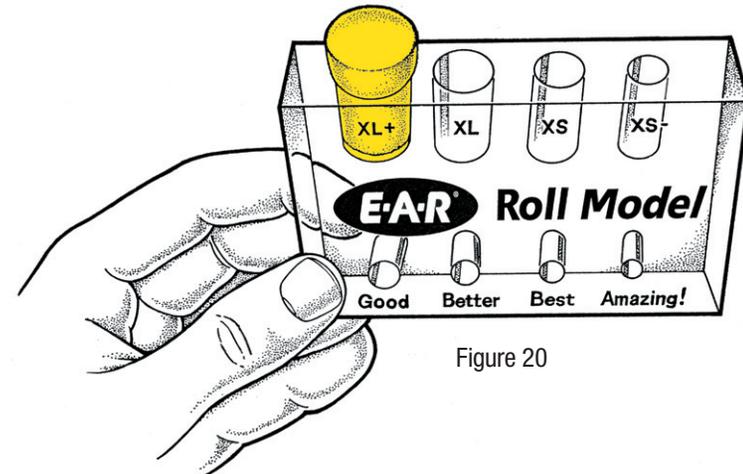


Figure 20

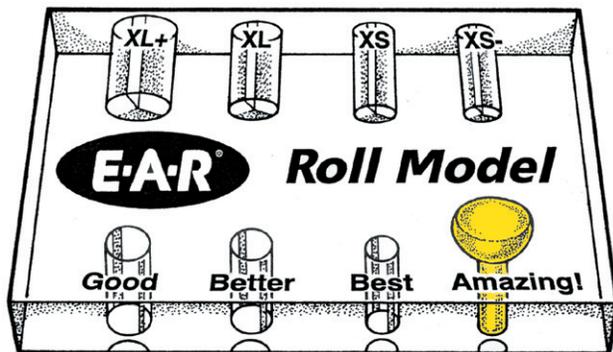
Example 2: Molded/shaped urethane foam earplug

Many of the one-sized designs sold today are simply too small for the larger male earcanals. Drop one in the XL+ or XL holes and note how sloppy the fit is. Often, when the Roll Model is turned upside down, the plug will simply fall out. Although it is true that many earcanals do taper as the eardrum is approached, the fact that a plug fits loosely in the XL+/XL holes suggests that in a noticeable segment of the population it may not provide an adequate seal, or it may need to be inserted too deeply to conveniently, comfortably, and consistently block sound.

Although molded PU foam earplugs feel softer in the hand than do their PVC counterparts, comfort studies demonstrate that in-the-ear assessments show little difference between the products. Furthermore, PU plugs are normally about twice as dense, which means they cannot be rolled to as small a diameter. This can inhibit proper insertion as can be demonstrated by comparing the smallest Practice Hole into which PVC and PU plugs can be inserted. Normally, PVC plugs can be inserted into a hole that is one size smaller than can be fitted by their PU counterparts, even though the polyurethane plugs may be a smaller-sized product in its uncompressed state.

Example 3: Premolded earplug

The Demonstrator Holes can also be used to estimate the ability of premolded, fiberglass, or other types of earplugs to successfully fit the population extremes. Note for example how the E-A-R UltraFit™ earplug handily fits the XL+ and yet also can be fitted to a depth of 1-1/2 flanges in the XS- hole. Likewise, the Express™ Pod Plugs™ can also successfully fit both of those hole sizes. Can the other products you are assessing do the same?



The Eargage Tool: Use in Size Selection

When two-sized foam earplugs are utilized, selection of the proper size product is a concern if optimum protection is to be obtained. As a guide in estimating earcanal sizes, 3M makes available the Eargage™ tool that consists of plastic spheres of increasing diameter mounted on plastic shafts [approximately 1-mm increments from 7 mm for the extra small (XS) to 11 mm for the extra-large (XL)], as illustrated in Figure 21.

To use the Eargage tool start with a ball that appears to be a close match to the earcanal. Pull the pinna outward and upward while inserting the ball into the canal, with the tab pointing to the back of the ear as shown in Figure 22. The tab of the gauge should not enter the earcanal. It should rest on the flesh directly to the rear of the entrance of the earcanal. If the ball and tab can both slide into the earcanal, try larger sizes; if the ball cannot be inserted far enough, try smaller sizes. The best fitting ball indicates the approximate size of the earcanal. Each ear should be sized individually.

When working with two-sized E-A-R brand foam earplugs, persons with larger earcanals (L and XL) should wear the larger-sized products; those with smaller earcanals (S and XS) should wear the smaller-sized products. Those persons with intermediate sized earcanals (M) can wear either size, whichever works best for them. Final size determination should be made by fitting the actual plugs into the ears. Plugs may be judged to be too small if when removed from the earcanal no sign of deformation can be observed in the product; too large if they create substantial discomfort when properly fitted. Figures 10 and 11 depict suitable amounts of deformation.

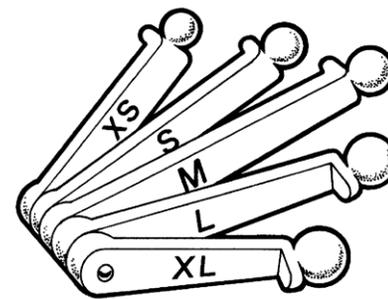


Figure 21

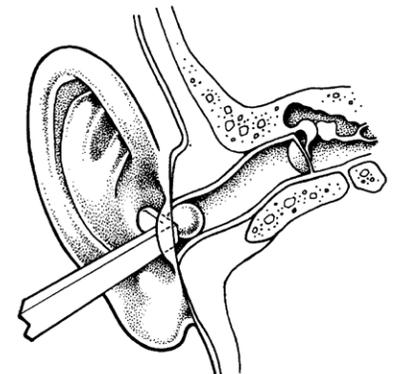


Figure 22

Benefits of a Proper Fit

The most obvious and important benefit of training and motivating employees to better wear foam earplugs is to improve their real-world protection to more closely approach laboratory-rated values. But, there are also two important collateral benefits that should not be overlooked!

Better Comfort

Properly fitted foam earplugs tend to be more comfortable than poorly fitted ones since better (more deeply) fitted plugs feel more snug and secure. A fuller insertion also allows the foam to distribute its force more evenly along the canal walls. This is, of course, contrary to experience with premolded and custom molded earplugs for which a deeper and tighter fit is typically less comfortable.

Less Body Sounds

Wearers often object to hearing protectors because of the “occlusion effect.” This effect, arising from blockage of the ear canal, causes wearers’ perception of their own voices and body sounds to be amplified and distorted. The distortion is characterized by a boomy, hollow, resonant sounding voice (more so for those with deeper voices) and an exaggerated awareness of chewing, breathing, footfalls, and other body movements. Proper and deeper insertion of E-A-R foam plugs reduces the occlusion effect and thus improves worker acceptance.

Additional Questions

Question: I’ve noticed that one end of my E-A-R Classic Plugs is shinier than the other. Does it matter which end is inserted?

Answer: No. The difference in the two end surfaces of the plugs results from the manufacturing process. It does not affect the performance of the product.

Question: If I leave foam plugs in the Roll Model for extended periods, overnight for example, they take a long time to re-expand. Is there something wrong with them?

Answer: No. The recovery time for a foam earplug is related to both how long and how tightly it is compressed. Although all of the holes in the Roll Model represent dimensions to which plugs can be compressed for insertion, the tinier holes are in most cases smaller, not at body temperature, and of course less yielding, than actual ear canals. Thus, leaving plugs in the Roll Model’s smaller holes for extended periods of time is not representative of actual usage conditions, and is not an appropriate method to assess the plugs’ recovery characteristics.

Question: Can E-A-R foam earplugs be washed?

Answer: Yes. E-A-R Classic is reusable and washable. For specific information see the FAQs under hearing protection at e-a-r.com/hearingconservation.

It’s Up to You

If you are already using the E-A-R Classic you have chosen the finest foam earplug available today, one that has been repeatedly tested and proven both in the laboratory and in the real world to provide the maximum in comfort and protection. With the addition of the E-A-R line of polyurethane (PU) foam earplugs, 3M provides the purchaser a comprehensive range of foam earplugs from which to choose. And now you have in your possession this pamphlet, the Roll Model, and the Eargage tool, in order to provide the best in foam earplug training for your employees, so that they can get the most from their plugs. How they use them, and whether they wear them is up to you.

We suggest you begin by reviewing this booklet one more time, and then make sure that you can both properly fit the plugs yourself and demonstrate the process to others. Wear the plugs for extended periods, a day or two in a row, not just for a few minutes. Get used to them. Become familiar with them. Prepare yourself so that when questions arise or employees voice concerns, you can answer from your own experience.

We at 3M stand ready to assist you. We not only manufacture E-A-R foam earplugs, but also offer a full range of hearing protection products including the Peltor™ line of earmuff and communication devices, educational literature, and informative films. If you have problems or questions, please call. And above all, protect your ears, so that you never have to miss what you’ve been hearing.

Video Available

To see a 5-min. video demonstrating how to fit Classic foam earplugs and discussing much of the content of this booklet, go to e-a-r.com/hearingconservation.





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