Preventing and Fixing Brake Noise

By Bill Williams (reprinted from Brake & Front End magazine, October, 2000)

One thing that both customers and technicians have in common is they both hate dealing with brake noise. Customers find brake noise annoying and embarrassing. Technicians find brake noise frustrating and unproductive. Unfortunately, both groups find brake noise all too common. Most shops that perform brake service will tell you that brake noise represents the most common reason for brake comebacks.

Brake noise is the layman’s description of the symptom. Brake noise is actually vibration that is occurring at a frequency that is audible to the human ear. All brakes make noise or vibrate. The difference is that most brakes operate at a frequency that we can’t hear. Well then its simple, to prevent or fix brake noise all we have to do is make sure the brakes operate (or vibrate) at the right frequency. In theory it is that simple but in real life there is often much more to it than meets the eye. There are many variables involved in the equation that can result in brake noise. Understanding these variables is the starting point of preventing brake noise complaints.

Notice I used the word “prevent” not fix. This should be our primary goal. If we get a handle on how to prevent noise complaints from occurring then we will be better able to handle any comebacks. Most brake noise complaints involve disc brakes so we are going to focus our attention on disc brakes. As the brake pedal is applied and the disc brake pads are squeezed against the rotor, vibration is produced. The points where the vibration takes place are pictured in Figure 1.

Vibration can occur between the:

1. pads and rotor
2. pads and caliper
3. caliper and knuckle or mounting bracket
4. pads and knuckle or mounting bracket
5. caliper and mounting hardware

The number of points where the vibration occurs will vary with the type of disc brake used. The type of disc brake will also determine which causes will be more common. As you can see from the list, the prevention of most brake noise complaints will boil down to performing quality brake service and using quality parts. We will discuss each of these potential problem spots and cover what should be done to prevent them.

Rotor Finish

The vibration that occurs between the pad and rotor is a leading cause of brake noise complaints for a variety of reasons. If the mating between the pads and rotors isn’t correct a likely result will be a brake noise complaint. A huge variable in the brake service arena is the quality of the
surface finish achieved when machining a rotor. It is such a universal problem that one OEM has issued a bulletin not to machine rotors unless certain conditions exist, while another only allows the use of one brand of on the car lathe. MAP (Motorist Assurance Program), an organization dedicated to improving the industry’s reputation, states “Friction material replacement does not require rotor reconditioning unless other justifications exist.” This position is largely based on the position that some of the OEM’s have taken. I sum it up with one statement – In many cases there is more harm done to the rotor than good when refinishing is performed. Don’t get me wrong, I am a firm believer in rotor service when it is done properly. There is where the problem lies, how to get it done properly.

When machining a rotor you have two primary goals. The first is to provide a smooth surface finish for the pads to ride against. The second goal is to provide a true surface finish. A true surface finish is one where there is little or no runout and no thickness variation. You must understand that it is possible to accomplish one of these goals and not the other.

The smoothness of the friction surface of a rotor can be described in terms of microfinish or RA factor. RA stands for roughness average and represents a way to measure the smoothness of a rotor. Some rotor specification books provide a value for the acceptable RA factor but it is not practical to measure a rotor’s RA factor because special equipment is required. There are surface finish comparator gauges available that have samples of different RA values as seen in Figure 2. The finish of the rotor can be compared to the gauge to get an idea of the smoothness. You may have heard there are a couple of simple ways to determine if a rotor is smooth enough without the use of any gauges or special equipment. For years it has been said that you can use a ball point pen to write across the surface of a rotor to check its smoothness. If the line formed is solid then the surface finish is acceptable. If it is broken then the surface is too rough. Another simple test advocates running your fingernail across the rotor. If your fingernail runs smoothly across the surface then the finish is acceptable. Care must be taken when using either of these two methods. I have measured the RA factor of rotors that both failed and passed these tests and have had the results contradict each other. The rule of thumb to follow is the smoother the better. Most lathes out there when in good condition and used properly will yield very acceptable RA factors. So let’s take a look at what it takes to accomplish a smooth surface finish.

Most lathes that I see in the field are in serious need of a tune-up. A lathe tune-up includes everything that is involved in returning the lathe to proper operating
condition. There are too many different makes and models of lathes to cover them in any detail in this article. Consult your owner’s manual or equipment supplier for what is necessary for your specific lathe. In general the list would include cleaning and lubing, making necessary adjustments, replacing any necessary parts and calibrating the assembly. Most lathes over time will experience different types of wear that will affect the quality of surface finish achieved. A couple of common examples are shown in Figure 3. The lathe in the right of Figure 3 requires periodic adjustment of what I call “crossfeed wobble”. Excessive crossfeed wobble will allow the cutting tips to vibrate against the rotor surface. The lathe to the left in Figure 3 requires periodic adjustment of the dovetail ways on the rotor feed assembly. Failure to keep up on this adjustment can result in poor surface finishes. The frequency and type of adjustments vary from lathe to lathe and depend on the amount and type of use. If you are not willing to find out what is needed and then get it done then my suggestion would be to stop machining rotors because you are probably doing more harm than good. This may sound harsh but it is that simple.

Once the lathe has been tuned up the adapters need to be checked. The adapters must be clean and true if you want to accomplish a “true” rotor surface. Nicks, burrs and chip build up all affect the accuracy of the setup. Some common examples of adapter problems are shown in Figure 4. If the adapters are ignored then runout will be machined into the rotor. This is a leading cause of re-occurring runout and is a leading reason why the OEMs have written the TSB’s I mentioned earlier. Using the proper adapters will have an effect on both the surface finish and trueness. Figure 5 shows some do’s and don’ts.

Once the lathe and adapters are ready for use the rotor can be setup. Follow the procedures outlined by your lathe manufacturer and make sure to use a vibration damper. The last step in assuring a smooth surface finish involves the cutting tips. Dull cutting tips are the leading cause of poor surface finish. How long the cutting tip will last depends on many factors. The quality of the bit will have a large impact on how long the bits will last. Some low quality bits will stay sharp for only a couple of passes. Paying a little extra for the quality will provide long term benefits that will far outweigh the increase in cost. Rust is probably the next biggest factor that will determine how long a bit will last. Rust will dull even a quality bit in a short period of time. Where possible cut beneath the surface of the rust to prevent this from happening.

Many times the cutting tips are changed only after a noticeable change in surface finish is seen. What you have to ask yourself is what about the last 3 or 4 sets of rotors I just machined? What did they look like? If you wait until your bits look like the one in Figure 6 then you have just “booby trapped” the last few
cars you worked on. There is a noticeable difference between the sound a sharp bit makes when machining compared to that of a dull bit. A sharp bit makes a smooth “hissing” sound while a dull bit makes a grinding noise. The key is to rotate or change the bit before it gets to the grinding point. If you calculate the direct and hidden costs of a comeback resulting from dull bits it is easy to see why you should do everything you can to make sure the bits are sharp at all times.

Most lathes when properly “tuned” will provide a surface finish well below the maximum allowable specifications. If we follow the rule of thumb smoother is better there is an extra step we should perform before removing the rotor from the lathe. Applying a non-directional finish will help to lower the RA factor which will provide a smoother surface for the pads to ride against. There are many different methods for accomplishing a non-directional finish and we don’t have the space to cover them. A commonly accepted procedure is to block sand using 120 to 180 grit sandpaper for 60 seconds per side. I have researched this technique and found it to be simple yet effective. On average it will provide a 10 to 20 percent reduction in the rotor’s RA factor. This is well worth the 2 minutes it takes to apply. One thing you must keep in mind about a non-directional finish, it will not compensate for a sub-standard surface finish due to a poor machining job.

Once the non-directional finish has been applied we are done right? Wrong, there is one more step in the process. If we don’t wash the rotor before installing it we are asking for problems. Figure 7 shows what will end up embedded into the pads if we don’t wash the rotor. The fine metal particles from the machining process will end up in the surface of the pad. Guess what this can cause? Most experts say the best method to use is a mild soap solution completing the process by drying the friction surface off with paper towels before installing.

**Friction Material**

The next component that needs to be discussed are the brake pads. It is commonly felt that the brake pad is the leading culprit in creating brake noise. While in some cases this is true it is not a blanket statement that can be applied to all cases. If you have access to Mitchell On Demand or All Data you might want to take some time and look through some of the TSB’s (Technical Service Bulletins) dealing with brake noise that have been published by the various OEMs. If you do, you would see that changes in brake friction material is often used to help combat brake noise complaints. If you take a closer look, you would see that it is not the only method used. How does this relate to you and the friction material you are using? My position on aftermarket friction and brake noise is this – if you use a quality product from a reputable supplier then you should not have noise problems with MOST vehicles. Quality pads should be designed after the OEM pad. This means they should have shims, tapered edges or dust slots if the OEM pads were equipped with these features. Quality pads will provide good results as long as you do everything we discuss in this article. There will always be a handful of vehicles out there that will provide us
with the greatest challenge in preventing brake noise. We will discuss these closer to the end of this article.

There are many different friction suppliers to choose from out there and each supplier offers a number of different grades or types of friction material. Some of you reading this article will not have any control over which friction you install on a vehicle. Your employer makes the purchasing decision and you have little or no say. In this case as long as it is a quality product you should not have a problem with most cars. Then there are those of you reading this article who make the buying decision and can choose which supplier and grade you install. In this case you could choose to stay with one line for all applications or you may choose to use one grade for most vehicles and then another for those problem vehicles. There are lines of friction out there promoted just for the effect they have on brake noise. Only you can decide which way you go based on the level of the problem, what you can charge for the job and the cost and profit of the product.

**Pad Shims**

Pad shims are used as an insulator between the pads and caliper. This serves to change the frequency of the vibration so brake noise is eliminated. The shims could be attached to the brake pad or they could be supplied as separate parts. Make sure your replacement pads are shimmed to match the OE pads and when servicing vehicles with separate shims either reuse the shims if in good condition or replace them. Do not reuse shims where the protective coating has worn off or if the shims are rusting and flaking. Do yourself a favor and add the cost of replacing the shims into your estimate now instead of giving them away later. You might want to look into stocking the most common shims in your store to avoid delays in getting them.

Some aftermarket shims use adhesive to bond the shim to the pad as in Figure 8. Usually if you look close enough the shims will say the adhesive is heat cured. Proper attachment of the shims requires a test drive that will heat the adhesive up so it bonds to the pad. We will cover a proper test drive later but it should be noted that failure to do it with these types of shims will allow the shim to “walk” as the brakes are used. The shim literally slips out from between the pad and caliper.

**Pad Hardware**

The use of anti-rattle hardware has increased over the last 5 years or so. It used to be that imports were the only vehicles using pad anti-rattle hardware but now disc brake assemblies similar to that shown in Figure 9 have become the standard on many domestic vehicles. The pads “snap” into the caliper mounting bracket and are held in place by various clips. The caliper straddles the assembly and serves only to provide the squeezing of the pads against the rotor. The caliper mounting
Bracket absorbs all of the braking force and maintains the pad's position. The anti-rattle hardware applies tension to the pads so they fit snugly against the mounting bracket. These clips are essentially small springs made of stainless steel. They are subjected to the same heating and cooling as rear brake hardware. How many of you are strong believers that the brake shoe hardware should be changed with each set of shoes? What's the difference with the front hardware? Simply cleaning and re-installing it won't be good enough in many cases. Some add an extra step of “re-tensioning” the clips by bending the tabs slightly. This may work for a short time but won't provide a long-term solution. Suggesting the replacement of this hardware with each pad replacement is something you should consider. The hardware can be pricey and you should explain to the customer why you are suggesting it. If they decline and have a noise problem later then you are in a better position than if you said nothing about the hardware.

Caliper Hardware

Most vehicles use floating calipers. The rubber bushings or sleeves in these calipers allow the caliper to move freely on brake apply and release. They wear over time and can increase the chances for brake noise. Careful inspection should be done and replacement should be suggested or required based on the findings. If the bushings or sleeves are too loose fitting the caliper will be allowed to move too much (See Figure 10). This will increase the chances for a brake noise problem especially if other problems are present. Again, if the customer declines the service, mark the invoice accordingly. If a noise comeback occurs you will have set the groundwork for what needs to be done. It’s a better position to be in then having nothing to fall back on.

Cleaning & Lubing

The amount and type of cleaning you will have to do will vary with the type of vehicle being serviced and the area of the country you live in. Some vehicles have only a few key areas that need to be cleaned when servicing the disc brakes while others require considerable more effort. If you work in the south or out west then you won’t have to deal with too much rust like those of us in the snow belt. We commonly have to deal with brackets that look like the one in Figure 11. Failure to clean the highlighted surfaces will cause nothing but problems. When cleaning, make sure only to remove the corrosion and not to remove good metal. The bracket in Figure 12 has had a number of the surfaces damaged by too aggressive of cleaning using an angle grinder. This can allow too loose of a fit for the pads or cause other related problems.

A commonly missed surface, especially where rust is common, are the caliper “ears” that support the outboard pad. These flat surfaces can have considerable rust build-up over time as shown in Figure 13. Failure to clean these surfaces will not allow the outboard pad to sit squarely against the caliper increasing the chances for vibration.
Once all surfaces have been cleaned they need to be lubed. There are many choices out there for brake lube and as many opinions of which ones to use. I recommend the use of a high quality moly-lube on all metal to metal surfaces and a high quality silicone lube on all metal to rubber parts. This is the same position most major brake manufacturers take and it works well. The reason I like the silicone on metal to rubber is that silicone repels moisture and if used properly will form a nice moisture barrier.

There are some basic rules of thumb to follow when using both lubricants. One is – “a little goes a long way” or conversely – “too much is not always a good thing”. For example, the bracket in Figure 14 should first have a light film of moly-lube applied as shown. Next, install the anti-rattle hardware and apply a thin film to the surfaces that contact the brake pads as in Figure 15. The bracket can now be installed on the vehicle.

How about the brake pads? What if anything should be applied to the back of the pads? There are a number of different products available for this task so which one should you use? Again, most experts agree that a thin film of moly-lube is the best method to combat brake noise. The key here is to apply it where it will make a difference. Rather than apply it to the entire back of each pad try this, apply a thin layer to each caliper “ear” and then a small circle on the inboard pad where the piston contacts the pad as shown in Figure 16. What about pads that already have shims? Should anything be done to them? I say yes, do the same thing. On vehicles with multi-layered shims put a thin layer between each layer. If you ever noticed this is how most of these vehicles come from the factory.

Pad Staking

Some outboard pads are designed to be “staked” to the caliper. This staking holds the pad firmly in place and prevents vibration. Older domestic RWD vehicles use outboard pads that stake to the caliper using small tabs as shown in Figure 17. This style of pad is best staked off of the caliper. Bend the tabs on the pad until a press fit is needed to install it. Use a pair or channel locks to press it onto the caliper using a piece of cardboard to protect the friction material. Some General Motors vehicles require a different procedure to stake the outboard pad. The pads pictured in Figure 18 are first installed on the vehicle. Next a chisel is driven between the hat of the rotor and the base of the pad to hold the pad against the caliper. Now, have an assistant apply and hold the brake pedal. This will hold the pads in place while you perform the staking. The tabs should be bent over at about a 45-degree angle. Release the brakes and check the tightness. No movement should be felt between the pad and caliper.

Pad Break In
Once the job has been completed a test drive should be performed. The test drive has two goals. The first is to make sure the brake system is operating properly. The other reason a test drive is performed involves mating the pads to the rotors. This can be called “break in” or “burnishing” the pads. It doesn’t matter what you call it just that you do it. Depending on whom you talk to the number of stops you should make will vary. A good average is 10 to 12. To mate the pads to the rotors make 10 to 12 stops from about 30 to 35mph down to about 10mph. Allow about 30 seconds between stops for cooling.

When you deliver the vehicle to the customer advise them not to do any severe braking for the first couple of hundred miles. This includes towing or hauling and having them anticipate their stops when possible. Not catching that customer who is leaving for vacation the day after your brake job with everything but the kitchen sink in tow can cost you big time. Talk to and educate your customers, it will benefit both of you in the long run.

**Dealing with Brake Noise Comebacks**

No matter how good you are you will be faced with brake noise comebacks. If the vehicle that has returned did not have everything we have just discussed done to it then that will be your starting point. Applying the steps outlined above will cure over 95 percent of the brake comebacks you experience. What about the other 5 percent? Here are some guidelines to follow on these vehicles that should yield positive results when applied correctly.

A good first step, if you have access to it, is to check for existing TSB’s dealing with brake noise. OEM provided TSB’s can be accessed through programs like Mitchell On Demand or All Data. There are hard copy versions available as well. Many brake vendors also supply their own TSB’s. These could be a rewrite of the factory bulletin or one based on their own findings. Access to this type of information can sometimes be critical to fixing the problem. You might say why wait until a comeback to check for these TSB’s? Why not check when the vehicle first comes in? I am in total agreement, this is a good idea. Some service providers pull up all related TSB’s before performing any service to the vehicle. Pulling the information up before hand can sometimes prevent the comeback in the first place. If there is a TSB listed then follow the recommended procedures.

Some friction suppliers offer a hotline service. This is another resource you may want to check with before you dive into the problem. They have access to both their and OEM TSB’s and take hundreds even thousands of calls on the subject. They may have a fix just waiting for you. What if there is no TSB or relevant advice from your hotline provider?

The starting point is rechecking your own work. Do not start with the common assumption that you should replace the pads and machine or replace the rotors. These should only be serviced if a reason is found to service them. Do not modify the brake pads in any way. Common “fixes” to pads include grinding the leading and trailing edges and “slotting” the pad. These types of modifications reduce the friction area and compromise the structural integrity of the pad. There is a tremendous amount of liability involved that you don’t want to sign up for.

Questions? Call Rob Wright at UCX, 1-888-740-0829
If you have done everything mentioned and still have a problem there are still a couple of things you can try. One is to install aftermarket shims. Many friction suppliers offer a shim line for those pads that do not come with factory shims. The shims have been designed to dampen the vibration which helps eliminate the brake noise. The other option is to see what is available in regards to different friction. There are some newer products out that have been designed with extra features to combat brake noise issues.

If you have noticed I have tried to steer you away from automatically machining the rotors and putting another set of pads in to fix your noise complaint. I try very hard to live by the advice I give but sometimes succumb to the “easy fix”. In a training class recently we had done a pad and rotor service on a vehicle. All of the above items were addressed and the job was a quality job. At the end of the test drive a loud squealing noise was coming from both front brakes! To make a long story short after a series of unsuccessful attempts at fixing the problem we tried some HD premium pads (This was a 1-ton truck) but had the same problem. It ended up being a problem caused by a combination of wear on the knuckle, caliper and hardware that was allowing the vibration to take place. Bringing these items back to spec cured the noise.

On last thing before concluding, what about the aftermarket products available that you spray onto the pads and/or rotors? These products claim to fill the surface imperfections and eliminate the noise. Talking to the different brake parts manufacturers and others in the industry backs up my own thoughts. First you shouldn’t need them if you do a quality job and second there is concern about what effect they have on the braking performance? I personally have been involved in many brake noise complaints and have never had to use such a product. Whether you use one or not is your decision. The key to preventing and fixing brake noise comebacks is attention to detail and getting back to the basics.