How To Record Locomotive Sounds

Sound Recording of Locomotive Sounds for Use in Quantum Sound Systems

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The Quantum System use up to 32 separate channels to produce model railroad sounds. Each sound, such as bell, horn, chuff, motor sounds, etc are reproduced separate from the others in the Quantum Sound system and then summed together before being feed into the system audio amplifier.

Because each sound is separate, they need to be recorded independently. Sounds that occur together during recording are seldom of any use to QSI sound technicians. For instance, most audiotapes and videos usually have all sounds occurring together such as chuff, whistle and bell on at the same time. In addition, the sounds are usually moving, such as run bys, so the frequency is shifted from the Doppler effect and again cannot be used.

Special care must be taken when recording any railroad sounds. The following provides recording tips and procedures to ensure the best possible results to be used by our sound technicians.

General Recommendations and recording tips:

- We recommend using a crew of two people. This allows one person to concentrate entirely on the sound recordings while the other works with the engineer to operate the different appliances on the locomotive to create the best sounds.
- It is best to record sounds on a stationary engine to avoid Doppler shift.
- Make sure your tape recorder and microphone can accept sound levels over 120 db.
- If you are using a conventional cassette recording, use high bias tape with appropriate settings along with Dolby noise reduction turn on. Make the tape with the settings, date, and subject. After finishing your recordings press out the plastic tap that will prevent any accidental future recordings that may erase a valuable tape.
- Modern digital field recorders are preferred because of their very low noise floors, no moving parts, no wow or flutter, and wide dynamic range. “Ruggedized” recorders allow movement while recording. If not using a ruggedized unit, be sure to not bump, swing or jostle the recorder *while recording*. The finalized recoding should be archived on CD. WAV files on a CD at 44.1 k samples per second is the format that QSI prefers for the finished recording. Do not use any data compression on any recording (such as mp3). Do not use any special effects in the recording such as audio compression, added reverb, etc.
- Protect your ears during recording, particularly horn and whistle blasts, and during steam pop-offs.
- Always check the peak sound levels on short duration sounds such as bells. It is easy to overdrive the recorder on these sounds unless the VU meter or sound level indicator is responsive enough to indicate fast rise-time sounds.
- Do not record with Automatic Level Control on. Also use manual level control and watch your VU or sound level indicator meter often to be sure you are not over driving or under recording the sounds. If necessary, you can use a peak limiter but we prefer to have the levels adjust to get the full volume range of the sounds.
- Always take some quite time to listen to the sounds you have recorded to be sure that every thing has been working correctly and that the recorder is not being over driven.
- Watch for talking among rail fans. Any talking which may appear inconsequential during playback can show up when the sound is looped.
- Be aware of chirping birds. These sounds can corrupt the best sound recordings. You may have to pick the time of day or the time of year to minimize these effects.
- Be aware of other corrupting sounds such as traffic sounds, air planes, children at play, industrial sounds, air conditioners on passenger cars, etc.
- Be especially aware of wind. An amazingly small amount of wind will destroy a live recording. A windscreen for the microphone is a must. Other measures may be required as well.
- Be sure that all sources of steam hiss on steam locomotives have been turned off. Pump up the air tanks and then shut off the pumps. Make sure any other air or steam leaks have been arrested before you start recording. Sometimes it is not possible to eliminate every last source of steam/air leaks. Do the best you can. For very loud sounds like whistles, bells and pop-off valves it is less crucial. Remember even a very loud sounds often have subtle endings and beginnings that must be cleanly

recorded.

- The locomotive should be recorded in an open area to prevent reflected sounds from nearby buildings, hills, etc. While reverb makes the sound more dramatic, it makes the sound lab work more difficult. We can easily add reverb and echo back in after we finish the sound work.
- Stand back about fifty feet from the engine when recording engine sounds. In particular whistles, horns and bells provide the best sounds when recorded at ground level. Do not record the whistles or bells while on the locomotive. It will sound artificial when used in the model train. After all, the observer of most trains hears the sounds from fifty or more feet away and we want to preserve this affect.
- Always record the bell start up effect. On most diesels, the pneumatic bell does not come on immediately. It takes a while for the air-driven clapper to come up to speed. Steam engine bells can also have a start up effect, particularly if the bell is hand pulled.
- Always record the bell shut down effect. This is particularly important with steam engine hand pulled bells.
- If possible, it is a good idea to record a single bell ding. This allows us to change the bell rate in the lab or to provide a way for the model train operator to change the bell rate. If the recording is of a repetitive bell, the next bell strike occurs before the current bell sound has had a chance to decay. This makes it impossible to separate the individual bell sounds. When recording a single bell strike, if possible, have someone move the clapper by hand with the same force that the clapper normally moves when producing bell sounds. Be sure to continue recording the single bell strike for some time to be sure to get the entire decay sound period. The tail of a bell is very long. Don't start talking or turn off the recorder before the bell has completely decayed.
- When recording any individual engine sounds, make sure all other engines sounds are off. On steam engines, all appliances should be shut down including blower hiss. The steam engineer will not want to do this too long since the fire will tend to go out on a stationary engine if the blower is not on, so make your recordings quickly.

On diesels, the engine should be started to generate full air pressure. The motors can then be turned off to record horn and bell sounds without the background sounds of the diesel engines.

- Be aware of steam pop-off sounds. They occur unexpectedly and can be deafening loud and will have you running in all directions to protect your ears. Always use ear protection, even when recording relatively low volume sounds.
- Engines can make a number of interesting sounds that may not be common to all locomotives. It is always a good idea to sniff around a working engine to notice some valuable sounds, or some appliance turning on or off. Anything unusual should always be recorded and then described verbally on the audio recorder. If you are not sure that the sounds are ask the engineer or other train crew member while leaving the recorder on to get his explanation.
- It would be very good to also capture ambient groans, pops, clanks and various random sounds that such a big piece of machinery invariably makes. These types of recordings are especially prone to containing disturbing background sounds (like talking). Be mindful of this.

Whistle and Horns: Whistles and horns have three components that we utilize in our sound work. The first is the attack or start up sequence, which represents the sound starting from zero volume to when the sound stabilizes at max volume. The second component is the constant or sustained period, which we use to create a looped record using a short segment of the constant horn or whistle sound. The third component is the decay portion where the sound volume reduces from it max sustained volume to zero. It is important to be aware of these three components when make horn and whistle recordings since they can affect how we reconstruct the horn and whistle effect in our sound lab.

- Steam whistle will heat up over ten or fifteen seconds as steam is passed through the pipes. This causes the whistle to elongate which will change its frequency. Since it is difficult to create a whistle loop if the recording has any frequency shift, it is important that a recording be made after the whistle has heated up. We recommend that the whistle be blown for fifteen seconds, then shut off for only a second or two and then recorded when it is blown the second time (or any subsequent recordings that occur before the whistle has a chance to cool down).
- Diesel horns do not need to be operated before recordings are made. We have not noticed any changes in pitch with air-operated horns.
- Make sure that the engineer produces a reasonable fast turn-on, followed by a sustained period without any variation and a rapid (but not instantaneous) shut off.
- Record a series of short hoots with silence in between, since we use separate hoot records to produce short horn and whistle affects.

Playing the Horn and Whistle: Engineers on prototype railroads often change or vary the amount of steam or air in whistles and horns to affect their sound. The amount of steam or air not only affects the volume of whistles and horns but also their timbre and harmonics. This is called "playing" the whistle or horn.

Playing the horn or whistle is a feature we intend to add to our model trains in the future. However, it is more important to have a basic horn sound developed before we add on extra capabilities. When you make recordings, most engineers want to do their best and will often play the horn or whistle in a variety of ways to provide the most dramatic effects. We cannot use recordings with lots of "playing" to produce the basic whistle or horn sound. However, once this is done, we would like a number of special horn and whistle sounds.

- Record a series of horn and whistle with different ending sounds. As the engineer reduces the steam or airflow, they can often vary the sounds as the horn or whistle is shut down. We have included software to allow the user to playing special horn or whistle endings on demand. If we have a number of these records, we can add a lot of variety to the horn and provide a limited way for the operator to at least play the way the horn or whistle ends. Each of these special end records should vary from one to about three seconds.
- Record the horn or whistle at some intermediate air or steam level. Start by playing the horn or whistle at full level followed by reducing it an intermediate level and leave it there for five seconds or more, followed by increasing back to full level. Repeat this procedure for a number of different intermediate levels. We will use one or more of the intermediate sustained levels as well as the transitions between levels to provide a way for the operator to have some variable control of the horn sound. The transitions should be quick but not instantaneous. It should represent the type of transition common for the engineering playing the horn or whistle.

Tapes and Videos: Do not believe the accuracy of the train sounds on some commercial prototype video tapes. These sounds are often dubbed, particularly on the older videos or films where they may not have actually recorded the sounds when the films were shot. Cassette tapes or LP records will usually have authentic sounds. Hollywood movie videos very often use modified or different sounds that are not accurate for the engine being shown.

Sounds to record: Model railroad sounds should be considered to be as important as any detail parts on the engine. The customer not only wants the proper number of rivets, he wants the sounds to be accurate to the model. We will use generic sounds from our library, only if it is impossible to make or find recordings of the correct engine sounds. Even when no recordings exist, we will use the memory of ear-witnesses who can sometimes describe the sounds sufficiently well for us to get close to the original sounds. Model railroaders not only want accurate sounds but they also want variety. While it might be our perception that all chuffs sound alike, using different recordings keep up the interest of the customer and encourage him to buy additional locomotives. The following list is what we would like recorded as individual sounds from each locomotive model.

Stream:

1. **Whistle** (see above)
2. **Horn** (if it has one)
3. **Bell** (see above)
4. **Chuff:** Get chuffs when the engine starts out with heavy load. It should have a sharp "bark" sound. Also record when the engine is coming into the station. The engineer will often have the cut-off at max, which will provide a much more softer "whoosh" sound. If possible, have the engineer do slow run-bys with different amounts of cutoff.
5. **Steam cocks:** Steam cocks will often be turned on when the engine has been idle for an extended period of time. This provides a very recognizable long steam release sound concurrent with each chuff as the engines starts out from a dead stop. Steam cocks are used to blow out water that has condensed in the steam chest while the engine was stationary.
6. **Wheel and rod clank:** We have added rod clank on some of our Quantum models. This is best recorded on a slow moving engine where it is coasting with throttle and all appliances turned off. Here we are trying to only record the engine rods and value gear, not the sound of the wheels on the track. Do not record value gear and rod clank near a track joint or turnout.
7. **Blow Down:** This occurs when the fireman opens a value in the cab that ejects the sentiment from the bottom of the boiler through a pipe on a idling engine onto the track or beside the engine. It produces sounds of water and steam venting plus the sounds of more solid matter being expelled. Record both the startup and ending sounds as well as the full period of the sustained sounds.
8. **Water Injector:** These sounds can vary from engine to engine. Always get the turn on and turn off effect.
9. **Feed water heater:** These usually do not make noticeable sounds but it good to ask and judge for yourself.

10. **Dynamos:** Record both the turn on and turn off as well as sustained sounds. If there is more than one dynamo, record each separately. Have the engineer describe verbally on the recorder what each generator is used for.
11. **Air pumps:** Air pumps can be simple or compound. If there are two pumps, record them both separately and together. Record any start up and shut down effects.
12. **Drift chuff:** If the engine has a drift chuff, have the engine do a run-by with drift chuff operating. All other appliances should be off. If there is any start or shut off effects for Drift chuff, record these as well.
13. **Coupler Sounds:** Record the lift pin bar being raised and chain being pulled taunt. Record the lift pin being pulled up and knuckle opening. Record the brake air-line hoses being parted along with the concurrent air release.
14. **Start up sounds:** Steam engines have a very long start up period. Either house steam is used to get the engine going quickly or the engine is started from cold by building a fire. We have both a quick start feature and an extended start up procedure. Record any sounds related to preparing the steam engine for service including verbal explanations on the field recorder.
15. **Shut down sounds:** Steam engines also require a long period to shut it down. This includes dropping ash, stopping the coal auger, shutting down the air pumps, shutting down the blower, placing blower cap over the stack, shutting down the lights and dynamos, sometimes venting steam, blow down, firebox grate operation, hosing down the firebox, cocking the wheels, etc.
16. **Crew talk:** Crew talk is an option we can add while the engine is in neutral or being prepared for service or when the engine is shutting down. Since steam crews seldom communicated by radio, most shouted to be heard above the engine sounds. Any comments relating to an engine at idle can be used such as engine status such as water level, fuel level, steam pressure, turning on the blower, brake pressure, etc.
17. **Shoveling coal:** This is a good sound effect for most small steam engines. Large engines had steam operated coal augers, which obviated the need for the fireman to shovel coal under most circumstances. However, if the engine was being started cold without house steam, the fireman still had to fire the engine, which did require some coal shoveling. Record the shovel picking up coal and tossing into the firebox. Record the firebox opening and closing sounds. Some steam engines had a pneumatic firebox door, which could be operated each time a new shovel full of coal was loaded. Record the shovel being picked up and shovel being laid or toss down at end of shoveling session.
18. **Coupler lines charging:** When brake air-lines are all connected, the brakes are released by pressurizing the lines. Record these sounds away from the pumps and other engine sounds where this low volume and unique sound can be isolated. All other appliances should be off. Record any start up and shut down effects for this operation and record how long it takes to charge the lines to the point where the train can move.
19. **Blower:** The steam blower vents steam through the smoke stack to create a draft for the firebox. The blower is often used when the engine is idle to maintain a healthy fire and to prevent smoke from the firebox from entering the cab area. The blower sounds like steam hiss. Record the start up and shut down effects as well as the sustained hiss sound.
20. **Tender Coal loading:** Quantum has a number of loading features that can be triggered in Analog and DCC. Coal loading from a coal station involves a number of sound affects that can also be part of a sound system in the coaling station. However, the sound of coal loading into the tender should be part of the engine sound system since the Quantum system can know how much coal is needed. Record all starting and stopping sound effects of the shute lowering, coal starting to fall into the tender and the sustained loading and shut down effects.
21. **Coal auger:** Coal augers on modern large steam engines are powered by auxiliary small steam engine located under the engine cabs. These power screw mechanisms that transports the coal to the firebox. Record the sounds of the auger steam engine starting up, followed by the auger screw starting to turn and sustained auger sounds and turn off effects.
22. **Water filling sounds:** Water filling involves the tender water hatch being opened, followed by the waterspout being placed, the water value being opened and the sound of water filling the tank, followed by the water valve being shut off, the spout being moved back and the hatch being closed.
23. **Oil filling operation:** Oil filling usually involves opening the oil hatch, the sounds of a portable diesel motorized pump starting up and the sound of oil tank being filled, etc. However, different railroad companies used different methods

depending on the fueling facility. Record any method that is being employed and describe the operation in detail on the field recorder.

24. **Pop-Offs:** This is violent and loud sound of steam being vented when safeties or pop-off values open to release excess pressure in the boiler. These values open whenever their internal pressure sensors are triggered by high-pressure buildup in the boiler. They usually operate while the engine is idle and the blower is on to maintain the fire. A continual fire generates increasing steam pressure in a non-moving engine, which results in safety values opening at irregular intervals.
25. **Air Brakes:** Train air brakes are applied when pressure is released from the brake air-lines that run the length of the train. These sounds are usually not heard from outside the engine but are easily heard from inside the cab. We use these sounds as audio feedback for the user to know when he is applying or releasing brakes. Record these brake sounds in the cab as the brakes are applied and released with other cab sounds reduced as much as possible. It might be good to record these sounds when the engine is not moving.
26. **Lubrication and maintenance:** This is another future effect that can be operated in Quantum. Steam engines require continual lubrication maintenance particularly of side rods and axle bushings. Grease is often applied by hand using a pneumatic lubricator connected to the engine's airline to force lube into the joints. This procedure is quite involved with lots of interesting sounds. Record all aspects of this procedure and add verbal commentary of the process on the field recorder. Also record any crew talk during this operation.
27. **Short air let-offs:** Appliances are often operated by air with characteristic air short air release sound during start up and shut down. We also use short air releases in Quantum as feedback for some operations. Record as many different short air releases as possible for each engine type.
28. **Power reverse:** Small engines use a mechanical level in the engine cab to operate the reversing valve linkage. Large steam engines usually have a pneumatic reversing appliance to do this operation. Record the long air release and other mechanical sounds associated with this operation. Also, record the mechanical motion on engines that use hand operated reversing levers.
29. **Cab sounds:** This includes applying air brakes for train and locomotive, opening firebox access door, coal auger, firebox roar, pulling the Johnson bar throttle, reverse lever operation, and any other sounds such as values, levelers, etc. along with explanation of what is happening.
30. **Wheel slip:** When steam engines lose traction, you can hear the familiar fast chuff followed by the throttle being decreased and chuff slow down until the wheels regain traction. This sound can usually be recorded as the train is starting out with a heavy load.
31. **Water Scoop Sounds:** Large Pennsy and NYC locomotive tenders were equipped with special water scoops that could be lowered from the tender on a high speed trains into a water trough located between the rails. This forced water into the tank at a high speed. The sound was deafening. When the tender was full, the water shot out of special overflow values that told the fireman that the tender was full. It is not possible to record this effect today but someone might have original recordings and/or film of this event.
32. **Brake and Flange Squeal:** When trains stop or are moving through a curve, there is considerable squealing sound. Record as many of these sounds as possible being mindful of extraneous sounds from track joints, turnouts, engine sounds, passenger car air conditioners, etc. Sometimes the best squeal comes from trolleys and other electric engines that do not have all the other competing engine sounds.
33. **Cab Whistle:** Steam engines sometimes had a shrill cab whistle to indicate that the engine was traveling over the speed limit. If this is available, record this sound from within the cab.
34. **Sanding:** Record the application of sand to the tracks. Do this on a stationary engine. Record the startup operation as well as the shut off.

Diesel and Electrics

1. **Horn:** Multi-chime diesel horns are more difficult to loop than most steam whistles. It is most important to have the best possible recording of horns. Have the engineer start the engine to charge up the air reserve and then turn off the engine and pumps while he operates the horns.
2. **Bell:** See above.
3. **Diesel motor:** We currently only use the diesel idle sound and rev up this basic record using internal software. However, we are intending to enhance this feature and will need motor sounds at all eight notches as well as clearly discernable motor transitions between the different notches. If the chosen model is a modern locomotive with turbo sounds, we would prefer the have the recordings without turbo since we add this in as a separate

record. Sometimes, prototypes can be found where the turbo has already been removed. We are not sure it can be done, but ask the engineer if the turbo can be disabled temporarily during recordings.

In addition, we would like labored engine sounds. This is difficult to do when the engine is pulling a heavy load since there are so many other competing sounds. Some locomotives allow the diesel motors and generators to be tested while the engine is stationary by turning on the dynamic brakes as load. This will allow labor sounds to occur. However, the dynamic brake fan comes on soon after power is applied to the dynamic resistor grids, which corrupts the primary diesel sound recording. However, if I remember correctly, there is a few seconds before the dynamic brake fans turn on since they are thermally operated. It would be ideal to set the motor at each notch without any load, and then turn on the dynamic brakes. You should be able to get enough sounds under load for our purposes. If you cannot get the loaded sounds at high notches, try to get these sounds at idle. Even if the RPM drops when dynamic brakes are applied, we can compensate for this in our sound lab.

If it not possible to have the engine under dynamic load without the dynamic brake fans operating, try to place the microphone in an area of the motor that minimized the dynamic fan sounds. This may require that side access hatches be opened to place the microphone closer to the motor and shielded from the dynamic fans.

4. **Low idle:** Diesels sometimes have a special low idle sound that is used to maintain the locomotive in a "ready to run" condition. We use this quieter more soothing sound in our "standby state" as a way to have idling engines without the added cacophony of many competing active locomotives. If the engine you are recording has a low idle or standby state, record it and also record any transitional sounds to this state along with any associated turn on or turn off sounds.
5. **Air pumps:** Diesel air pumps do not occur separately from the locomotive's other sounds like they do in steam engines. Locate the area of the engine where the pump sounds are the most noticeable and record these at idle along with any turn on or turn off sounds. If it helps isolate these sounds from the diesel motor, open side vents to place the microphone closer to the source of pump sounds.
6. **Dynamic Brakes:** Diesel locomotives use the locomotive's traction motors as generators to produce braking. The power output is applied to a resistor grid that is usually located on top of the locomotive. This resistor grid will get quite hot as all the energy of the moving train is applied and dissipated in this array. To keep this appliance cool, large fans are turned on to dispel the heat out through the top of the engine. The sounds of dynamic brakes are primarily from these fans. It is often difficult to get dynamic brake sounds on a moving engine because of competing sounds and Doppler shift. However, since dynamic brakes can be applied on a stationary engine by directing the diesel/generator to the resistor array, these sounds can be more easily recorded. After the dynamic brake fans come on, ask the engineer if the motor can be shut down to idle or turned off completely without affecting the fans. You should have a few minutes to record the fans without other sounds. Record the shut down affect that will occur when the resistor grid cools down and the fans quit. If possible, record the turn on affect as well.
7. **Coupler Sounds:** See above.
8. **Start Up sounds:** We have two different start-up sequences. The first is a simple and short motor start up. The second, called "extended start up", produces all the sounds of an engine being started cold. Diesels have less complicated start up sounds than steam engines but they can go through quite a procedure to prepare the locomotive for operation. In general, if a prototype engine has been running, and needs to be restarted after a brief down time, there is enough air available to do an air start. We do not use this for our short start up since it takes to long to do and most model railroaders want the engine to be ready to go quickly. However, this is an idle sound effect for an extended startup. Record both the electric start and the air start. Also record both engines starting up, one after the other, in a dual motor diesel. Record all other preparation sounds, include the engineer opening and shutting the cab door, any air releases or appliance start ups, radio and crew chatter, and record a description of the procedure on the tape to help identify the sounds and their importance.
9. **Shut down sounds:** Shut down sounds for diesels are also way simpler that shut down sounds for steam engines. We provide a simple and quick shut down procedure as well as an extended shut down. Record all sounds associated with shutting a diesel down along with a description of the process. If the shutdown procedure requires shutting both motors down in a dual motor diesel, record these shut down affects, one after the other. Record the sounds of the engineer leaving the cab and any radio or crew chatter during the process.
10. **Crew talk and radio chatter:** In switchyards, diesel cab radios are sometimes left on with the engineer's window left open. The sounds can be heard all over the yard. Perhaps this is done to keep the hostlers informed about any changes or orders

from the dispatcher. We will sometimes provide radio cab chatter sounds in neutral to model this procedure. We have recorded railroad radio communication in the Northwest area of the country but we could also use new recording within the locale of the prototype railroads we are modeling. Purchase or borrow a railroad scanner and record the sounds directly from the scanner's speaker. We want all the pop's, buzzes, and distorted sounds from these radios so it sounds authentic. Diesel crew talk can be either shouting between workers and/or radio communication.

Steam engines seldom had radios. One exception is the later Pennsy engines that used radio between engine and the caboose and perhaps with the dispatcher. Most of the time, orders were in writing. However, there is a lot of verbal communication relating to a stationary steam engine. These engines required a lot of care and often had the crew moving around the locomotive and shouting to each other over the engine sounds to communicate. Hang around any steam engine and record these sounds and also record a description of their activities and the reasons for their communication. Since competing engine sounds may corrupt these verbal communications, it is a good ideal to have these same people shout the same orders away for the engine based on a scripted text compiled from many hours of recording and listening to the real scenarios.

11. **Coupler line charging:** (see above)
12. **Fuel loading:** Diesel fueling stations will have associated sounds of opening the fuel cab, inserting the nozzle, pumping the diesel fuel, etc. Also record any crew or attendant verbal communication and record a description of the entire operation.
13. **Water filling sounds:** If the diesel is designed for passenger service, it will have facilities for steam heat in the locomotive, which is piped down to heat radiators in the cars. Steam requires water. Record all sounds of the water reservoir being filled and record any crew sounds associated with the procedure.
14. **Air brakes:** (see above).
15. **Lubrication and Maintenance:** There is less maintenance activity on a diesel. However, it is worthwhile to record the testing of the diesel motor generator procedure using dynamic brakes as a load. It is particularly important to record the procedure and describe it verbally. Since the diesel will be making a lot of noise, any crew talk will be verbal shouting. It is best to script this and re-record as the men "shout" their lines in a quiet area.
16. **Short air let-offs:** All locomotives use compressed air for appliance operation, particularly diesels. Record as many of these air let-offs as possible. Since there will be competing engine sounds, place the microphone close to the sound source and make sure you do not overdrive the recorder on these very high rise-time sounds.
17. **Cab Sounds:** Record all sounds in the cab include the clunk of levels being moved, throttle being turned up or down, appliance air releases, air brake sounds, crew talk, etc. and verbally describe what is happening with each sound.
18. **Wheel Slip:** Diesel wheel slip is difficult to record and probably the engineer will be reluctant to do anything to cause wheel slip. If possible, record these sound from a moving train, usually in an area where the train is climbing a grade under load.
19. **Turbo Sounds:** Modern diesel locomotives use a turbo to increase the air intake pressure to improve horsepower. These turbos are driven from the engines exhaust and can often be heard to "hang" in the air after the motor has been turned down. Turbo sounds are usually less noticeable at low RPM's. It is difficult to record the turbo without the engine sounds. The best procedure is to locate the turbo and place the microphone in a way that maximized the turbo over the motor sounds.
20. **Cooling fans and vents:** Engine cooling fans and vents are probably operated automatically and you will need to wait for the operation of these appliances. If the engine has the ability to open vents or turn on the fans manually, see if this can be done when the motor is off. Record all turn on and turn off effects.
21. **Squealing brakes and flanges:** (see above)
22. **Traction Motors:** Traction motors on diesels are hard to record and are often obscured by the motor sounds. However, on electric engines, the traction motors are often the only sounds heard as the engine starts out. Record these sound from an electric engine as it moves from stop. Ask the engineer to turn off any fans or competing sounds during this start out procedure.
23. **Sanding:** Sanding on diesels are often pneumatically operated and produce a very distinctive sound. Record this with the engine not moving and all other sounds and appliances off.