

# Why is Church Sound So Confusing?

## Nuts and Bolts and More Tips

*This article is Chapter 4 in a new book "Why is Church Sound So Confusing?" by Joseph De Buglio. See page xx for information on the complete book. It will shortly prove to be the complete word on church audio installations.*

### WHEN TO START TRAINING?

Before we can suggest a sound system design, we must look at the larger picture. It is one thing to give a church a sound system that finally does what it is supposed to do, it is another thing to know how to use the system to enhance the worship, rather than degrade it.

The operation of a church sound system is a team effort. That team includes the Minister, the Organist, Pianist, Choir Director, Song leader, Soloist, Musician, Lay readers, Guest Speakers, Guest Soloists, Guest Musicians, Children, Teen-agers, Lay members, Ushers, Deacons, Elders and of course, the sound person. (Some women have proven to be the best sound system operators in North America.) Every person in a church needs to be taught how to use a sound system, what to expect of it and how to get the same high quality results every time.

We are now approaching the third generation of churches with audio and it seems that 98 percent of the people haven't a clue about what they are doing. The purpose of the sound system is to have the people in the pews intimately involved with every part of the worship.

Example: In some churches there are lay people who pray out loud during a planned part of the service. Often, they will simply pray out loud from where ever they happen to be standing. In small churches this works just fine but in larger churches, a person's voice needs to be amplified. It is interesting to see what happens when a microphone is put in front of most people. Give a person a microphone and their automatic volume control turns down. Furthermore, they often hold the mic so far away they give the impression that the mic has teeth. Sometimes they hold the mic as if it has the pickup capsule in its side. Now, if you combined these two responses, you may conclude, as I often do, "what that person has to say must be so personal they don't want to share it with others." The only reason for these responses is lack of education. People have to be given permission to speak out with the equipment they have. Would you build a church to protect you from the elements and then have all of your services out of doors because you're afraid to wear out the building!

The worst offenders of not using a microphone properly are ministers. Most ministers act as if the micro-

phone is a hindrance or an obstacle that well meaning people put in front of them. Considering what Bible Colleges teach and what those institutions own, it is no wonder ministers are afraid of using audio equipment. A poor system in a church literally drives people away. All the mic techniques in the world will not help.

However, in a proper sound system, the microphone becomes an extension of your voice so everyone can participate. If you treated a microphone like an ear of a very close friend, you would be well on your way to taking advantage of your ministry.

### HOW TO USE A MICROPHONE

The way this works is very simple. If you were speaking softly, as you would with a close friend with whom you have an important message to share, you move closer. This means getting within 4 to 12 inches from a mic. With a good system this is whispering. When you are talking as to a friend across a living room with general comments, you should be 9 to 20 inches from the microphone. When you have important statements or a special point on which you want to raise your voice, you should be 15 to 36 inches from the microphone.

The reason for using this method is straight forward. When your voice is low, there is a lot of detail that people often miss. This detail is needed because it's not what was said but how you said it that will carry the largest impact. Your words of comfort are meaningless if people only hear 30 percent of them. Therefore, getting closer to the mic allows people to fully understand the importance of those supporting words. Likewise, when you are excited, you need to move away from the microphone.

When you speak louder, you will blow more air. As you blow more air, you will pop the mic with strong bass sound. This is annoying, distracting and easily avoidable. If you are able to move away from the mic (if you are hand holding it, it works the best), you will also keep the volume down while getting your message across more effectively.

Getting louder often does not mean getting clearer. In fact, as you increase the volume of a sound system, the room starts to fight back. If the acoustics are good, the sound can be louder but, as in most churches, there is a narrow window at which the volume can be

set and it is up to the person speaking or performing to know the limits. It is insulting to everyone when a sound system is so loud you can not understand what the minister is saying.

There are many churches today that are abusing our hearing. Did you know the average sound pressure level of congregational singing in a conservative Protestant church is about 95 decibels (dB) and in a Pentecostal type church the singing is about 5 to 10 dB louder? According to most of the Health and Safety Acts around the world, long-term exposure to sounds at these levels will cause some hearing loss. In one church, the congregational singing could last up to an hour and a half. In this 2,000 seat church, the sound levels were often over 108 dB. According to OSHA, your exposure time is 30 minutes without hearing protection. Perhaps if people started to ask for hearing protection in some churches, the sound levels would come down.

(Many of these churches have serious acoustical problems and most sound men and audio companies have the attitude that if you turn up the sound loud enough, eventually, the room will not have any effect on the sound and it will eventually get clearer. Folks, the opposite is true. Turning the system down will not only make it clearer but people would get more out of it than just abuse.)

Distance	SPL dB	Increase
32 in	60	0 dB-Performance of a HIS System
16 in	66	6 dB-Normal Speaking Distance
8 in	72	12 dB
4 in	78	18 dB-Typical singer holding mic
2 in	84	24 dB
1 in	90	30 dB
1/2 in	96	36 dB
1/4 in	102	42 dB
1/8 in	108	48 dB-Lips touching the windscreen

#### *Sound Pressure Change When Moving Into A Microphone.*

This chart shows the amount of change that occurs as a person moves around a microphone. Just as doubling your distance changes sound levels 6 dB at the speaker end, the same happens with input. When a person moves into a microphone room 16 inches to 1 inch, the sound pressure change is 24 dB. In this close distance, there is little or no room effect on the input signal.

#### **A CONSTRUCTION DETAIL TO CONSIDER—AND MUCH NEEDED**

Cable chase ways: Since there has been no standard in church sound systems, the idea of a cable chase way seem pointless. However, if a cable chase way for lighting and sound were planned, then the church could have flexible options in the future.

Cable chase ways are not new. In fact, offices have had them for years. Cable chase ways cost more during construction but later when changes are done, there would be no need for expensive conduit work af-

ter the fact.

#### **IS THE "Q" IMPORTANT?**

It is now generally accepted that a church is best served with a central cluster speaker system. The speaker system is often placed somewhere over the front of the pulpit or platform area using directional speakers that have a predictable and constant dispersion of sound. Omni directional speakers such as spheres, column speakers, low "Q" speakers and Hi-Fi speakers fail to perform in so many critical ways they are not worth the paper to criticize.

Not all speakers are the same and these other speakers work better in application where non-critical listening is required. Finding so many Soundspheres in church closets, for a "State of the Art Technology" that is considered current, is a clear case of buying the wrong tools for the wrong job. Between spheres, column speaker, flat speaker other speaker designs and audio products, if all of the churches who owned them donated this equipment to other churches who are determined to waste their money on this inappropriate equipment, the equipment could be recycled many times and churches would spend less of my money foolishly. However, as one church board chairman said, "I wouldn't want that equipment wished upon anyone else...." Those strong opinions are often made after a church has had the opportunity to compare a proper church sound system with one designed with good intentions.

In the early days of church sound, speakers generally were all horn types with horn loaded woofers. Amplifiers were expensive and rarely over 100 watts in power. (Today, many amplifiers can produce over 400 watts X 2 channels at a 4-ohm rating.) A term often used and often misunderstood is "Q". "Q" is the directivity rating of a speaker.

High "Q" speakers are designed to project sound over large distances. A low "Q" speaker is a speaker that allows the listener to get comfortably close without serious degrading of the sound. A hi-fi speaker is a low "Q" speaker. A police Bull horn is a high "Q" speaker.

Just as the installation of the Organ was resisted in the church because it was once played while Lions were feeding on Christians in Roman arenas, churches have also been slow to embrace the sound system for similar reasons. At first, churches used their sound systems strictly for speech only. Today, some of the best sounding systems in public places are in churches.

In the beginning of church sound, people soon learned that a sound system was very limited and often the room had to be fixed. Many churches did fix their sanctuaries with very good results. In the mid 50s, bigger and less expensive amplifiers arrived in the market place. At the same time, speaker engineers began to understand what "Q" was and how to measure it. A high "Q" rating could be from 10 to 25. A low "Q" is from 2 to 9.

There is a direct relationship between reverberation, "Q" and how much direct sound arrives to the people in the pews. Poor reverberation limits the performance of a speaker system. By increasing the "Q" of the speaker, you can compensate for the increase in

room reverberation. However, there is a limit as to how high you can increase the reverberation of the room and have a speaker with enough "Q" that will still give the best sound coverage possible.

As more churches began to accept and use sound systems, audio contractors suddenly had to deal with churches that had reverberation times of over 1.5 seconds. (Most audio contractors rarely have to deal with as hostile an acoustical environment as that which occurs in churches.)

There are some speakers that have a "Q" of 50. A police bull horn has a "Q" of over 50. Police bull horns don't sound very good. Many church sound systems sound like bull horns but regular two way speakers are being used which should sound very natural. Once a speaker "Q" rating passes 25, it no longer sounds natural due to too much compression of the sound within the bell of the horn. (Horns compress sound in terms of ratios. A highly projecting horn can have a compression ratio of 12-15 to 1. A natural or musical sounding horn has a compression ratio of 4-8 to 1. Low compression, high "Q" speakers give the best overall performance in a church.) Speakers with a "Q" of over 22 generally are not very musical. They have to be supplemented with woofers. The end result is the woofer drags the "Q" rating, over the full range of the speaker system, down.

Later, someone discovered that if you stacked several horns on top of each other, you could increase the "Q" of the speaker system and maintain a reasonable quality of sound.

This works fine but where do you draw the line? When is it time to stop looking to sound equipment as a magic wand to solve poor building designs or poor use of construction materials?

In one photograph (page 348 in the book *Sound System Engineering* by Don Davis), it shows a speaker cluster of 4 horns and 4 woofers stacked one on top of the other. It was demonstrated that the test worked very well but the speaker system looked awful. This was an example of creating a high "Q" array using a column speaker approach. In this case, it would have been better to fix the room rather than having a speaker system that looked like a monster.

There have been several studies and charts suggesting the limits of reverberation and the "Q" of the speaker system for churches. (These charts can be found in the books mentioned earlier. Klark Teknik has a manual that has excellent charts on this subject.)

From experience, a church with a reverb time of 2.4 seconds or longer at 200 hertz will not be able to count on their speaker system to work properly for every part of the worship service. "Q" is important but there is a limit. The higher the "Q", the more speaker compression.

For churches that have ambitious music programs, a medium to low "Q" speaker that sounds very musical and low reverberation are a must because in a loudness war, the room always wins. (A list of the 5 top speakers for the HIS System discussing their good points and bad points and when to use them will be in the next update.)

Note: Dome tweeters and bullet horns have a very limited use in a church. They have two major prob-

lems. If the speaker system was only controlling pre-recorded music all day, they would work very well. However, speech requires a lot of speaker output in the mid range. Many domes and bullets fail and fall short of the power demands of speech. Secondly, most domes and bullet horns have such wide dispersions that gain before feedback is seriously limited. Although domes and bullets allow you to make a lower cost speaker, the performance limitations and high rate of failure make them impractical for use in a church.

## ARE ALL SPEAKER CLUSTERS THE SAME?

It would be fair to say there are huge differences in speaker components and the jobs they are designed to do. It is also important to know that the position of a speaker in a room is super critical. Every room has a sweet spot. A speaker out by 1 foot can make \$2,000 speakers sound like \$50 A.M. radio speakers.

Some speaker systems are less critical than others and in some rooms there is no room for error or flying by the seat of your pants in design. You should have a detailed knowledge of your sound system supplier. The following is a list of things you should know about your supplier:

1. Learn everything about the speakers you are being recommended. An audio contractor doesn't have time to know about every speaker that is available or how they sound.

2. Avoid custom built speakers. A custom built speaker is often designed on a given set of assumptions.

3. If you have a custom built speaker for an original design, ask for the printed test results. Usually, there is no laboratory testing on custom speakers so you have no way of knowing 100 percent how the speaker will behave under church conditions.

4. A good sound contractor will have a limited number of speakers they use and will know them inside and out.

5. Learn how to read a spec. sheet and understand what it all means.

After selling over 100 complete sound systems, it never ceases to amaze me how a church can spend huge amounts of money based on a proposal without going to hear the finished product in other churches. Many speaker clusters look the same. Many audio companies use the same equipment. The end results are like day and night. When you buy a church speaker system, it must be assembled and strategically located in your church. What good is it to have a speaker shoot-out at your church when the audio company doesn't know how to install it for the best performance. Speaker testing is often a waste of time for the client. It is very important for the contractor.

In many speaker demonstrations, people are often caught up in how a speaker sounds rather than knowing how a speaker performs. In reality, the differences between speakers from the major speaker manufacturers is very small. It is the ability of choosing the right speakers for a given job, that takes skill.

In a recent speaker demonstration in a church, three different horn speakers from three manufacturers were represented. Before equalizing and before

setting the volumes at equal levels, all three speakers had very distinct sound differences. However, after equalizing the speakers and setting the volume levels to equal loudness, the differences were very small. In each case, the speaker system was limited by the performance of the room. Once the room was factored in, the sound quality of the speakers became very similar. What was more noticeable was speaker coverage and control. One speaker was more musical, the other could play louder and the final speaker had better control.

### WHAT DOES THE CHURCH NEED? DOES THE CLIENT KNOW?

Speaker clusters have a very small window in which to work. When you buy a sound system for your church, it must include the skill of your contractor and his sensitivity to the needs of the church and the acoustics of the room. It is nice to buy the speaker system that sounds the best, but if the best speaker system can't sound better than the others because the room gets in the way, isn't it better to find the best combination supplier, speaker and room repair?

When a church asks for a demo in their sanctuary, the smartest sales person is going to win. When a church takes the time to visit other churches to hear the system in action during a worship service, the best performing system will win. Not all speaker clusters are the same and not all audio contractors know how to find the room's sweet spot.

### ONE RULE—ONE FACT

One of the most important rules for all sound operators is simple: Once the minister begins to preach, you are allowed only one volume level adjustment throughout the whole sermon (unless your minister instructs you otherwise). With a good sound system, the minister should be able to control their own volume by using the microphone properly (more effectively). However, there is one adjustment most ministers won't mind.

Most sermons begin 3 to 7 minutes after singing. Since most singing is very loud, your hearing of low sounds is stressed for a while. Speech is intermittent. Speech gives our ears a chance to rest between words. When the volume is set right after a Hymn, chances are it is too loud. Some people get the impression the sound system has been turned up. Rather, it is our hearing that became more sensitive to lower level sound.

Often the sound person can lower the volume of the system by 3 to 5 dB at about 5 to 10 minutes into the sermon. The interesting thing is, if you don't do this and you need more volume from the sound system, it won't be there.

Another rule is to turn off all other microphones not in use during the sermon. The more mics that are on, the less gain you have before feedback. This is important for the times when your minister has a throat problem but is determined to continue in a lower voice. Furthermore, the sound tends to sound clearer because there are no open mics to reinforce the first sound. There are other reasons for turning things off or down, but for now, these reasons will do.

### A POWERFUL PERSON

One of the most important facts is, the soundman, in churches with a good sound system, is the most powerful person during a worship service. The soundman can either enhance everything and assist people sitting in the pews to be more involved with the service or, the soundman can undermine everything the minister does without the minister knowing it. It is time we wake up to the fact the 95 percent of all churches have a sound system of some kind. Unfortunately, only 5 to 10 percent of these churches have a sound system really usable as a tool. All other churches have sound systems that get in the way. When something gets in your way, it undermines everything. Even a good sound system can have the same problems of getting in the way.

For example: In a good system where people expect to hear properly, the minister or a lay person may move to a mic that has been turned off to give the other mic better control. The sound person should be alert and see the minister moving to the other mic.

If the mic is set right, the mood of the service continues. If the minister speaks for 3 seconds or longer with the mic off, and the minister notices it, what happens? It breaks the mood and often, his concentration. This single event upsets more ministers than anything else. Moving from one mic to another at the closing of a sermon may be just what the minister needed to do to make his final plea or point. A soundman asleep at the controls is unacceptable.

Of course some will suggest using a wireless lapel mic. In my opinion, a wireless lapel microphone has some noticeable limitations. Most churches do not have the acoustics needed to use a lapel mic effectively. (Usually this means a dead room and most churches don't want dead rooms.) With a lapel mic you cannot raise or lower your voice too much without losing something or distorting the wireless. (Automatic volume controls will cause other problems.) With a wireless, all you get is plain vanilla in the presentation. Just as some ministers wear the well-earned title of word smith, a person can also be an *amplified voice smith*—a person who knows how to present a message using all of the inflections of voice. Casey Kasim has the most recognized voice on TV today. He has made millions of dollars selling his voice to television.

On PBS, the public broadcasting service, there is a weekly show called *Nature*. The success of *Nature* and its continuance is based on the voice of George Page. This is a voice that brings life to the screen. Jason Robards, Lorne Greene, Robin Williams and Dick Van Dyke are all examples of the use of voice. As they say in the business world, it's not what you say but how you say it. A good sound system accurately reproduces everything you say and how you say it — the key to a successful presentation.

A lapel mic can not give you anything more than a vanilla presentation. Then again, there are many gifted ministers who know how to make plain vanilla taste like chocolate. Of course, this is only an opinion based on many experiences. What have your experiences been?

This is not to say wireless are not effective. For drama presentations, plays and other specialty

events, a lapel wireless setup is just the ticket. Today, some ministers make the usage of a wireless microphone a condition of their employment. Getting a wireless mic just to have "freedom" must be combined with planning to be more dynamic with body language. What a church should avoid is getting a wireless lapel mic for a minister who does not use body language in their presentation when they could have done better buying 6 regular microphones for most of the other events they wish they could do better. A good wireless lapel is a lot of money. If all you have is \$1,000 to spend, 6 mics with stands and cables could be the wiser choice.

## ASSESSING THE SANCTUARY

### Room Shapes

There are six basic room floor plans with hundreds of variations of each. There are rectangles, squares, diamonds, ovals, triangles, circles and pentagons. In roof designs there are several basic shapes with many variations of each. There are Domes, "A" frames, Flat, Sloped, Vaults and waves. Almost all the known shapes will work but you need to know at which end of the church you will preach and at which end you will listen.

The type of room shape must match the nature of the service or denomination. There is no such thing as an ideal or perfect space but, it is important to recognize the shape, how it works and where the speaker system must go. Don Davis wrote in his book *Sound System Engineering* that a speaker system often goes where a wall or ceiling should be. This is very true. But as you get into larger spaces that seat 200 people or more, you need more than a reflector. The wall must amplify as well.

## SOUND SYSTEM DESIGN TYPES

In churches, you will see a variety of system designs used. Some designs are chosen because of appearances, others are chosen because of the perceived cost savings but most are installed to compete with room acoustics. Unless you have a ceiling lower than 12 feet, the best system in any church is a Central Cluster design.

The Central Cluster design forces you to look at the person speaking or singing. It offers the highest levels of intelligibility. It has the lowest levels of Listener's Fatigue.

It is usually the best layout for operating and hearing the speaker system. It usually has a higher level of gain before feedback. It is a system that you notice the least.

Therefore, you can say a central cluster system is the least obtrusive available. The other sound system designs are either creators of dead spots or very expensive if done correctly.

The following is a description of the various system types and why they are not appropriate in a church.

## PEW BACK SYSTEMS

The pew back system is most often attempted in churches with long reverb times. It is based on the idea that if you get the sound sources closer to the peo-

ple, the listener will get more direct sound and less interference from the reverberation of the room. If it is to work, it can only be a speech system. It will not work well for music because music has to be played loud enough for the musicians to hear themselves. This means, in the pew back system, a listener could hear both the direct sound and the amplified sound coming from many directions, depending on how the listener moved their head during the live music. Music, at a medium level in a pew back system, will increase the reverberation time of the sanctuary. Remember the reason for the pew back system?

From the experiences known, there is no church that has a pew back system that works as good as a properly designed cluster system. Generally, a pew back system is abandoned after several years of trying to make it work. Robert Schuller's Crystal Cathedral in California is a prime example. They went from a cluster system to a pew back system and now they are back to a cluster system. The next step is to find a method of reducing the reverberation without interfering with the appearance of the "Glass Slipper".

## DESIGN PRINCIPAL

The pew back system will have speakers mounted either on the back of the pew, under the pew or on the floor under the pew. A speaker is placed every few feet to give even coverage in each row. Each row, or in some cases, every other row gets speakers. Some people have tried one speaker for every other person or a 2 to 1 ratio, while others have tried up to 10 to 1 ratios.

For every 2 or 3 rows of speakers, you have to install a delay system. The delay is used to delay the electronic sounds from one row of speakers to the next and to delay the electronic sound from the source of the sound. Without the delay, you will hear echoes. Costs can vary. For a speech only system that works reasonably well, the cost per seating position can be well over \$80. This makes it the most expensive way of doing sound. Would it not be better to spend \$35 per seat on sound and \$45 per seat on acoustics?

Contractors who have tried pew back systems have used all types of speakers at all angles. It doesn't seem to matter whether it is a \$10 speaker or a \$200 speaker, overall performance is low. Some systems are on a 70 volt or 100 volt distribution layout, while others have tried a mini amplifier for every 2 speakers. Others have also tried to series speakers together to try and keep the amplifier cost down. Running an audio signal from speaker to speaker does create other sound quality problems as well.

The only place for a pew back system is in town halls, city hall council chambers and in churches that have no music in their services.

## THE LEFT/RIGHT MONO SYSTEM

The left/right mono system has always been called the poor man's system. It is installed out of convenience, lack of planning and a copy of what entertainers do when they only have a few hours to put on a show. Of all the books available on sound reinforcement, not one book shows how to install such a system. Rather, they go to great lengths to explain what is wrong with it. Instead, they all support the cluster system as the

best way to install a permanent system. The left/right mono system is strictly a portable or temporary system setup. It was (and still is) a fast and convenient system by which entertainers could put on a show for their public.

There are four main reasons for not using such a system in a church:

### 1. Dead Spot

When you have two mono sounds separated by 10 feet or more, the left and right speakers will start canceling each other out in the overlap areas and whenever you are at a different distance from each speaker. When you are at an equal distance to each speaker, the sounds are summed together, often increasing the sound level 6 to 9 dB.

When you include wall reflections, the problem is compounded and it creates additional dead spots. When the speakers are 25 feet apart or wider, the areas of overlap increase dramatically. A dead spot can be easily measured with an inexpensive sound level meter such as the one Radio Shack stores sell.

In many testing experiences with computerized measurement systems, some very interesting pictures of sound began to appear. In many churches with a left/right system, it could be seen how the sound from the left speaker was louder than the right speaker but, the test microphone had been placed in front of the right speaker. This position would be about 30 to 55 feet out and about mid point of the right side of the church. By standing at this position and running the test signal, you could indeed hear which speaker was louder. Please, remember that dead spots are often frequency dependent. That is, since every frequency has a different wave length, not all sounds or notes will cancel or boost at a given position. A sound level meter can tell you whether the sound is lower or louder. A computer system is needed to determine if certain sounds are missing in a given position. In translation it means that in this pew the vowel "a" and a "Mc" are not audible and all "b" and "ch" sound are too loud. Some people can fill in the blanks better than others. People with hearing aids have problems in this setting.

### 2. Gain Before Feed Back

In a left/right speaker installation, the speakers are often placed behind the pulpit at equal height or slightly higher than the pulpit. Most speakers have great vertical dispersion control but poor horizontal control. This is like placing a microphone in front of the speaker, and we all know that will cause the system to feedback. The causes of feedback are a combination of acoustics, angles of incident, proximity effects and oscillation. As you turn up the level of a microphone, it is able to pick up and amplify everything. This includes any low level noise generated by your electronics (mixer, amplifier, equalizer, preamps, effects devices and other pieces of electronics connected to the sound system that is unstable. Poor wiring and electrical induction are other causes of noise.) As a result, any speaker close to a microphone will cause feedback. Any speaker that has a signal path with an angle of incident that reflects sound back to the microphone will cause feedback. When the gain of the mic is turned up so loud that the noise from the system is being recycled (that is when the noise in the

system is being produced by the speakers and picked up by the microphone, the level increases in a cycle many times until you hear it. This can appear to happen instantaneously), it causes feedback.

The acoustics part of the picture is more complex. All large rooms are constantly flexing and moving. This is a constant effect altered by room temperature and humidity. Speakers move air. Microphones will amplify everything whether you can hear anything or not. At a level you can not hear, the room's flexing is being picked up by the sound system. As long as the level of sound system is kept low, the sound system is stable. When the levels of the sound system are turned up, decay time of the rooms flexing becomes longer. Now, at the same time, the speaker system is moving air and exciting the room, multiplying the energy output hundreds of times. This creates a chain reaction in which the sound system amplifies the resonant frequency of the room (room flexing) and causing feedback. Acoustics play an equal part in the causes of feedback. When there are multiple speaker locations in a room, the number of wave forms that will excite the room increases. Also, the number of hot spot reflection points increase which causes feedback. This is only a partial explanation.

### 3. Intelligibility

Intelligibility is the understanding of individual words. As discussed earlier, in a 45 minute sermon a minister can speak about 10,000 words. A sound system with a score of 80 percent intelligibility will mean that 2,000 words in a 10,000 word sermon were missed or misunderstood. Depending on your seating position, one speaker will either boost or cancel certain frequencies. That means every "ch" sound is canceled and every "a" sound is amplified. As a result, many words and word fragments are missed. Fortunately, our brains are usually fast enough to fill in the blanks because of familiarity with the subject matter and the person speaking. A visitor to the church does not have this advantage. For this reason, no church should accept a sound system that scores below 87 percent intelligibility. Below 87 percent people can misunderstand complete phrases. The TEF or MLSSA acoustical measurement systems can test a room's intelligibility in minutes.

### 4. Localization

Churches always say they don't want to see or hear the sound system, but it must be loud enough and crystal clear. When you have a sound source at ear level, you are automatically programmed to first look at where the sound comes from, then to look for the source of the sound. This is a basic protective instinct all creatures possess — to be able to tell where danger is coming from is natural. Since humans have no natural enemies that attack from overhead, man has his eyes and ears where they are, on the front and sides of our heads. A mouse is most often attacked from overhead. They need their eyes and hears closer together, near the tops of their head. A mouse can also rotate the ears to find the noises.

When the sound is coming from one direction (Speakers) and the visible source is in another direction (the person speaking), the human brain goes into overtime matching up the two events. When you compound low levels due to feedback problems, low intelli-

gibility and multiply sound sources, you have classic listener's fatigue syndrome.

It has been shown that a poorly designed sound system can help people lose their attention span or cause them to nap sooner than when a proper sound system is used.

The difference can be as much as 20 minutes.

When the eyes and ears can focus on the same event, you spend most of your time understanding what was said. When a left/right, or distributed or pew back system is used, you really spend most of your time just trying to hear.

It would be fair to say most church sanctuaries, by themselves, do not have dead spots. Rather, most churches are so large they need amplification. If all you need is extra level, then why would anyone install a sound system that creates dead spots?

### WHAT ABOUT A STEREO SYSTEM IN A CHURCH?

Some churches have successfully installed Stereo Reinforcement Systems. With the arrival of electronic instruments, stereo keyboards and tape accompaniment, some churches have felt it necessary for this kind of investment because they had the facility and talents.

Remember, a Stereo system at home is the opposite from a stereo system in a church. At home you position yourself between two speakers and the recordings play tricks with phase to give the impression that sounds are coming from different places within the sound field. In a live situation, you can see where the sound is coming from. Therefore, the sound system must give the impression the sound comes from the same place otherwise the performer will hear an echo and it will disrupt their playing ability. A live stereo speaker system is really many speaker clusters over the performer's head. The nearest cluster amplifies and the other speakers are silent. This gives the effect that sounds are coming from the different parts of the stage where the performer is, giving a better picture of localization. As a result, a true stereo church sound system can cost 4 to 5 times more than a good quality mono single cluster. (Church stereo systems will be

discussed in detail in future editions of the book.)

### SPEAKER LOCATION

The location of the speaker system in a room is the most important step in clinching the desired results. If the speakers are in the wrong location, the rest of the system will sound mediocre despite the quality of the equipment. In almost all churches, there is only one proper location for a speaker system. Any other location is a noticeable compromise in comparison.

The speaker system in your church is the most important part of the audio link. If this part of the system is not correct, you will not be able to successfully make any improvement through electronics. It is vital therefore, to make your speaker system the first step in correcting your sound problems. Not treating the speakers first will result in needless experimentation and expense. (It is amazing to see all of the gadgets churches try to invent. If only they knew the laws of audio and acoustical physics, they would spend millions of dollars less on audio products that don't work.) In rectangle shaped rooms, a single point is ideal for all church application.

(According to Dr. Dave Eagan and Dr. Don Davis, there is no other shape better than the shoe box or rectangle church. Boston Symphony Hall is a prime example.) Often the speaker location is always several feet in front of the pulpit, overhead. Other times it is directly overhead while in some rooms it is 2 or 3 feet behind the pulpit. The exact positioning must consider ceiling height, pulpit height, width of room and pulpit to back wall distances.

In wide or fan shaped rooms, localization of sound does present a minor problem. Those sitting on the ends will perceive two sound sources. This will not reduce intelligibility. However, it will introduce minor amounts of listening fatigue.

For this reason, it has been our practice to divide the sanctuary into several rooms. This gives all people a point source for listening comfort. Sub clusters are very effective. Phasing problems are controlled by separation, crossovers between horns and sometimes digital delay circuits.

*Typical comparison of a Single Cluster Speaker System verses a Multiple Speaker System.*

Situation	Cluster Systems	Other Systems
Dead Spots of 3 dB or more	Almost none	Many
Phase Cancellation	None	10 to 30%
SPL from front to back	6 dB or less	Often 12 dB or more
Realism	98%	15% or less
Articulation	+85%	75% or less
Intelligibility	Great	Poor
Max. working distance before feedback	20" to 40"	4" to 16"
System design life	Permanent-possibly unlimited	Replace when no longer tolerated
Listening fatigue	0.5%	20 to 50 %
Music Quality	Hi-Fi	Limited
Flexibility	Very good	Limited
System headroom	20-30 dB	10-20 dB
System focus	Pulpit area	To each speaker
Echo Amplification	5% or less	10% and up

## CLUSTER HEIGHT

The maximum height for a cluster should be no higher than 40' and no lower than 13'. However, height is also determined by the speakers throw distance and other room restrictions. Remember, the closer to the ceiling, the more bass the speaker system will produce. If the room is bass heavy, hang the speaker lower if there is room to do it.

If you require a throw distance greater than 145', a sub cluster system may be required. Ceilings below

Height	13'	Max. Length	48'
"	20'	"	72'
"	25'	"	85'
"	30'	"	110'
"	35'	"	130'
"	40'	"	145'

*Height Ratios. The target point is usually the third row of pews from the back wall.*

13' may require other system designs. This book will not discuss these requirements in detail in this edition. Send for a Supplement for your church.

## SPEAKER SAFETY

Hanging a speaker from a ceiling presents some concerns that need to be addressed:

1. Cabinet construction: Ceilings in many churches have a wide temperature range. During the summer in some churches, the ceiling can exceed 120 degrees for many days on end. Many speakers are only fastened with nails and glue. There are a number of stories circulating the Audio Engineering Society (AES) and the National Sound and Communications Association (NSCA) that describe how speakers are falling apart and falling down. Look for a speaker cabinet that is reinforced for roof suspension.

2. Do not use chain: Speakers vibrate and it can cause metal fatigue to the chain links. Also, a lot of bass sounds are lost with chain suspension.

3. You should not use aircraft cable because of sound quality in the bass. It has the same problem as chain.

4. Speakers should be supported from the side walls, not from the top of the cabinet only. (Some speakers have metal rods or bars that run through the speaker box to support the bottom of the speaker from the inside. Also, look for a speaker with a space frame type of construction.)

## SPEAKER BRACKETS.

Custom steel speaker brackets are the best way to support the speaker system and they are very inexpensive to make. A properly welded steel bracket wins in many ways. Depending on the number of speakers in the cluster, there is a wide variety of fast and simple adjust you can make that are often too awkward with chain or cable.

In most single and two speaker clusters, the steel bracket is very cheap to make. A bracket that is safe up to 400 pound can often be made for under \$50. That includes the steel, welding and paint.

## THE BEST ILLUSION OF THEM ALL!!!

There are three very strong effects only a central cluster can do. The first, which has already been mentioned, is localization. From 80 to 90 percent of all the seating in the church, when someone on the platform of the church speaks, sings or plays, everyone's attention is on that person. Since the cluster is positioned in the vertical axis of our ears, the sound arrives to both ears at the same time. The reflected sounds will give the direction.

Since the reflected sounds are much lower, your first reaction is to look at the pulpit area or center to the altar area. At the same time, your eyes will focus on the first moving object or to the tallest person standing at or around the pulpit. The only people who will notice the cluster are people seated at the extreme right and left of the front three rows of pews.

The second effect clusters give is the illusion that the minister is only four or five feet away. Since you are listening to only one speaker in your seating position, there is no presence cancellation. Generally, this effect is for 70 percent of the seating and when the RT60 is below 2 seconds. When the RT60 is longer, not only does the sound system lose intelligibility but the music program is degraded.

Multi sound source speaker systems can never give this effect. This system gives the illusion the minister is further away than what he is in reality.

The third and most exciting illusion a cluster has to offer is movement of sound. Since 80 to 90 percent of the people seated have sound arriving to both ears at the same time, it is very difficult to say where the sound is being amplified from except from the source, the minister, lay person or singer. When the person moves, the sound appears to move with them. There is a limit to this. If the minister moves from a central pulpit position to the extreme left, talking the whole time with a wireless lapel mic, it leaves the audience thinking the sound followed the minister until he had moved half the distance, then the speaker is high. Example: If the cluster is 20 feet high, the minister can move 10 feet to either side of the pulpit and have the illusion that the sound is following him.

Since it is natural to look at what we hear, the central cluster approach to church sound is the only truly natural method of sound reinforcement.

## SOUND OPERATOR TIP

One of the rewards of installing a high quality and affordable sound system is in the listening to the system. When a system is properly adjusted, for the many different parts of a worship service, you will have the impression that the sound system is not on at all. Although many listeners like the effect, a new problem keeps showing up.

For every new system, you try your best teaching the volunteer operators of the system. In recent years, video taping the training session has become a valuable tool in reminding the sound operators of all the tricks to using the new system. However, as good as some sound operators are, training can take many sessions.

As stated earlier, many people with audio experience have generally picked up many bad habits. The

one habit that is hard to break is the most obvious. In many retraining sessions, I have found the operator has changed the channel equalizers or the main equalizer in such a way that the sound system sounds like a bull horn.

It seems that hearing the minister as though he were only 2 feet away is not enough. Many sound operators want to hear the sound system sound like a PA system so they will be convinced the system is working. The bottom line is, they don't trust their hearing. Although this is not a serious problem, it has caused some embarrassment to the suppliers of such systems.

If you operate a good sound system, trust your hearing. As long as you can understand the minister, everyone else will too.

## MIXER LOCATIONS

The best location for a sound operator in a church is on the main floor, 1 to 3 rows from the back of the church and in the pews. Preferably, just inside of the outside isles.

If there is a balcony with seating under it, the mixer desk is best located 2 or 3 rows out from under the balcony's front edge. Although it is a new concept to most churches of today, historically, churches started the idea of having a sound operator controlling the sound system from within the congregational seating area in the 1940's.

As it turns out, it is impossible for a person to adjust sound levels from one area for people in another area. It doesn't work. The idea of having a mic mixer in a place like a pulpit or a room behind the altar is very awkward. How many times have you been to a church with such a setup and have heard the sound system ringing or sounding like someone is speaking through a tin can through the whole service. People come to church to pray and hear what the Minister/Priest has to say. It is annoying, insulting, and rude to have to put up with something that could have been adjusted in seconds.

And of course, when someone complains, the Minister/Priest says he didn't hear it! Well of course not. You have to be in front of the speakers to know what is happening. Well, enough with people frustrations.

Having a sound operator and a lockable secured wooden or steel mixer desk is the best choice. For some denominations, that have a very structured hour of worship, in most services the levels can be pre-set with 3 or 4 mics and no one needs to operate anything. The only problem with this or any automated system is that everyone speaks differently from week to week, day to day, minute to minute. Even with the most professional presenters, no one is able to speak at a constant level for everyone to hear all the sounds at the same volume. True, you can get expensive gates, limiters and compressors but their use is very limited. For example, if you set your limiters for a person with a powerful voice who is speaking very close to a microphone and seconds later pass the same microphone over to pick up the choir at 10 feet away, you will hear nothing. Move the mic 5 ft. away and you still hear nothing. But if you bypass the limiter, compressor, and gate you will find that you have more than enough audio level.

If there are several things going on at the same time in which many mics need to be turned on or off, having a sound operator is the most natural and best way to run the sound system. With a good operator, most people will not be aware that any adjustments are being made. Besides, when the operator is in the pews, he cannot day dream or fall asleep. He is forced to stay alert.

It is no secret that the fewer mics that are turned on, the higher the system can be turned up. Most churches that have tried to use an automated mixer system wind up having the bypass switch on all of the time. This translates into a \$10,000 expense that is not being used. The only place where an automated mixer will work well is in rooms with RT60s that are below 1.3 seconds and the NC is 15. There is nothing better than a person operating the mixer for live sound reinforcement.

Balconies are an option under certain conditions and if the sound operator is young and in good health. Stairs are not fun. Setting up a service that has special music or concerts takes three times longer when a balcony is the location of the mixer. Operating from the balcony is a two man job unless you are willing to hold up the service from time to time to let the sound man finish the set up.

From a listening stand point, the balcony must not have an arch or beam above the railing. If there is a beam or arch, it automatically reduces the sound level considerably unless the sound operator is in from the beam by 10 feet.

A good quality custom mixer desk that matches to pew design and color can cost from \$900 to \$1,500 to make. The mixer desk would only contain the mixer, tape machines, wireless receivers and remote controls for lighting and AV (Screens).

## SPEAKER, MICROPHONE WIRES AND WIRING

### Microphone Wire

Recommended Pin connections should be:

- Pin 1 ground, drain wire  
[do not solder pin 1 to the shield]
- Pin 2 ( + ) Hot Red wire
- Pin 3 ( - ) Cold Black wire

This is a standard followed by many contractors and audio companies. However, some manufacturers use pin 3 as hot. Check the manufacturer's specification sheets before you interconnect your electronics as it can often cause some hums and noises when pin 2 and 3 are incorrect.

All microphone { LINES } shall be of a LOW IMPEDANCE TYPE.

All microphone { CORDS } shall be of a LOW IMPEDANCE TYPE.

The line will consist of 2 stranded lines with 1 drain wire or ground and foil shield.

Shield *must* be aluminum foil wrap for permanent wiring. This is currently the best available shielding that will give 100 percent protection from RF. This wire is not suitable for mic cords as the foil shield is prone to breakage or unraveling.

For movable mic cords use a stranded shielded wire. Depending on the manufacturer, the best braided shields are between 85 to 93 percent. However, short

mic cords will maintain a shield under stress from bending. Braided wire is not suitable for permanent installation work as it will not give a 100 percent shielding from RF interference.

### INSTALLATION DO NOTS

1. Do not run parallel to AC (Alternating Current) electrical lines.
2. Do not run parallel to ballast routes or fluorescent lights.
3. Do not run parallel to unshielded speaker lines which operate over 100 watts.
4. Do not twist wire or have any 90 degree turns.
5. Do not splice mic cables. All mic line should run from stage to mixer without breaks. (There is one exception. If you need to split the signal for TV or Radio broadcasting, you need to go through a splitter box first.)

### Conduit Tips

Using Beldon 8451 or equivalent and 14/2 stranded speaker cable:

Conduit Size	Mic Line	Speaker Line
1/2 in	4	1
3/4 in	8	2
1 in	12	3
1 1/4 in	20	4
1 1/2 in	30	6

Never have more than two 90 degree turns in each conduit run. In any system with more than 8 channels as a starter system, you should consider conduits for the following projects that require conduits:

1. Mic cables
2. Speaker cables
3. Video cables
4. Remote lighting
5. Remote platform lighting
6. Electrical
7. Audience mic inputs
8. Distributed system

### HOW MANY MIC LINES?

The number of mic lines you need is also the size of mixer you should have. The only thing to determine a larger mic input requirement is the size of your music program.

Generally, you should have 1 mic input for every 70 square feet of altar or platform space. This does not mean you can't group all of your mics to one location. What this does ensure is that for 99 percent of your churches functions through the year, you will have enough mixer channels and mic input so that you should not have to rent equipment for special services.

To calculate this you have to measure the size of your altar area and divide by 70. The following chart will assist you in your decisions.

- 1 to 9—8 channel mixer
- 10 to 13—12 channel mixer
- 14 to 18—16 channel mixer

- 19 to 26—24 channel mixer
- 27 to 34—32 channel mixer
- 34 to 42—40 channel mixer

There is an exception to the rule. For smaller churches, you should always install at least an 8 channel mixer with 8 mic lines.

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**As it turns out, audio amplifiers are not very efficient but the amount of current generated does raise some safety and fidelity issues.**

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If you can, avoid patch bays. It is often cheaper to buy a larger mixer than to go through the expense of building a patch bay. Besides, most churches I know of who have a patch bay never use them more than once a year. Rather, these churches wished they had larger mixers.

### MIXER TIP

Always number your stage and the mixer the same with mic stage number starting from left to right from the soundman's position. Therefore, if you pulpit is in the middle of the church and you have a 12 channel system, the pulpit control on the mixer will be either 6 or 7. This is very helpful for people who only operate the mixer a few times a year.

### SPEAKER WIRE

For those people who are looking into the audio industry and wondering what all of the hocus-pocus is about in speaker wire, have we got some bad news for you. Are the claims of the seller of expensive speaker wire telling you the truth about speaker wire?

### DOES WIRE MATTER IN A CHURCH INSTALLATION?

For hi-fi people, this book will not settle any disputes. There are dozens of claims that speaker wire manufacturers are making every day. Sometimes one would think that somebody, with nothing better to do, is figuring out what the next scam for wire will be. I wonder how far they will push before they are unable to get away with it any longer?

For the church, there are several solid reasons for doing some of the things needed for a church installation.

Let's start with a high current amplifier. A 200 watt into 8 ohms 2 channel amplifier can generate a considerable amount of current. There is enough current in two of these amplifiers to trip a 15 amp. fuse.

In some of the large current 200 or 300 watt amplifiers that boast they can work at 2 ohms, the outputs either have a 10 or 15 amp. fuse for each channel. That is enough current to run two drills drilling into steel (intermittently). Fortunately, all of that power is momentary. Different frequencies and rapidly changing volume levels often avoids thermal shutdown in a

church setting.

However, we must recognize that even for a millisecond, a 200 watt amplifier at 2 ohms can generate a potential of 10 amps per channel of the amplifier. If this amplifier were 90 percent efficient, it would require a 20 amp service to plug into. As it turns out, audio amplifiers are not very efficient but the amount of current generated does raise some safety and fidelity issues.

Will expensive wire help the church sound system to sound better? In most cases no. The reason is simple. Sonic differences in wire is usually subtle.

Many churches have an NC above 25 dB and/or they have a reverb time longer than 1.8 seconds. This is a very hostile environment for playing games with fidelity. If your church has either of these two problems, there will be too much interference to hear the difference. Furthermore, if the speaker is further than 30 feet away, as it is in most cases, room effect will also interfere with the sound quality.

If your church has neither of these problems, then the wire issue becomes a cost consideration. Some high tech wire can cost over \$15 per foot. In a 150 foot run, the cost of 1 wire run would be \$2,250. The wire costs more than most professional speakers. Therefore, unless you have the speakers to justify expensive wire, common sense should prevail. And one more point, expensive wire on cheap or poorly designed speakers is a waste of money. If you have to choose between speakers or wire, spend the money on the speakers.

It would be fair to say in most cases, the average person in the pew and the musicians will not hear the wire difference in low cost, budget speakers. The magic wire has to offer can easily be defeated by choosing a better sounding speaker.

### **DOES WIRE SIZE MATTER?**

Yes it does. Wire size determines the amount of current you can send over a given distance. In the appendix there is a wire chart that shows the wire gauge to use over distance with 100 watts - 8 ohm, 4 ohm and 2 ohm loads. The length of the cable run, size of amplifier and the speaker's handling capacity have to be taken into account.

The following list and rules should help in choosing the wire you need for the job:

1. Always run 1 speaker wire to each speaker cabinet or speaker component. If your cluster is a 2 way system with 2 woofers and 4 horns, run 6 speaker lines. If you have 2 full range speakers in the cluster, run two speaker lines. This is a real asset in trouble shooting your system.

2. Whenever possible, keep your speaker cable runs under 100 feet. Otherwise, use 14 gauge wire on runs 100 feet or less. Use 12 gauge wire up to 200 feet. For longer runs, double up on the 12 gauge wire.

3. Don't use inch tip sleeve jacks for your speakers. Some amplifiers will not tolerate a momentary short on the output of the amplifier. Either the speaker will be damaged or the amp will fail.

4. Do not use 16 gauge wire or smaller for amplifiers with an output of 75 watts or higher.

### **HEARING IMPAIRED SYSTEMS**

There are four basic types of hearing impaired systems. Each one has an advantage over the other. In most cases, the FM systems do better mainly because of price but an FM system is not for every church.

The four system types are:

1. Hard Wired Systems
2. Loop Systems
3. FM Systems
4. Infrared Systems

Hard Wired Systems are by default the best quality of the 4 systems. However, it is the most restrictive.

The design of the system is simple. From the mixer you run a distributed cable under the pews you want covered. At each seating position you mount a box with a volume control, tone control and headset input. This can be a line level system or 70 volt system. With a good quality full ear cup headset, you have the best signal to noise ratio.

Drawbacks on the system are obvious, you can't move. Therefore, you have to provide many seats with input boxes which drives the cost up. Churches with concrete floors or closed basement ceilings can not use this option. Installation is labor intensive. Cost of the system varies. For 10 people on two rows of pews, you can spend as little as \$400 plus installation. A good quality system will cost about \$1,000. At 12 seats, a wireless system becomes more attractive.

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**FM Systems have recently become the most popular system while many public facilities have standardized with infrared systems.**

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Loop Systems are making a strong comeback. A popular system in the 60s and early 70s, the loop system almost disappeared in churches. In recent years, loop systems have been very effective in simultaneous translation systems, school classrooms and business meetings.

The design of the system begins with an amplifier, a coil of wire around the area people are seated and various types of receivers. A person with a "T" switch on their hearing aid will not need any additional equipment to hear.

Problems with the loop system are frequency range and uneven coverage. Where the loop system wins out is in situations where you need more than one program taking place at the same time. For example, you can have as many simultaneous translation languages you want for as much space you have available. There is no limit. This may mean people have to sit in designated areas but no wires are required. The other advantage of the loop system is privacy. Once you step out of the field there is no further signal pickup. For some churches, this is an important issue.

FM Systems have recently become the most popular system while many public facilities have standardized with infrared systems. FM systems are an alternative to the infrared systems, which are costly in

comparison. The FM systems are every bit as good as the infrared system but they have one drawback. When a person leaves the sanctuary, the signal continues. Some FM systems can transmit over 1,000 feet under good conditions. That means someone could leave to go to the bathroom during the service and not miss a word. It also means that you are subject to public airwaves being listened into with radio scanners. This also applies to FM microphones. If privacy is important, FM will not give you that kind of security. For simultaneous translations, you can have up to 32 channels at the same time.

The *infrared system* has been around long enough to become a standard in public places. Some churches choose this kind of system because the theatre or concert hall down the street uses infrared. Most infrared systems seem to be compatible. The infrared system is secure for privacy and it is very good quality sound. Some of the drawbacks are light and line of sight. In some churches with large windows, the sunlight can add noise to the audio signal. Relocating the emitter can help but a second emitter is often the solution. Another problem concerns the elderly.

Some elderly do not stand when everyone else does. Depending on the receiver, a person standing in front of them can block the infrared signal completely.

As a personal preference, the FM system is the best buy where privacy is not a problem. However, newer infrared systems have been coming down in price. The hardwired system is the lowest price as long as volunteers install it. The loop system is very useful if most of your church members already have "T" switches and then they don't need anything attached to them.

Pop = - a father - a soft drink—a lot of air vibrating the surface of the microphone diaphragm generating an undesirable, low frequency rumble or bang. Words with the letter "P" or "B" are often the cause of blowing too much air = pop

OSHA = Occupational Safety and Health

Poor reverberation is usually when reflected energy is focused back onto the microphones in the platform area. This inhibits the choir, organ and sound system.

Note: Some of the best looking and most impressive spec. sheets in the industry have sometimes been found to be the worst sounding speakers.

Shoot out—OK coral—Frisbee contest

—various speakers set on a stage for side by side comparisons. All speakers must be equalized and set at the same volume using pink noise and a SPL Meter.

Sound travels through wire faster than through the air. Sound travels at 1125 feet per second or 660 miles per hour. A frequency is speed of sound divided by the length of the sound wave.

1125 x 10 ft. = 112.5 hertz

1125 x 3 ft. = 375 hertz

1125 x 6 ins = 3,125 hertz

Series wiring is when you take the negative terminal of a speaker and contact it to the positive terminal of the second speaker. This can be with full-range two way speaker boxes or from driver to driver. This is a low cost method of matching an impedance load. 8 ohms series to 8 ohms = 16 ohms. 8 ohms parallel to 8 ohms = 4 ohms. This most often degrades the overall signal because the signal path includes the voice coil and the crossover in two or three way speakers.

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**Always leave yourself a way out. By not soldering pin 1 to shield, you can easily isolate your audio components to trouble shoot your system for noises, hums and levels.**

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It was once said that if you bring too much attention to a problem, people will either try to prove you are wrong or they think that you are hiding something. Isn't this like watching someone else burn their hands in the fire and then putting your hands in the fire to see if you will burn too! Is experiencing it for yourself more important than learning from others?

SPL = Sound Pressure Level

Remember, you must always think of the cosmetics. Everything you do must appear as if it was meant to be there and not just something added on.

To be finished.

During the late 50s and early 60s, many churches did live radio broadcasts of the service. This resulted in many churches building an enclosed sound booth combined with the broadcast and live sound. This was not just a compromise, it was a handcuff to both the live and radio sound.

Always leave yourself a way out. By not soldering pin 1 to shield, you can easily isolate your audio components to trouble shoot your system for noises, hums and levels. If you need additional grounding to reduce a specific problem, pin 1 to ground in the right location can make a world of difference. However, if pin 1 is already grounded throughout the system, trouble shooting can be a nightmare.

Tip—If you don't have any 12 gauge wire available for runs up to 200 feet, you can double up on the 14 gauge wire.

db