

JdB Sound Acoustics

Article by Joseph De Buglio
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Church Sound System and Acoustics - Signal to Noise Ratio's

Introduction

So, this guy who is a sound expert writes that you only need a signal to noise ratio of 15dB in a church. I believe it should be 25dB for the whole sound system and the acoustics. Well, why is there such a difference. A 10dB different is equal to double the loudness and 10 times the power. How can we be so far apart?



I think the difference is in what that Signal to Noise Ratio (S/N) means in a church setting. I do agree that to hear the playback of music you need to be about 10dB above the back ground noise. I think Muzak is effective for what it does at around 3dB above the noise. For hearing pre-recorded speech as in a Movie or when watching TV 15dB is good enough and 10dB if the music or speech is compressed.

Signal to Noise is also about Input and Output

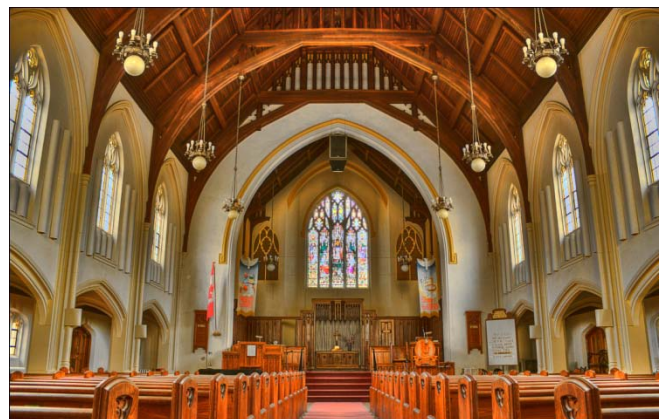
When it comes to churches, you should include the whole circuit of the input as well as the output in that signal to noise ratio. In other words, you have to include the background noise going into the microphone as well as the background noise arriving to people in the pews or chairs. This has to include all of the open microphones you may be running during worship. Furthermore, you also have to include the reflected sound/noise of the room of the person talking and the reflected noise from the sound system too. It is very important of how people hear themselves at the pulpit with and without the sound system. (This gets explained later)

Using A Microphone

In the real world, not everyone will speak up properly and get within 2 inches of a microphone the whole time they are talking unless they are using a headset mic. Even then, the amplified sounds from the sound system at the pulpit or speaking area can be so loud that the S/N can be 10dB or less which puts the whole system at the verge of feedback.

Signal to Noise is not just about Noise

1. There is the S/N of the room.
2. There is the S/N of the amplified sound in the audience.
3. There is the S/N of the amplified sound at the pulpit or input to the open microphone and the ambient sound at the pulpit.
4. Finally there is the S/N of the room where 65dB is the average volume for speech at 3 ft or 1 meter.



When I ask for a S/N of 25dB, it includes all of these variables. Let's face it, many people feel you should be able to talk in front of a microphone at 12 to 18 inches and the sound system should be able to do its job. In the real world, not everyone knows how to use a microphone. Not everyone knows how to project their voices and have great diction. In fact, for some people with less than perfect diction, the closer they are to the microphone, the harder it is to understand them regardless of how loud they are.

The Soundman's dilemma – Can you hear yourself?

Now here is where things get interesting. In a poor room, the reflected sounds from the sound system are so loud at the lectern that the S/N is often less than 12dB and that can include most of the stage. When a person hears themselves so loud, they tend to lower their voice thinking that everyone out there is getting blasted too. As they lower their voice, the soundman turns the level up. The person talking then lowers their voice more. After doing this several times, the sound system becomes unstable and goes into feedback. In many cases if the S/N is less than 12dB at the pulpit, then the sound system is always at the verge of feedback and everyone has to "eat the mic."

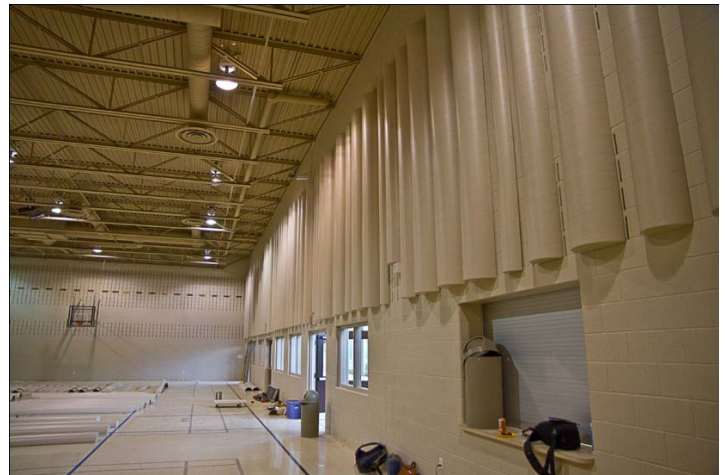
Managing Stage Sound

When I ask for 25dB above the noise, that includes 25dB above the reflected sounds at the pulpit. When a room meets that level of performance, that encourages people to speak louder, and that gives the sound system the ability to do a better job at broadcasting your voice across the whole room. That also means less stage spill from floor monitors. This ratio is also important for churches with drums, percussion and bass guitars. If the reflected sounds from their playing are too loud, the performers will not be able to hear each other and the group leader will drown everyone else out. This leads to IEM (In Ear Monitor) systems and glass shields around the drums. While these technologies work somewhat, there is a disconnect between the performers and the audience. The worship seems more mechanical rather than spiritual. The performers are more like studio musicians and out of touch with the worship. It also undermines younger performers from expanding their talent and growing their skills.

The same also applies to the audience. If the audience hears themselves too loud, they will not sing out as much. They also will feel like they are singing alone. With a better S/N ratio of the congregational singing the congregational singing will get much better too. Here is where a S/N ratio of 15 to 20dB of the audience hearing themselves is good enough.

S/N and Frequency

However, S/N is only a part of the story. For live sound, S/N is also frequency dependant. In a good room, if the average S/N is 15dB and you have a S/N of 25dB at 500 hertz, most churches would be extremely happy with that. On the other hand you can have an average S/N ratio of 20dB but, if you have a S/N of 30dB at 2K and a S/N of 9dB at 200 hertz, your church is struggling. You will spend and spend and spend on technology and only get very small improvements. Congregational singing will never sound good and everyone has to swallow the mic when talking or singing. Stage mix will be a mess, even with IEM systems.



S/N and Dynamic Range

Finally there is one other detail. Dynamic range: Speech can have a dynamic range of 40dB when someone is really excited. For most of us when we talk, we often speak within a range of 25dB. When people visit a church for the first time, the majority of them will not be familiar with church speech, phrases and expressions. The greater the dynamic range, the better people can understand the spoken words. There are some lecturing type of speakers who can limit their speech dynamic range to about 15dB. This is often perceived as boring. The good news is, the last time I measured the dynamic range of a Catholic Priest, an Anglican, Baptist and Presbyterian ministers, they all spoke within a 25 to 35dB range. Pentecostal and independent church ministers can often reach a range of 50dB at 1 meter. So, how much of this dynamic range do we need to hear for good comprehension of speech. With all things considered, if all you hear is 10dB of that range, you're not missing much of anything.



listen to. That is a huge difference.

Now if the S/N of the room is only 15dB, how much of that dynamic range are you hearing? How much of the details of speech are you getting to give you as much comprehension of what is being said as possible? If for crowd control you need to be 10dB above your noise to start understanding speech, then in a church, if your S/N is only 15dB above the background noise, then you're hearing speech within a 5dB dynamic range. This makes for very stressful listening. This puts you in the situation of just trying to hear rather than understanding fully what is being said. When you have a room with a S/N noise of 25dB, then you will have a dynamic range of 15dB to

Conclusion

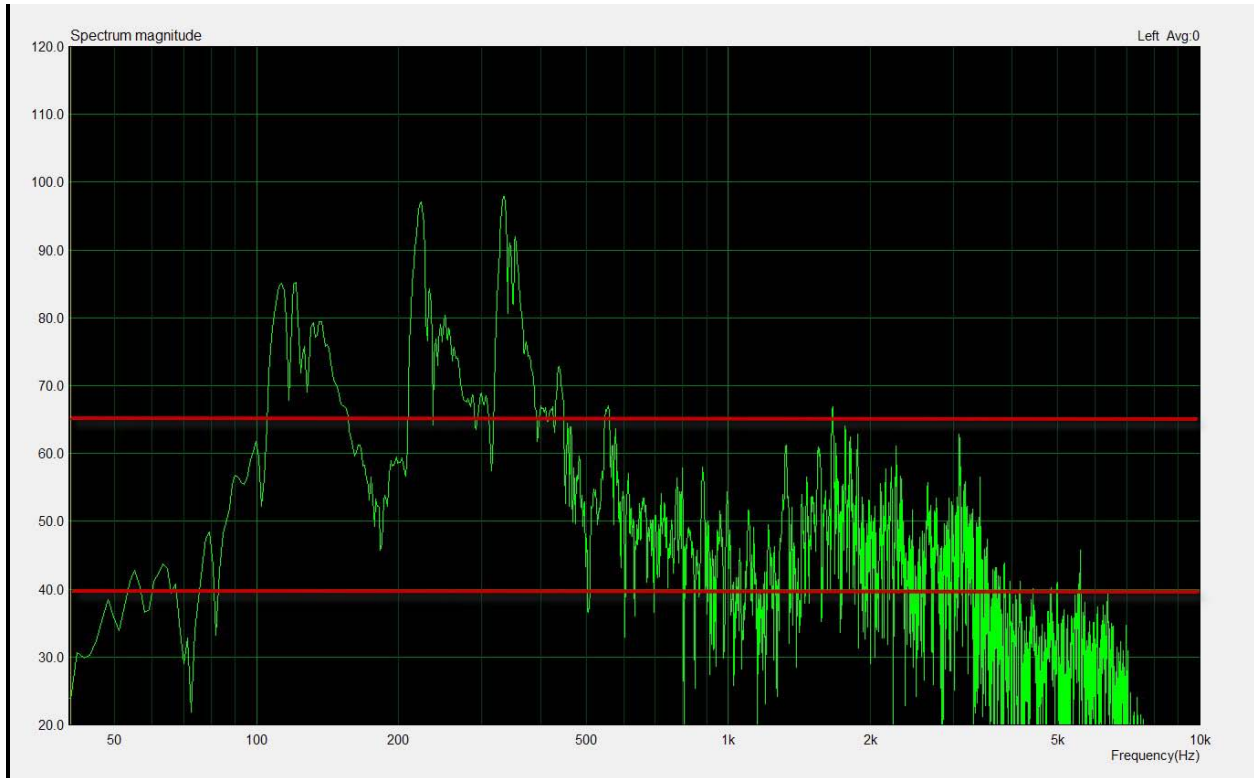
The good news is, if you can get an average S/N ratio of 25dB of the room's ambient noise, then the rest of the sound system will work better. Better yet, if you can include a S/N ratio of 25dB of all of the reflected amplified sounds, that too would be an immense improvement. And that is not all, if you have a minister that still hand holds their microphone, then they can control the dynamic range with proximity control. When hand holding a mic or using the fixed pulpit mic you can increase your dynamic range an extra 10 to 20dB by moving in and out of the mic. That means even though a person is talking within a 25dB dynamic range, by moving in and out of a microphone at the right time, your dynamic range can increase to 45dB and this is without yelling. A good preacher will know what I am talking about. At best with a headset mic you can get a comfortable 15 to 30dB of dynamic range.

My blanket statement of wanting a signal to noise ratio for a church of 25dB is much more than just about controlling the sound for the HVAC or road noise intrusions. When you have that kind of room control, it affects every aspect of a church's worship and the involvement of the worshippers. The better the S/N of the room, the better the worship experience. The lower the S/N ratio, the poorer that worship experience is and the less likely first time visitors will come back. I hope that this short outline and partial explanation helps to clear the air a little about the importance for good room acoustics of ambient noise and the noise the sound system and people make and its impact. Faith doesn't come from noise; it comes from understanding the word of God. You can't spread the faith if you hear too much noise in the background.

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The two graph below show what a 15 and 25dB window looks like. The recording was done in a space with an NC 25.

In the first graph we see a noise floor marking of 40dB without any scaled weighting as the input of a pulpit mic or headset mic is flat, not weighted (although you could roll off the mic EQ to match an “A” weighted scale. It sounds awful – much like a telephone.) As we can see in this minister’s voice, it shows a dynamic range of 50dB at 18 inches from a microphone. As shown, there is a lot of information right up to 5K in the person’s voice. The two red lines show a typical 25dB window and in this case, the room’s background noise is 40dB which is boarder line to being acceptable. If your church can be even quieter, then the amount of information for people to hear increases. Remember that the average for a person talking is 65dB at 1 meter or 3 ft.



The range of the human voice is as follows.

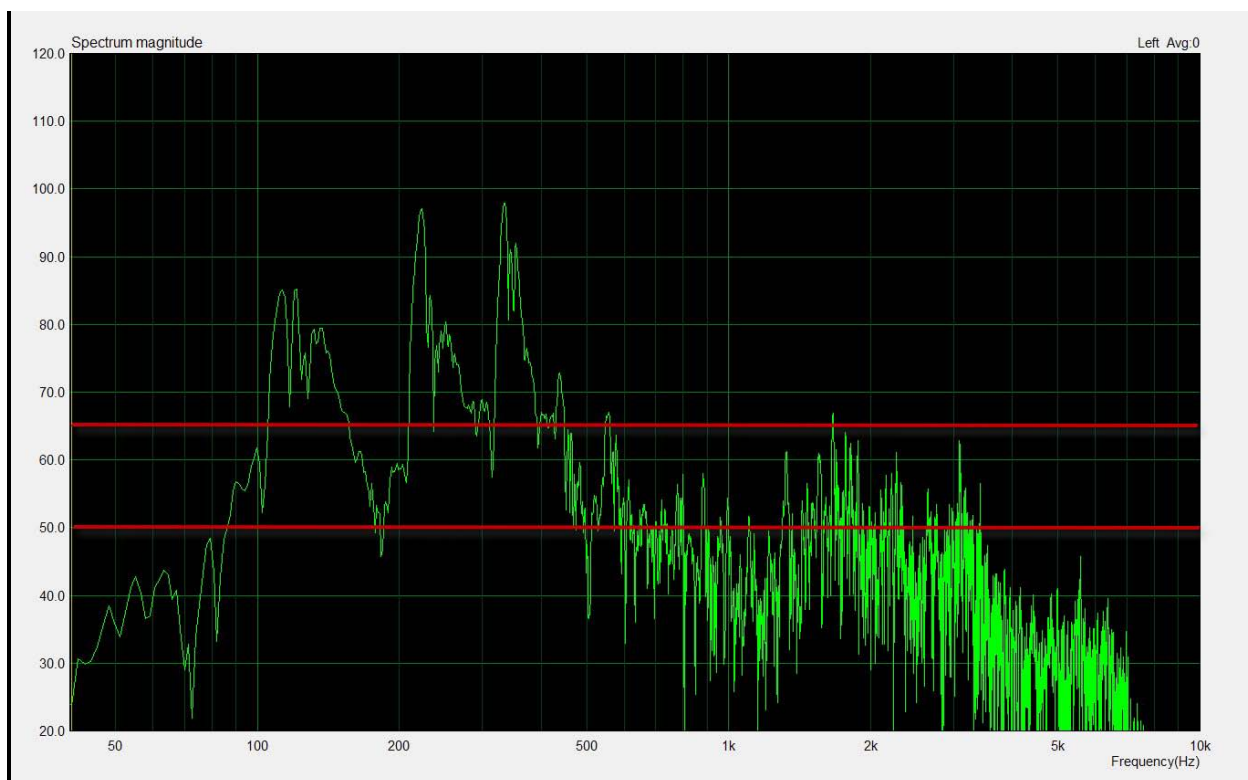
For fundamentals of speech and the power range in a person’s voice is from 80 to 1200 hertz.

For the harmonics and speech recognition is from 1000 to 5000 hertz. This is the range of sounds in the voice that makes all of our voices unique. It is also the range that most critical for understanding speech.

A typical telephone has a range from 300 to 3000 Hertz. 30% of the speech range delivers the power in a person’s voice and 70% is the harmonics. This ratio of power and harmonics remains the same in a full range church sound system. The peak of that power range is from 100 to 500 hertz,

In the second graph it shows a noise floor of 50dB. Sounds in the 600 to 1100 hertz range and above 3000 hertz are being masked by the ambient noise in the room. Now this is typical of what the pulpit microphone hears. All that sound below 50dB is not heard by the microphone – it is being masked. If you turn the mic up to raise the amplified sound in the sound system, the ratio of Signal to Noise remains the same. If you raise the sound system level 10dB, you are also increasing the noise 10dB!

There is a way to compensate for this. You can get closer to the microphone. Most ministers are not trained in proper microphone techniques and they have minimum training at Bible College in projecting their voices. Furthermore most laypeople have no idea how to use a microphone. (A microphone is not a magic wand that all you have to do is put it in front of someone and regardless of how loud they speak and the quality of their diction it will give perfect sound.) Most ministers who know how to project or use a microphone learned on the job and if they don't have a good room and sound system early in their careers, it often shows later in their ministries. (ouch...)



In my travels in helping churches, I have measure background noise at the pulpit as loud as 73 dB. This is a data logger recording where the microphone of the recorder was placed at the pulpit. It recorder the ambient noise of the sanctuary of the HVAC system and road noise of a local street on a Sunday afternoon. The sanctuary was empty and locked up. The data logging was for 1.40 hours. In this church, everyone has to get as close to a microphone as possible. Headset mics don't work well in this situation. In this case, the room must be fixed but unfortunately, all too many churches just put up with this problem thinking that it is too expensive to fix. The fix for this church which seats 800 people was less than \$5000.00.

