

PROMETHEUS RADIO PROJECT

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Low Power FM Radio Equipment Guide

Before you put your Low Power FM (LPFM) station on the air, you will have to make a lot of decisions related to equipment. This document is intended to help you figure out what components you need for your station, and what features to look for in those components.

Below is a list of equipment with explanations of each device's function in a radio station. Most are essential components, but a few are optional and are noted as such. The list is broken into two main categories. The studio category contains equipment that you may want in studios where on-air content is being produced (either live or in advance). The transmission category contains equipment that takes the audio signals produced in the studio and sends them out over the airwaves.

The final section, "Notes," has further information about transmission power, used equipment, time-sharing stations, and how to get additional help setting up your studio. The Appendix to this document has suggested equipment setups for different price ranges and a list of sources for the equipment you will need.

STUDIO EQUIPMENT

Studio Types - Many radio stations have only one studio. For some stations, however, it is worth having a second studio for producing shows in advance. With a dedicated production studio, one person can prepare material to be used in future broadcasts while other material is being broadcast from the on-air studio. The production studio can be simpler than the on-air studio. It may be as simple as a computer with audio editing software and headphones. It could have source equipment and a mixer, but it doesn't need to have features such as an on-air light, a telephone hybrid, or an EAS decoder. To determine whether you need multiple studios, consider how much material you will be preparing in advance, and whether you will have off-air time when you can use the on-air studio for production. You can always start with one studio and leave space to add a production studio down the road. Instead of a second production studio you could provide your programmers with information on how to turn their personal computers into mini-production studios with only a USB microphone and free or cheap audio editing software.

Source equipment - The source equipment in a studio may include CD players, turntables, line inputs for a laptop or iPod, cassette players, or even reel-to-reel tape players. Of course, none of this equipment is required for a radio station – you only need as much of it as you want to use.

Computers - There are a number of uses for computers in the studio, and the requirements for a computer will depend on its intended use. If you only want a computer for Internet access, you won't need a fast processor, a giant hard drive, a fancy soundcard, or really anything beyond the bare minimum. If you want to stream your programming over the Internet, you won't need a fancy computer, but you'll need one computer dedicated for encoding and streaming whenever you're on the air. (For more information on Internet streaming, check out the Key to Internet Radio, a set of tools that Prometheus put together to help community radio stations start streaming, at prometheusradio.org/k2ir_v1.) For playback of recorded music, you'll want a good chunk of storage space – audio files take up a lot of space and accumulate quickly, so a 250 GB or larger hard drive isn't a bad idea. For audio editing and production, it helps to have a computer with a nice processor (2 GHz or faster) with at least 2 GB of RAM, but you can get by with less if needed. Be sure to check the hardware requirements of the software you want to use before purchasing a computer. Some stations also use computers for automated playback to allow unattended programming. For more information on automations, see the Automation Handbook created by Prometheus and KDRT at prometheusradio.org/studio#automation.

Microphones - A studio should have one microphone for each DJ or host and a few for guests if needed. It is best to limit the amount of microphones in the studio to around 4—having lots of microphones active at once leads to a lot of background noise. Guests can share microphones if need be!

There are many different kinds of microphones to choose from when building your studio. The studio microphones might be the second most important equipment in a radio station after the transmitter. Microphones need to sound good, be easy to use, and perform reliably under constant use.

Microphones can be either directional or omni-directional. Directional microphones, also called cardioid microphones, only pick up sound waves from one direction, and as a result pick up less ambient noise (equipment hum, paper-shuffling, etc). Omni-directional microphones pick up sound from all directions, and are therefore useful for speakers who don't have experience using microphones or will be moving a lot while talking.

There are two main types of microphones most commonly used in the audio industry: dynamic microphones and condenser microphones. Condenser microphones are generally more sensitive, particularly in the higher frequencies, and are great at recording quiet sounds and musical instruments. Condensers are made up of many electrical parts and therefore tend to be more fragile and less reliable than dynamic microphones. Condensers also require a special kind of power source (called Phantom Power) while dynamic microphones do not. Both types can be used in broadcast radio applications. However, radio stations generally use dynamic microphones because of their superior durability and ease of use.

The following chart lists some of the most popular and useful microphones used by broadcasters. Some microphones listed are more suited for use as your station's primary studio microphones while others are best for interview or music recording purposes.

Microphone	Price	Comments
Shure SM57	99	<p>The SM57 is the workhorse of the audio industry. It is a notoriously durable instrument mic that has been used in live events and recorded music since 1965. It is versatile enough to be used as a vocal mic as well: the '57 has been used by every US President for speeches since its introduction.</p> <p>This microphone would be a great choice for recording live performances in your studio. If you plan to start with a bare-bones studio setup for your new station, the SM57 would do a fine job as your primary vocal mic until you can upgrade. Be sure to use a foam pop filter when using it as a vocal mic.</p>
Shure SM58	99	<p>The SM58, released one year after the SM57, is designed for vocal use. Like the '57, it is very durable. It is often used as a vocal mic for live performances. The '58 performs well as a broadcast microphone.</p>
Electro-Voice N/D767a	130	<p>The 767 is a dynamic vocal microphone that features low background noise and high-frequency clarity. It is similar to the Shure Beta58A and makes a superb broadcast microphone for the low price.</p>
Electro-Voice 635A	140	<p>An omni-directional mic heavily used in radio and TV news as the go-to handheld interview mic. Primarily used to record audio outside a studio setting, it could also be used in the studio when interviewing a group of people.</p>
Shure Beta58A	160	<p>Designed for live performance, this mic features low background noise and high-frequency clarity. A great microphone for radio broadcast.</p>
MXL BCD-1	170	<p>MXL makes low-priced but generally reliable microphones. The BCD-1 is the lowest-priced mic on the market specifically designed for broadcast.</p>
RODE Procaster	230	<p>Specifically designed for broadcast and voice over applications, the Procaster gets good reviews and compares well to the more well known SM7B and RE20 microphones.</p>
Electro-Voice RE320	300	<p>The RE320 is based on the popular RE20 microphone. Expanding on the versatility of its predecessor, the RE320 has two switchable modes, one for broadcast and instrument applications and another for kick drum micing.</p>
Shure SM7B	350	<p>The SM7B is a popular broadcast microphone with a long track record of reliability. If this microphone is within your budget, it would certainly be worth the expense.</p>
Sennheiser 421	375	<p>The 421 is a popular instrument microphone used in radio and recording studios for several decades. It is versatile enough to use as a broadcast microphone.</p>
Electro-Voice RE20	450	<p>The RE20 is one of the most used microphones in broadcasting. Originally designed as a heavy-duty instrument mic, it became a favorite of radio announcers and an industry standard. Its popularity has led Electro-Voice to produce several similar microphones for radio broadcasting including the RE320. Quick and terrible fact: Rush Limbaugh uses an RE20 cast in 10k gold.</p>

Microphone booms or stands - It is important to have an arm to position each microphone at a comfortable position relative to the speaker's mouth. You can buy professional mic arms, but you can also probably fashion one from parts, such as from a lamp arm.

Mixer or console - An audio mixer takes input from multiple audio sources and lets the user determine which channels to use in the output, and at what levels. A console is generally the same thing as a mixer, but sometimes has some additional fancy features used just for radio. A mixer or console is essential for any station that will broadcast using multiple audio sources. A nice mixer should have ample channels to accommodate all audio sources and easily visible level meters with sliding controls. Another useful feature is monitor muting, which automatically mutes the studio monitor speakers whenever a microphone channel is on. Without this, the sound from the speakers goes back into the microphone and creates feedback, which most people find unpleasant unless listening to Jimi Hendrix. If the mixer does not include automatic monitor muting, you can make or buy a speaker muting device that does this automatically, or the DJ can mute the speakers manually to avoid feedback.

EAS decoder - The Emergency Alert System (EAS) is a nationwide system through which emergency warnings are relayed. If you've heard a radio program interrupted for a weather warning, that was probably an EAS message. The EAS decoder is the piece of equipment at a radio station that listens for emergency alerts on other stations and sends them out over the airwaves. The FCC requires every LPFM station to have a working EAS decoder, so this component is absolutely essential. While full power radio stations need an EAS unit that can both encode and decode messages (sometimes called an ENDEC), LPFMs are only required to decode the messages. Some manufacturers make decoder-only or "LPFM model" EAS units for a reduced price. However, if you find a good deal on a full-blown ENDEC, that will also work just fine.

As of September, 2011, the FCC requires all radio and TV stations to be able to receive a new kind of emergency message. The new messages are called Common Alerting Protocol (CAP) messages and are disseminated over the Internet with a system called IPAWS. To meet the new requirements, you will either need a "CAP-capable" EAS unit or a CAP-to-EAS converter.

FM tuner - It is important to have an FM tuner so the DJ can listen to the signal that is being sent over the airwaves. The receiver should be tuned to the frequency at which the station is broadcasting. The DJ can switch between the on-air signal and the console signal to make sure the station is broadcasting loud and clear.

Monitor speakers - Monitor speakers let the DJ listen to what they are playing. The monitor speakers might be internally amplified, or might require an external amp for power. The best monitor speakers have a "flat" response so that the sound coming out of the speakers sounds as much as possible like the audio going into them, but any old speakers will work in a pinch.

Headphones – Headphones should be used by anyone speaking into a microphone. This allows the DJ or hosts to monitor their audio levels as they speak. Each microphone in the studio should be paired with a set of headphones. Headphones tend to wear out quickly, so durability is an important consideration if you want to avoid replacing them frequently. It's also a good idea to keep a couple pairs in reserve. If there are lots of headphones in the studio, you might want a Headphone amplifier to split up the signal and allow all of the guests to set their listening level to whatever is comfortable for them.

Telephone system - Most studios will have at least one telephone. If you plan to put callers on the air, you will need a Telephone Hybrid. The hybrid feeds the signal from the phone line into the console, and feeds another signal back to the caller. More complex (and more expensive) caller management systems are also available to handle multiple calls in cue, and sometimes do audio processing with the phone signal as well.

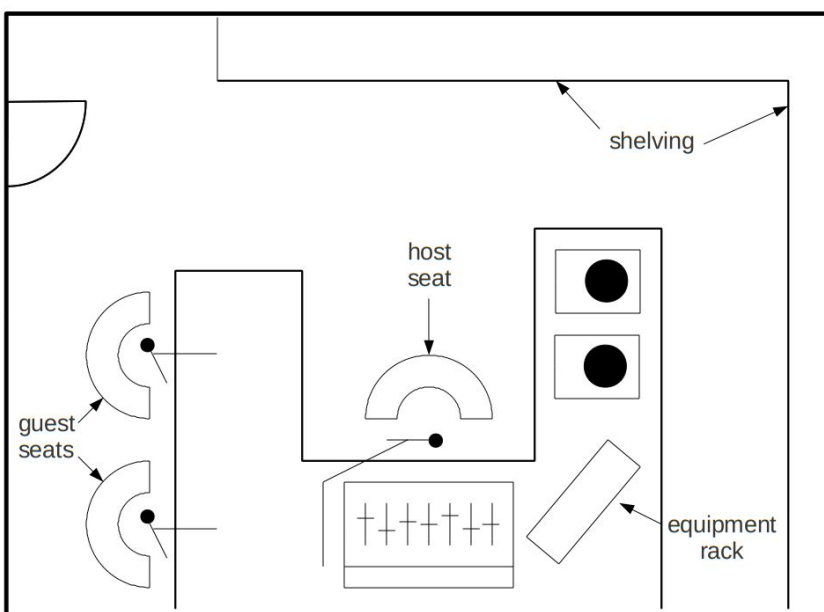
On-air light and relay circuitry - An on-air light notifies others outside of the studio when the DJ has microphones on in the studio. There is usually some circuitry outside of the console to turn the lights on and off. It is typically controlled by some switches inside of the console. Mixers not designed for radio probably won't have this feature. An on-air light is not essential, but it will make things easier for the DJ and for any visitors to the studio.

Distribution amplifier - A distribution amplifier splits the signal from the audio console and sends it in multiple directions without overloading the console output. If you have many destinations for your signal – for instance, a CD recorder, streaming computer, production studio and transmitter – you might need one of these.

Audio cables and connectors - Audio cables transmit audio signals from one place to another, such as from an audio source to the console. You will likely need an assortment of connectors to make custom cables, depending on what equipment you use.

Equipment racks - Some audio equipment can be freestanding, but in many cases a studio will want to rack-mount the equipment. There is a wide variety of free-standing wood and metal racks that you can hang equipment in, or install shelves in for equipment that doesn't come with "rack ears". Equipment racks keep the equipment secure and the cables hidden out of the way, which is nice for the aesthetics of the studio, but not necessarily important for basic functionality.

Furniture - When you get that slick new console and are chomping at the bit to set it up, you can't just set it on the floor! There are lots of different ways to keep the equipment up at a usable height, but our favorite here at Prometheus is furniture – tables, counters and such.



Some companies provide prebuilt studio furniture, and others will custom build furniture to suit your studio's specific needs. However, the cost for custom-built furniture from a specialty company can be exorbitant, so we recommend contracting local carpenters if you want custom furniture.

The layout of the studio can be as important, if not more important than

the equipment you choose for the studio's usability and accessibility. Below is an example studio with a basic "unbalanced U" set-up.

The mixing console sits in the middle of the "U". This is the main control point for your broadcast so there will almost always be someone sitting there—most likely the host or an engineer. There will be another counter to the left side, with enough space for some turntables or other equipment to fit on top, and a rack of other equipment on or beneath the counter. On the DJ's right side, there will be a shorter "sidecar" or side counter for guests.

Of course, depending on the room, this might all need to change. Every studio space is different, so you will have to layout the studio based on the features of your space like doors and heaters.

There are a huge number of considerations when laying out the studio. Here are a few starters:

- People don't like sitting with their backs to the door.
- No through traffic, just one door if possible.
- The computer should be in a comfortable position to type at.
- The layout should work for solo DJs as well as for an engineer, an interviewer, and one or two guests.
- At least one surface should be kept clear between an interviewer and guests, for glasses of water, microphone stands, and books or scripts, and so on.

There are many more things to consider here, far more than we can cover in a single guide. If you are stumped, or have some questions, the friendly folks at Prometheus are willing to talk to you about it. Just give us a call! We can even work on the physical setup of your station in person, if you would like. More on that later. Oh, and don't forget the chairs.

TRANSMISSION EQUIPMENT

Audio processor - The audio processor ensures that the amplitude of the audio signal does not exceed the FCC's limit. Without a processor the signal can become over-modulated, which decreases the quality of the resulting radio signal and can cause splatter on other frequencies. Some stations use additional audio processors in the studio to further control the sound quality, but the final processor is most important.

Transmitter - The transmitter modulates the audio signal, turning it from a sound wave our ears can hear into a radio wave FM receivers can detect. The FCC requires that the FM transmitter for your LPFM station is "type certified" - meaning it has been through certain tests by the manufacturer. It may be necessary to call and ask the transmitter maker if their transmitters fit the bill. An important transmitter characteristic is output power, which determines how strong the signal is and therefore how far it reaches. You will likely need something in the 100 watt to 200 watt range, but the needs of every station will be different. See the "Effective Radiated Power to the People!" section below for more information about output power.

Antenna - The antenna sends the signal from the transmitter out over the airwaves. Some antennas are focused in a particular direction, but LPFM stations are limited to an omnidirectional

pattern. There are different polarizations for antennas. We recommend a circularly polarized (CP) antenna, which radiates equally in the horizontal and vertical planes. You will need twice the transmitter power for a CP antenna, but it's worth it.

Tower or mast - The location of an antenna (particularly the height) will impact how far the signal travels. FM waves travel best within the line of sight of the antenna. If you have an antenna site that is already high, such as a hill or a tall building or church steeple, you can probably mount the antenna on a simple pole or mast. If not, you may be able to build a dedicated tower structure for the antenna. For more suggestions regarding towers and masts, read "Hang 'Em High: Options for antennas, masts, and towers," at prometheusradio.org/transmission#antennas_towers.

Grounding and lightning protection - An antenna structure should be connected to an electrical ground. This will allow charges to drain from the structure to ground, preventing a charge build-up that could decrease antenna efficiency. A strong path to ground will also help to reduce the damage to equipment if lightning strikes.

Cables and connectors - Coaxial cable is used to carry radio frequency signals. Types of coaxial cable vary in the amount of attenuation (signal loss) over a certain length. It is most important to use low-attenuation cable for long lengths, while it may be acceptable to use slightly higher attenuation cable over short distances. You will need to match the connectors on the cable to the output of your transmitter and the input of your antenna.

Studio-to-transmitter link - The studio-to-transmitter link (STL) carries the audio signal from the studio site to the transmitter (and antenna) site. If your studio is close to your transmitter for instance, if the studio is in a building and the transmitter and antenna are on the roof – you may be able use a long audio cable. If the transmitter location is further from the studio, options include microwave transmitter systems with directional dishes, a "dry pair" (unused telephone line) provided by a phone company, unlicensed wireless Internet, or streaming over the public Internet. More specifics on these options are detailed in "Sound Around Town: Some options for linking your studio to your remote transmitter site" at prometheusradio.org/transmission#sound_around_town.

NOTES

Effective Radiated Power to the People!

Every low power FM station will be allowed a specific Effective Radiated Power (ERP) by the FCC. The maximum ERP will be stated on the construction permit. ERP is the final power that comes out of the antenna. The maximum allowed ERP for any LPFM station is 100 watts, but your permit might only allow you to broadcast with a lower ERP - in some cases only a few watts! The power restriction is based on the height of the antenna above average terrain, because a higher antenna will give more coverage than a lower antenna with the same ERP. At an antenna height between 0 and 30 meters above average terrain, your maximum ERP will be 100 watts. Above 30 meters it will be lower.

The antenna you choose will affect a few other things when you are selecting your equipment. We generally recommend going with a circularly polarized (CP) antenna, as it gives the most uniform

coverage for both receivers in cars and receivers in homes. Circularly polarized antennas can be stacked one above the other to increase the gain of the antennas. When antennas are stacked like this, they are called “bays”. A single bay is just a single antenna, a two bay is two antennas stacked on top of each other (with a certain separation), and so on. Gain can be thought of as a multiplier for power – if you have 100 watts going into the antenna, and your gain is 0.5, your ERP will be 50 watts.

If you have a gain of 2, that 100 watts will be 200 watts ERP. A single bay CP antenna will have a gain of around 0.5 (but specific to that antenna – check with the manufacturer!), and a two bay CP antenna will have a gain close to 1. We recommend getting a two bay antenna if possible, but there are downsides to that. A two bay antenna is more expensive, takes up more space on the tower, and is more complicated to install. The upside is that you will have higher gain, so you will need less power coming from the transmitter for the same ERP. This can translate to lower utility bills in the long run.

Generally, a higher power transmitter (say a 250 watt over a 150 watt) will cost about \$1000 or more over the lower power version. So, if you have the space on a tower (at least 20 vertical feet near the top) and the bit of extra know-how, go for the two bay antenna and save on your power bill. Otherwise, go for the simpler installation, get a single antenna, and get a more powerful transmitter to compensate. Always leave yourself some headroom with the power of the transmitter, since you will lose some power in the cable up to the antenna. On average, it is around 80% efficient. If your Construction Permit allows you 100 Watts at 30 meters, and you only have a single bay antenna, you will need about 240 Watts of transmitter output power (TPO). The reason is that about 20% (40 watts) will be lost in the cable, and the antenna gain is about 0.5, so the 200 watts going into the antenna will be halved to 100 watts ERP. Of course, you will need to compute the exact loss for the length of cable, and the gain of the specific antenna you have. Every installation will be different, so these numbers are for example only.

Donated/Used/Abused Equipment

Everyone is looking for a deal. It’s natural - this stuff can be expensive! Cutting corners with a broadcast studio can be tricky, because there aren’t many things you can leave out. So, what about used equipment? Well, as a rule, try and get as much of the core equipment (transmitter, antenna, tower, console, microphones) new, if possible. These things are on 24 hours a day, in some cases getting pounded on by your DJs. You want to get hardy equipment that can take the punishment. Or, think about it this way: do you want to rely on a used piece of equipment that may not have any warranty, and might not be easily fixed? If it breaks, will you be off the air? Sometimes it is worth the cost of a new transmitter to know that you can get replacement parts, or call a technical support person any time. That rusty tower from a neighbor’s backyard might look sturdy until it comes crashing down. Something like an old console might be a constant headache, as well. If a few channels or inputs on it don’t work reliably, the DJs will start getting annoyed and complain. They might even take matters into their own hands, and start switching cables around, leading to all sorts of confusion as to what goes where.

Some equipment might be totally fine used: CD players are a great example. There are tons of consumer CD players out there, and if they break, they're far more replaceable than other pieces of equipment. Maybe buy a few extra CD players, and keep a stack in the back room. If one starts acting up, swap it out and take it to the stereo shop down the street. It'll still be cheaper than investing in one \$400 CD player.

Speakers, headphones, and FM tuners are all good things to find used as well. In some cases, you can find excellent old broadcast processors (the kind that go right before your transmitter and keep your station from over-modulating) on the used market. These things might have cost \$5000 new, and can be yours today for the bargain basement deal of \$999. A lot of people shop for equipment deals on online auction sites. Sometimes you can find good deals there, but sometimes you end up paying a lot more than things are worth. I don't recommend it very often, as you can't tell what condition the equipment is in until it arrives at your doorstep. Just be savvy and something might come your way!

There are a few places to ask for equipment donations. Community radio and TV stations in your area might have some friendly engineers or technicians with a back room full of goodies. Recording studios are another place to ask. It can be worth a long drive to pick up some equipment. Try calling every station you can find or look up within 50 miles. You might hit gold! By that same token, if there are equipment manufacturers in your area, try calling them. They may be willing to donate equipment in exchange for underwriting. I know a station that had several thousand feet of new audio cable donated by a local cable maker. Your group is a non-profit, so you might be able to convince people to make a friendly donation! It never hurts to ask.

Just as a note, there are some pieces of equipment you probably won't be able to find used: the EAS unit, for example. These don't come up on the used market very often because when a station buys one, they keep it. Forever.

Who shares wins!

Some groups may find themselves in a "Time Share" situation with other groups who were competing for the same frequency in their area. If you end up sharing a frequency with another group that you get along with, you can share your facilities as well! Since you are not required to have an official "main studio," the studio can be wherever your groups chooses to put it. You will still need to fulfill your local content and local ownership requirements if applicable, but those are related to the location of the transmitter in relation to the headquarters of the organization or board members for the station. If a few groups can share the costs on a transmitter, antenna system, studio transmitter link and studio equipment, it can bring the costs down quite a bit. It can allow several LPFM stations to share a building, with as many main "on-air" studios as there are stations, and with one or two shared production studios for recording or pre-production of shows or news. Of course, it's best if the studio locations serve the local communities for the groups. You don't want to put the studios in an inaccessible location and make it more difficult for your volunteer DJs and operators!

Getting more help

If this all still seems like too much, Prometheus can help! We enjoy helping folks figure this stuff out. We enjoy working with you directly and teaching your staff and volunteers how to build a studio or station even more! Prometheus has a technical services program that might be right up your alley if you need a little more hands-on help putting your station together. You can find out more about this by visiting http://prometheusradio.org/consulting_and_construction, or by calling or emailing our Technical and Training Organizer at 215-727-9620 x503 or technical@prometheusradio.org.

About this document

The original version of this document must be credited to Mike Brown, of Brown Broadcast Services, Inc (<http://brownbroadcast.com>). It was created back in 2000, when the Low Power FM broadcasting service was born. At that time, there were dozens upon dozens of stations that needed help picking equipment. That need still exists today, but the “market” for equipment has changed a bit. Prometheus has built a number of small community radio stations over the years, and the old equipment guide has helped stations find equipment. Still, we often had to help people come up with alternatives, as model numbers changed, new products came out, and so on. So, we created this “update” of sorts to the guide. Much of the structure was borrowed with permission from Mike Brown, but most of the research was new.

Appendix A: Sample Equipment Packages

These tables represent sample equipment packages for a main studio, a production studio, and a transmitting facility at minimal, economy, and moderate budget levels. The studio packages assume an existing space and do not account for studio furniture or utilities.

Main Studio - Minimal Set-up				
Qty.	Item	Example	Price	Notes
2	CD players	used or cheap	\$40 each	could also get donated
2	Turntables	used or cheap	\$75 each	could also get donated
1	DJ mixer	Gemini PS-121X	\$70	could also get donated
1	Computer	donated		
2	Microphones	Shure SM58 or SM57	\$100 each	SM57 requires foam windscreens
2	Microphone booms	OC White Proboom-B	\$100 each	
1	Mixer	Alesis S-12 12-Channel Compact Mixer	\$190	or similar model with multiple (4) stereo inputs
1	Monitor muting device	Henry Engineering Mixer Mate	\$195	may be able to build
1	EAS decoder	Digital Alert Systems DASDECII-LCR	\$2500	
1	FM monitor tuner	used or cheap	\$50	needs audio output jack
1	Monitor speakers	used or cheap	\$100	need amplifier to power
2	Headphones	used or cheap	\$15 each	should be closed-ear with 1/4" plug or adapter
1	Single-line speakerphone	used or cheap	\$10	should have mutable ringer
1	Telephone hybrid	JK Audio AutoHybrid	\$185	
1	Misc. wiring and hardware		\$100	
1	10% Incidental costs		\$400	shipping, hardware, extra parts, etc.
Total cost			\$4460	

Main Studio - Economy Set-up				
Qty.	Item	Example	Price	Notes
1	CD players	Stanton C500 (dual)	\$170	
2	Turntables	Numark TTUSB	\$100 each	
1	DJ mixer	Numark M2	\$90	
1	Computer	used or cheap	\$400	optional add-on: M-Audio Delta 44 sound card
2	Microphones	SM58 or SM57	\$100 each	SM57 requires foam windscreens
2	Microphone booms	OC White Proboom-B	\$100 each	
1	Console	AEQ BRAVO	\$2840	Or Allen & Heath XB-14 for \$1200, both include built-in telephone hybrid
1	EAS decoder	Digital Alert Systems DASDECII-LCR	\$2500	
1	FM monitor tuner	used or cheap	\$50	needs audio output jack
1	Monitor speakers	used or cheap	\$100	need amplifier to power
2	Headphones	used or cheap	\$15 each	should be closed-ear with 1/4" plug or adapter
1	Headphone amplifier	Rolls RA53b	\$100	
1	2-line speakerphone	used or cheap	\$25	should have mutable ringer
1	On-air light	homemade	\$10	
1	On-air light relay module	electronics store	\$30	should be SPST 4-32V DC activation 50-200V AC
1	Distribution amplifier	Rolls RA63S	\$155	
1	Misc. wiring and hardware		\$250	
1	10% Incidental costs		\$735	shipping, hardware, extra parts, etc.
Total cost			\$8085	

Main Studio - Moderate Set-up				
Qty.	Item	Example	Price	Notes
2	CD players	Tascam CD200	\$300 each	
2	Turntables	Audio-Technica AT-LP120-USB	\$280 each	
1	DJ Mixer	Numark DM1002MKII	\$100	
1	Dual cassette deck	Teac W790R	\$170	
1	Stand-alone recorder with USB, flash, and SD media	Tascam SS-R200 Solidstate Stereo Recorder	\$600	Or additional computer for audio recording
1	Computer	new moderately priced PC	\$600	
1	Sound card	M-Audio Delta 44	\$150	
1	Microphone	Shure 7B	\$350	
2	Microphones	Shure Beta 58A	\$160 each	
3	Microphone booms	OC White Proboom-B	\$100 each	
1	Console	Arrakis MARC-15-12	\$4950	
1	EAS decoder	Digital Alert Systems LPFM Decoder w/ Radios	\$3390	
1	FM monitor tuner	Rolls HR78	\$180	
1	Monitor speakers	M-Audio BX5A Deluxe	\$300	powered monitors - no external amp required
4	Headphones	Sennheiser HD202	\$20 each	
1	Headphone amplifier	RA53b	\$100	
1	2-line speakerphone	used or cheap	\$25	should have mutable ringer
1	Telephone hybrid	JK Audio AutoHybrid	\$185	
1	On-air light	Titus OALHS	\$180	
1	On-air light relay module	electronics store	\$30	should be SPST 4-32V DC activation 50-200V AC pass through
1	Distribution amplifier	ATI DA 208	\$490	
1	Equipment rack	Middle Atlantic RK12	\$120	
1	Misc. wiring and hardware		\$300	
1	10% Incidental costs		\$1360	shipping, hardware, extra parts, etc.
Total cost			\$15000	

Transmitting System - Minimal Set-up				
Qty.	Item	Example	Price	Notes
1	Audio processor, compressor/ limiter	Behringer AUTOCOM PRO-XL MDX1600 Compressor	\$120	Along with the FM limiter in the Ecreso Helios transmitter, a budget compressor with a peak limiter will smooth out your signal for a fraction of the price of an FM processor.
1	Transmitter	Ecreso Helios FM 100 w/ optional FM limiter	\$3470	add web control for additional \$600
1	Antenna	OMB MP1	\$350	
1	Transmission line	100' LMR400	\$75	
1	Mast	50' telescoping	\$85	best to purchase locally to avoid shipping
1	Lightning arrestor	Poly Phaser 1S-50NX-CO	\$60	
1	400' guy wire, hardware, etc		\$300	
1	10% Incidental costs		\$460	shipping, extra parts, etc.
Total cost			\$4920	

Transmitting System - Economy Set-up				
Qty.	Item	Example	Price	Notes
1	Audio processor, compressor/ limiter	Behringer MDX2600 Composer Pro-XL	\$150	Using a crossover, multi-channel compressor, and summing mixer, you can create a multi-band compressor system. Coupled with the FM limiter in the Ecreso Helios transmitter, this setup gives you control of your station's sound at a fraction of the price of an FM processor.
1	Audio processor, crossover	Behringer SUPER-X PRO CX2310 Crossover	\$100	
1	Audio processor, line mixer	Behringer MICROMIX MX400 4-Channel Mixer	\$20	
1	Transmitter	Ecreso Helios FM 350 w/ optional FM limiter	\$4350	Add web control for additional \$600
1	Antenna	OMB MP1	\$350	
1	Transmission line	150' LMR500	\$240	
1	Tower	70' Rohn 25G	\$1700	best to purchase locally to avoid shipping charges
1	Lightning arrestor	Poly Phaser 1S-50NX-CO	\$60	
1	Misc. hardware		\$300	
1	10% Incidental costs		\$725	shipping, extra parts, etc.
Total cost			\$7995	

Transmitting System - Moderate Set-up				
Qty.	Item	Example	Price	Notes
1	Audio processor	Audemat 4Bmini-FM Audio Processor	\$1690	Or used Orban Optimod-FM 8100A or similar model
1	Transmitter	Ecreso Helios FM 350 w/ optional web control	\$3830	
1	Antenna	2-bay OMB MP 2	\$1600	
1	Transmission line	150' LDF 4-50A	\$260	
1	Tower	100' Rohn 25G	\$2300	best to purchase locally to avoid shipping charges
1	Lightning arrestor	Poly Phaser 1S-50NX-CO	\$60	
1	Misc. hardware		\$300	
1	10% Incidental costs		\$1000	shipping, extra parts, etc.
Total cost			\$11040	

Appendix B: Sources for Equipment

The following is a list of online sources where you may be able to find equipment for your station. Some of these sources will offer discounts to non-profit community radio stations, so be sure to ask. This is not an endorsement for the sources listed, nor is it an exhaustive list. It's here as a starting point for your search, but we recommend that you look further as well and be sure to check out local sources. You may find better and/or cheaper equipment to suit your needs elsewhere.

Type of Equipment	Source	Website	Notes
Studio Equipment: CD players, turntables, mixers, microphones, sound cards, audio cables, etc.	zZounds Musician's Friend	www.zzounds.com www.musiciansfriend.com	
Consoles, phone hybrids, on-air lights, distribution amplifiers, equipment racks	BSW Broadcast Depot Broadcast Warehouse	www.bswusa.com www.bdnw.com www.broadcastwarehouse.com	
Tower and site hardware, transmission line, connectors	TESSCO Hutton Talley	www.tessco.com www.huttononline.com www.talleycom.com	Need to create an account before purchasing
Transmission line, connectors	The RF Connection RF Parts	www.therfc.com www.rfparts.com	
Transmitters, audio processors	Contact manufacturers directly		May be able to get refurbished or demo equipment
New equipment of all sorts	Broadcaster's General Store RF Specialties	www.bgs.cc www.rfspec.com	Selection varies: call and ask about specific equipment you need
Used equipment of all sorts	AMFMTV	www.amfmtv.com	