Certificate in Community Radio Technology

Setting up of CRS

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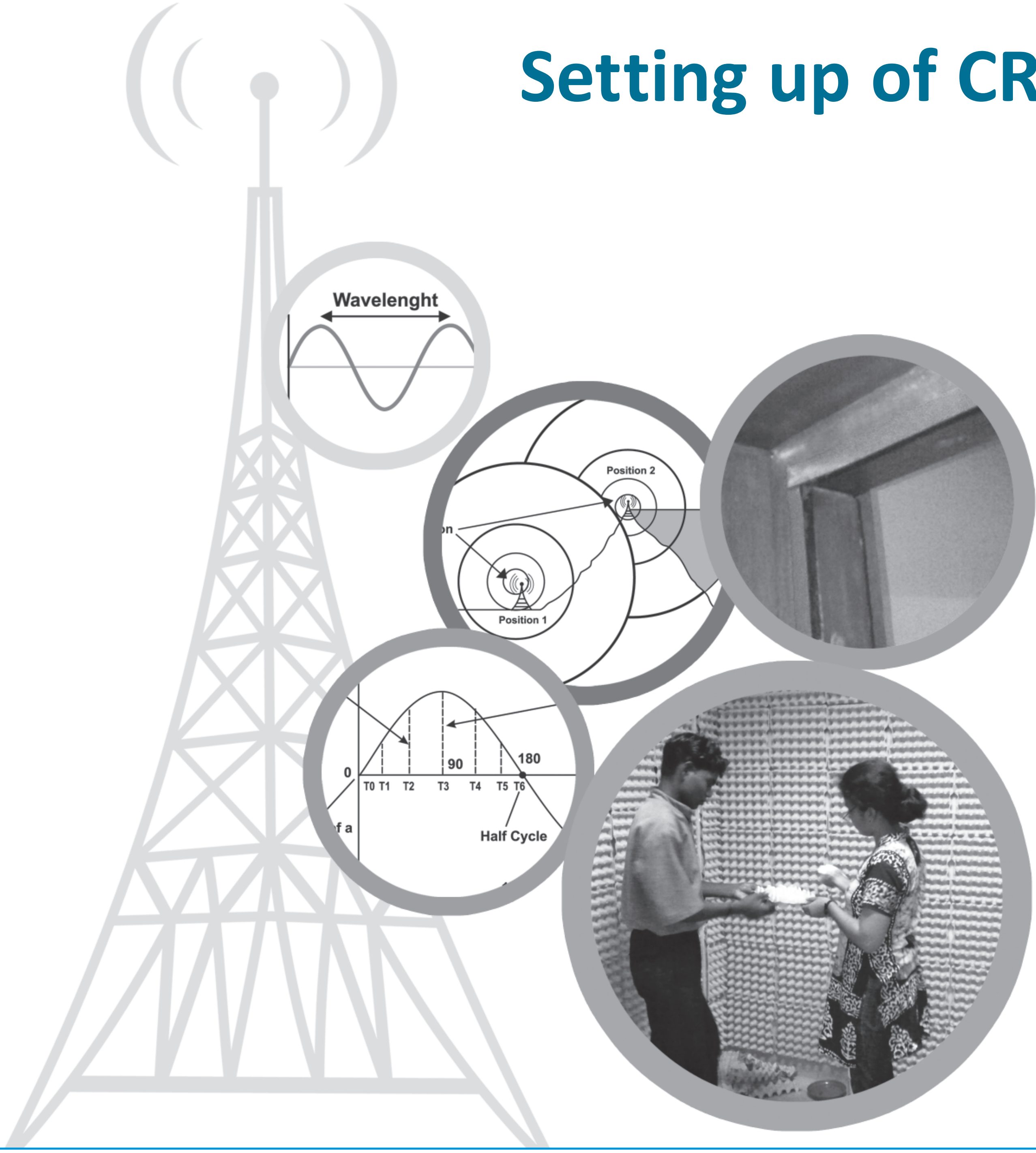
Module: 2

Setting up of CRS



CEMCA
Commonwealth Educational Media Centre for Asia
New Delhi

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Module 2: Setting up of CRS

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Certificate in Community Radio Technology

Courses	Modules	Units
Course I: Understanding Community Radio (3 Credits, 90 Hours)	**Module 1** Community Radio: An Introduction	**Unit 1 :** Community Radio: Concept and Evolution **Unit 2:** Context, Access and Equity **Unit 3:** Community Radio: Policy Guidelines **Unit 4:** Technology for CR: Guiding Principles
	Module 2 Setting up of CRS	**Unit 5:** Components of CR Station **Unit 6:** Radio Waves and Spectrum **Unit 7:** Basics of Electricity **Unit 8:** Power Backup and Voltage Stabilisation
Course II: Community Radio Production: System & Technology (5 Credits, 150 Hours)	**Module 3** Studio Technology	**Unit 9:** Basics of Sound **Unit 10:** Analog and Digital Audio **Unit 11:** Components of the Audio Chain **Unit 12:** Studio Acoustics
	Module 4 Audio Production	**Unit 13:** Audio Hardware and Field Recording **Unit 14:** Free and Open Source Software **Unit 15:** Telephony for Radio
	Module 5 Audio Post Production	**Unit 16:** Sound Recording and Editing **Unit 17:** Mixing and Mastering **Unit 18:** File Formats and Compression **Unit 19:** Storing and Retrieval
	Module 6 Studio Operations	**Unit 20:** Good Engineering Practices for Studio Setup **Unit 21:** Studio Equipment: Preventive & Corrective Maintenance **Unit 22:** Content Distribution: Alternative Mechanisms
Course III: Community Radio Transmission: System & Technology (2 Credits, 60 Hrs)	**Module 7** Radio Transmission Technology	**Unit 23:** Components of Transmission Chain **Unit 24:** Components of FM Transmitter **Unit 25:** Antenna and Coaxial Cable **Unit 26:** Propagation and Coverage
	Module 8 FM Transmitter Setup	**Unit 27:** Transmitter Setup: Step-by-step **Unit 28:** Transmission System-Preventive and Corrective Maintenance **Unit 29:** Transmission Setup-Good Engineering Practices
Course IV: Technical Internship (2 Credits, 60 Hrs)	**Module 9** Practical Internship Handbook	**Section A:** Introduction **Section B:** Activities to be Conducted During the Practical Internship **Section C:** The Internship Journal and Self-Assessment Paper **Section D:** Assessment of Internship **Section E:** Appendices

Videos in the Module:

1. **Components of a CR Station**
   by Hemant Babu
2. **Power Backup for CRS**
   by Hemant Babu
3. **Introduction to Radio Waves**
   by Vasuki Belavadi

1. http://tinyurl.com/ogqhsmf
2. http://tinyurl.com/pdqcrgt
3. http://tinyurl.com/p5kykyc

CONTENTS

CONTENTS

About the Module

In the previous module, you would have got not only an introduction to the concept of community radio, but also an idea about some of the guiding principles behind community radio, the basic technology in community radio, how community radio can be used in the context of gender and equity and so on. Now that you have put that behind you, the first step in becoming a technician for community radio is to start thinking about how to set up a community radio. This module gets you started on setting up a community radio, and the basic things you must know before beginning. This module has four units which will provide you with basic knowledge related to setting up of a community radio station.

The components of a CR station are meant for you to understand the basic building blocks of what constitutes a radio station. However, some of the components are explored in-depth in the later modules.

The Unit on radio waves and spectrum will be important for you to get an analytical understanding of the underlying technology of radio. While you may not get an opportunity to put this knowledge to use on a day-to-day basis, you will find this useful in understanding radio at a fundamental level. Remember that competent technicians don't just solve problems, but they know why those problems occur as well!

The Unit on basics of electricity is geared to give you a theoretical understanding of how electricity works. While working as a technician in community radio, it very well may be the case that you will be asked to solve issues which have to deal with power supply or in other words, electricity. Often there are issues like excessive voltage, uneven supply (i.e. dips or surges) of power, frequent power cuts and so on. If you have a good understanding of the concepts behind electricity, then it will equip you to come up with the best solution given the context of a particular community radio.

The last Unit is related to power backup and voltage stabilisation. As noted above, this is a problem which occurs frequently in most rural community radio stations. Choosing the right power backup or voltage stabilisation solution can be a complex task and requires a sound knowledge of how backup and stabilisation can be configured in the context of underlying principles as well as available resources at your disposal. Interestingly the Unit also mentions various alternative energy sources which could be used for power backup. Not only will this knowledge help you to propose environmentally friendly solutions but it could also be an economically viable solution in the long term!

Module Objectives

- Familiarity with processes and principles involved in setting up a community radio station
- Understanding of the technology behind radio waves and electromagnetic spectrum
- Familiarity with solutions related to power backup and stabilisation of voltage

Units in the Module

- Components of a CR Station
- Radio Waves and Spectrum
- Basics of Electricity
- Power Backup and Voltage Stabilisation

UNIT 5

Components of a CR Station

Structure

5.1 Introduction

By now, you have already received a broad grounding in the philosophy of community radio, as well as an understanding of the essential decision points according to which we select equipment and technology for a CR station.

This Unit will now discuss the various components of a CRS station, and will provide an overview of how these components are related to each other. It will discuss the key points we need to keep in mind while deciding on a site for the CRS; as well as when we setup the studio and production spaces. Through these discussions, this Unit will provide a broad introduction to the CRS as a whole, details of which you will study in further Units. You may require approximately 40 hours to complete this Unit.

5.2 Learning Outcomes

After working through this Unit, you will be able to:

- discuss various components of a CRS;
- describe the issues related to appropriate space and site selection for a CRS;
- describe how to plan the utilization of the available space for the various tasks in a CRS;
- describe the preparatory work in a studio, including acoustic treatment, soundproofing and related arrangements;
- explain the broad interactions between various technical components of a CRS.

5.3 The CR Station: Siting and Space Definition

Having understood the philosophy of community radio and the criteria for selection of equipment, it is now time to understand the first steps in actually setting up a CRS i.e. finding a relevant location, and dividing the available space into studio and working spaces.

5.3.1 Site selection

One of the most important decisions we have to take for the setting up of a CRS, from a social purpose point of view as well as a technological point of view, is where to locate it. This process is called **site selection**, or **siting**, and is based on a number of critical considerations. Let us look at some of the criteria we need to keep in mind:

The physical location and distribution of the served community

The core of a community radio station is its listener community, by which we mean the core group of listeners whose information needs the station will serve, and for whom it will provide a platform for expression. Given this, it is important that the station should be in a place where these community members can access it easily, and participate regularly in programme creation. In short, the station should be accessible to every member of the local community, young or old, man or woman, physically sound or differently abled. This is why the Community Radio Guidelines (2006), which lay out the regulations governing CR in India, also make it mandatory to establish the CRS within the geographical area where its potential listener community resides.

We can achieve this by first mapping where the potential listeners of the CRS stay, work and live. Once we have a clear picture of this, we must try to locate the CRS as centrally within this area as possible, so that it is roughly equidistant for all the people who live around it.

Simultaneously, we must also try to situate it in a building or space that is already familiar to the community members, and which they are likely to pass during their daily routine: near the village panchayat, say, or a community centre (if there is one). Some CR stations are set up near key crossroads within the locality, or near market places. Note that this can be a challenge where community residential spaces are clustered by caste or profession: many Indian villages are divided into caste–based and ethnicity–based sectors. It is best to place the CRS in a neutral space, where everyone can be encouraged to participate without hesitation. In keeping with our philosophy of community ownership, the station should be housed in a community donated or provided building. This way, it will become an intrinsic part of the community's life from the outset. It will also avoid the nuisance value – not to mention financial burden–of paying rent, and being subject to the whims and fancies of a landlord. This is especially important from the point of view of transmission licensing, which locks down your transmitter location to a given physical location for the duration of the license.

Local geography and terrain

The second most important criterion to keep in mind is the physical layout of the land: whether it is totally flat, undulating, or whether it has a slope or a depression anywhere.

This is important because the propagation of FM, the radio transmission technology used for community radio broadcasting, is **line of sight**. This means the transmission can only be heard when the radio receiver set can electronically 'see' the transmission antenna, with no or few obstacles. This means we must choose a location for the station (and by extension, the antenna and the mast/ tower it is mounted on) which is not surrounded by tall buildings, or hidden by a hill or mountain – or situated inside a depression in the local landscape. Such obstacles will block the signal and result in no-reception ("shadow") zones within the transmission area.

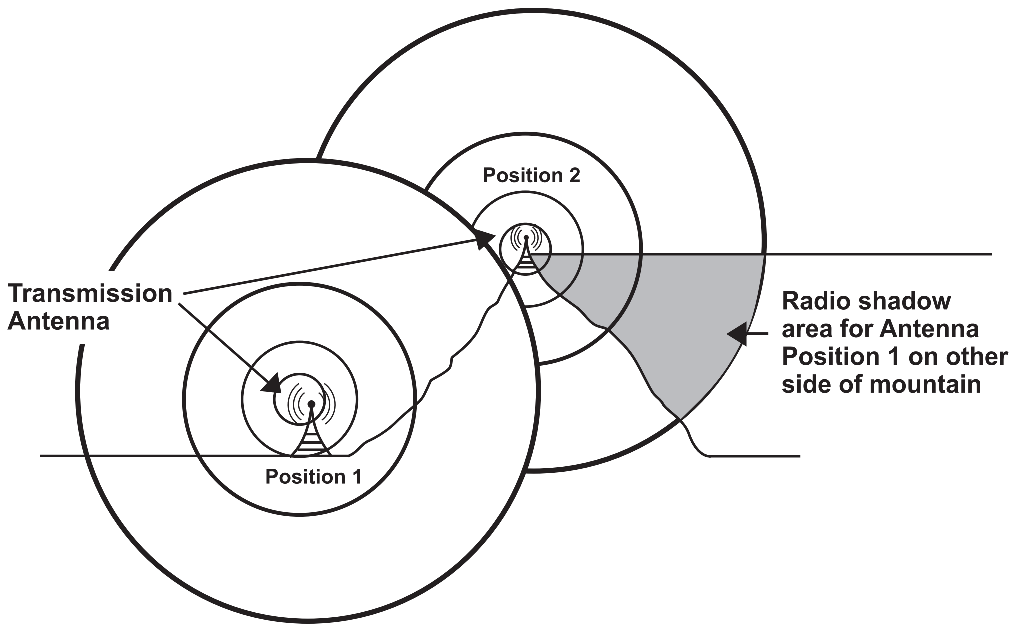


Figure 5.1: *Radio shadow zone caused by a mountain situated near the CRS.*
Source: *CR: A User's Guide to the Technology, N.Ramakrishnan/UNESCO, 2008*

Of course, this does not mean that we cannot use this phenomenon to our advantage on occasion: CR stations, by design and purpose, are low-output power stations, meant to reach comparatively small areas. But if our community happens to reside in a hilly or mountainous area, setting the CRS on the slope, or at the tallest accessible point in the area may well give it additional range. Just as standing on a hill gives you a vantage point for a commanding view of the surrounding area, such a site could increase your effective range, and reach a larger audience. Such considerations must not, of course, over-ride our primary consideration of accessibility and community participation – so don't go locating the CRS at a place only a mountaineer or rock climber could access! Moreover, mounting the antenna at a height greater than 30M from the average terrain of the geographical community may pose problems in getting the technical clearance from the authorities.

Local noise levels

Even while we try to locate the CRS in an accessible place, as close to community life as possible, we have to try and keep ambient noise levels low. By 'ambient noise', we mean the general noise levels in the area. Good recording quality is dependent on having minimum background sound, unless we are trying to create a feel of the area and context. If the ambient noise levels are high, we will have to invest more effort and resources in blocking the external sound from reaching the studio. (This is called "sound proofing" the studio.) On the other hand, if we can find a site that is accessible but where the ambient noise levels are low, we will need to do comparatively little to make the studio spaces suitable for recording audio.

Transmission signal strength

Transmission signal strength is a measure of how powerful the Effective Radiated Power (ERP) of the transmission system is. Just as a brighter bulb illuminates a larger area, a transmission system of higher output power can reach a larger area with the signal it transmits. Another factor that affects the signal strength is the effective height of the antenna above the average terrain (EHAAT). At a purely theoretical level, some areas could benefit by an increase in EHAAT, which could overcome physical barriers or geographical factors to some extent.

At a practical level, though, the transmission strength for a CRS is limited to 100 Watts of Effective Radiated Power (ERP) by the Community Radio Guidelines (2006) issued by the Govt of India. So we cannot increase the strength of our signal output in order to reach a greater area. However, the policy guidelines do allow for increase in ERP of up to 250 Watts in special cases such as if the community is sparsely distributed in the region surrounding the proposed site; there are challenges related to broadcasting in hilly or heavily obstructed terrain. In case these conditions exist, it is possible that the station could be allowed a higher transmission output.

The trade off between siting criteria

While it is important to keep the four factors we have discussed above in mind, we must also be realistic in understanding that we will rarely find an ideal site that meets all these requirements at the same time. You will have to trade off all these factors against each other, and take a decision that is in the best interests and purpose of the station. Very often, you will find that the decision is only partly in your hands, since the decision may eventually have to be taken on the basis of pure convenience and the availability of adequate space. So keep these criteria in mind to the extent possible when weighing options against each other.

5.3.2 Space allocation

Now that we have selected a suitable site for our CRS, it is time to examine how we will divide up the space that we have into suitable work spaces. Again, it is wise to remember that CR stations often work with community donated spaces, and often without the resources to put up a building from scratch. So it requires a bit of ingenuity to adapt the ideas in this section into feasible plans.

Broadly, there are three types of spaces that a CR station needs besides the transmission set up:

a. A broadcast studio (often also called the 'live' studio)

b. A production studio (often also called a 'recording' studio)

c. An office and administrative space

Let us look at these three spaces in detail.

The **Broadcast studio** is the primary studio space for the station. This is where the broadcast is managed from, and where the announcer or programme compere sits during the broadcast to make announcements. It is often referred to as the 'live' studio, because the audio from the studio floor can be played out directly over the transmission system.

The **Production studio** or the recording studio is the space where recordings are done for programmes that will later be edited and finished. The production studio is usually equipped with a sound booth or a recording floor where audio can be recorded in carefully controlled conditions.

The **Office space or administrative area** is the place where the volunteers and CRS team members can sit and work on production-related or management-related tasks. It is the space where scripts are written, records are maintained, and where visitors can make enquiries.

But, a small or medium CRS setup may actually have space for only one small studio that has to make do as the broadcast and the production studio. This can sometimes pose practical challenges to time management, because programme editing tasks may have to be suspended when the studio goes 'live' for broadcast. If broadcast hours for such a stadium are extended, and take up more than six hours a day, this will leave very little time for other editing work, because editing usually takes far more time than a live programme. In such cases, some CR stations dedicate one or more systems in their administrative areas for editing work when they can be spared.

Beyond these three basic spaces, if there is additional space available, the CRS could use it to set up a training hall, or a spare studio, or even a store where the equipment and recording archives can be maintained. Some CR stations develop outdoor spaces where they can conduct meetings, or hold gatherings and functions. Some have even been able to set up small kitchen spaces, so that everyone can have a cup of tea, or cook small meals as they work.

If it is feasible, it may also help to have a small enclosed area separating the entrance to the broadcast studio from the other spaces, so that you pass through two doors in order to enter the studio proper. Such a space is called a sound lock; and it serves to insulate the studio from external noise, specially when a broadcast is in progress. Opening only one door at a time keeps outside noises from filtering in.

In the next section, we will examine some sample layouts for CR station setups and we will discuss some of the special arrangements that we have to make in studios to ensure good audio quality.

Activity 5.1

Assume that you have to set up a community radio station in the area you live in. Make a survey of the area, and identify some locations and/or existing buildings where you could possibly set up the CRS. Draw a table as given below, and award each site points to enable you to select the top three locations. Against each criterion, award the site points from 0 to 5, with 0 being 'totally unsuitable' and 5 being 'excellent'. A sample entry has been done for you to show you how to do this. Replace these numbers with the points for your site.

Site details	Available space	Accessibility	Proximity to community gathering places	Ambient noise levels	Total
Site 1 (*Name*)	3	4	2	4	13/20
Site 2 (*Name*)					
Site 3 (*Name*)					

5.4 Studios for CR Stations

In the previous section, we have discussed some of the common space setups and studio arrangements in a CR station. Let us now look at some possibilities in which the studios partition of CRS can be laid out.

5.4.1 Sample layouts

The basic one-room CRS

As you can see from Figure 5.2, the basic one room CRS, has single space that serves as the broadcast, recording, storage and work space. This kind of a setup

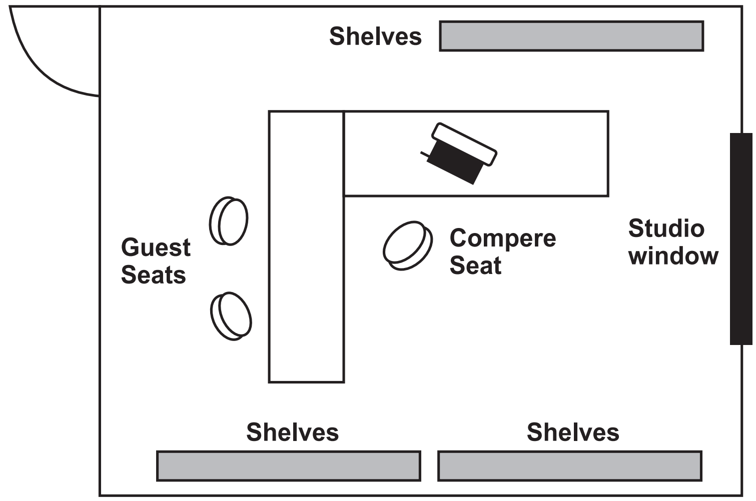


Figure 5.2: *A sample one room CRS layout*
Source: *CR: A User's Guide to the Technology, N.Ramakrishnan/ UNESCO, 2008*

only requires a small area, and very little setup time. On the other hand, with this kind of a setup, it can sometimes be a challenge to do more than pre-recorded or talk based programming, since you may not have space in the studio to record radio drama, or groups of musicians.

A simple 3 studio CRS

A CRS layout that allows us the kind of space depicted in Figure 5.3 provides for a better distribution of space, and a better distribution of tasks across the spaces. Note that the door at the bottom of the schematic would lead to the remaining spaces of the station, if such spaces are available. If they are not, this may constitute the CRS in its entirety. The voice booth in the centre can be used flexibly to provide a recording floor for both the production studio on the left and the broadcast studio on the right.

A full featured CRS: Layout 1

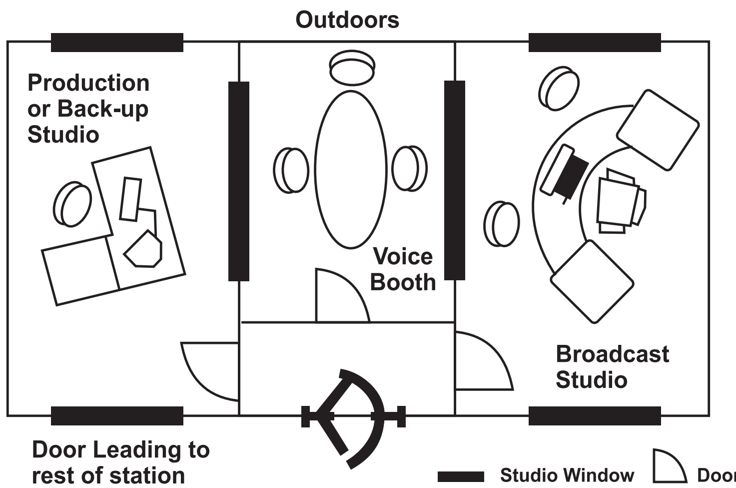


Figure 5.3 :*The three room simple CRS layout gives a little more flexibility.*
Source: *CR: A User's Guide to the Technology: N. Ramakrishnan/ UNESCO, 2008*

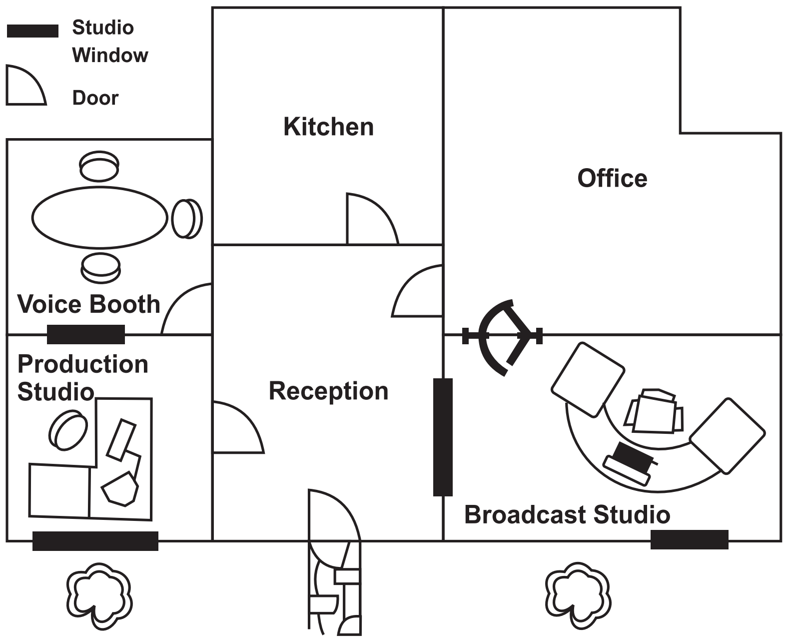


Figure 5.4: *This layout allows us to house a reception area where we can greet guests, as well as an office.*
Source: *CR: A User's Guide to the Technology, N.Ramakrishnan/UNESCO, 2008*

Where we have the space and the resources to be able to establish a more well-equipped CRS, we can set up a station that looks like the one shown in Figure 5.4, Note that we can now accommodate a formal office space, as well as a kitchen and a reception where we can seat and meet guests and visitors. Since the production studio is completely separated from the broadcast studio, programme recordings can carry on even during broadcast hours.

A full featured CRS: Layout 2

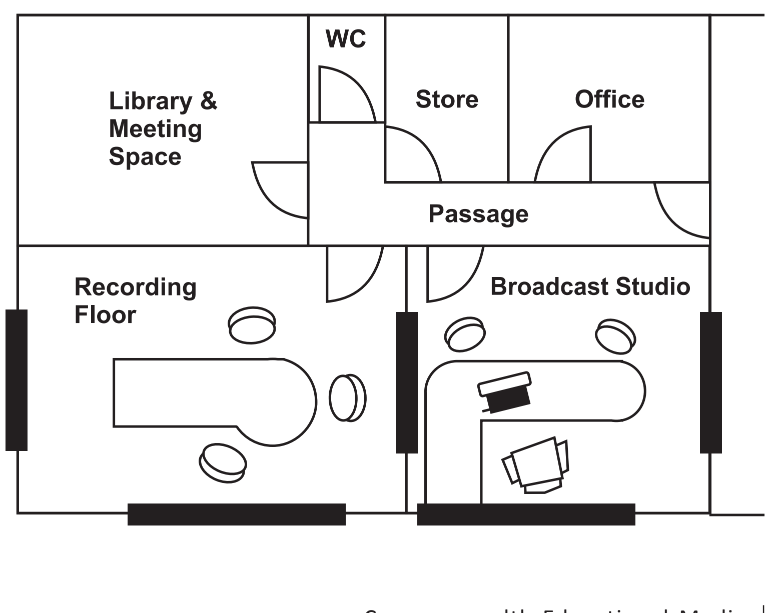


Figure 5.5: *This layout allows us to house a reception area where we can greet guests, as well as an office.*
Source: *CR: A User's Guide to the Technology, N.Ramakrishnan/ UNESCO, 2008*

If we change our priorities slightly and dispense with the kitchen space, we can create a library and meeting/training space for the station, as well as a small store for equipment. In Figure 5.5, we have dispensed with the production studio as well – with recordings done in the broadcast studio when it is free. This may also allow us to have a slightly larger recording floor.

Hence it is important to realize that there is no ‘standard’ way to set up a CRS space and studios. You have to be very clear about how much space is available, and what the priorities are. While these sample layouts are meant to bring out some of the decisions you will take, on the basis of these, priorities may not be implemented as they are shown! Depending on the resources available, you may like to equip a small one room station to start with, then slowly expand the station by setting up more studio spaces, offices and editing rooms. This will allow you to start small, with comparatively less resources; and also to think about the new spaces as you set them up.

5.4.2 Acoustic treatment & sound proofing

Understanding ambient sound and reverberation/echo

In any enclosed space, recording audio faces two challenges: unwanted sounds in the background (“ambient noise”); and echo/reverberation.

Ambient noise refers to any background sound that we do not wish to have in our recording. We have already discussed the need to keep ambient noise as low as possible when selecting a station site; but this alone will not guarantee a complete absence of ambient noise. There may be other people working at the station, and there may still be the occasional noisy vehicle passing by outside, which may cause noise that ends up in the recording.

Echo and reverberation, on the other hand, are caused by sound reflecting off the walls and floor of an enclosed space. The reflected sound reaches your ears a fraction of a second after the original, making it sound a little extended, and giving it the ‘hollowness’ that we associate with empty rooms. (This is especially noticeable in smaller rooms – bathrooms, for instance, since the tiled walls of a bathroom provide hard surfaces that reflect the sound even more. Try singing in the bathroom and see how different it is from when you sing the same song outdoors.)

If the difference between the original sound and the reflected sound is too short for you to perceive them as separate sounds, we call the effect **reverberation** (or **reverb**, for short). If, on the other hand, the sounds are perceived distinctly, we call it an **echo**.

As human beings, we can learn to ignore unwanted sounds and focus on what we want to hear. In a noisy gathering, where a large number of people are talking at the same time, you can still focus on what one of those people are saying. Microphones, on the other hand, are machines, that cannot make this distinction.

Thus, if we record in a space that has high ambient noise or reverb, what you get is an indistinct ('muddy') recording that does not sound clear at all, and which is difficult to edit. It should be clear, then, that if we are to record sound 'cleanly' – that is, we would like the sound to be recorded as faithfully as possible, and with as little unwanted sound and reverb as possible, we must make some special arrangements within the studio spaces to minimize the impact of both.

Sound proofing

The easier of the two to address, in some ways, is the ambient noise. We have to find an effective way to block external sounds from coming into the studio. We do this with a variety of different techniques. This can be more easily done in rural areas and sparsely populated areas when compared to urban and densely populated areas.

To start with, the studio spaces should be housed in a building with thick load bearing exterior walls – 9" or more if possible. The masonry itself acts as an effective insulation against sound transmission. It also helps to have a free standing building, because there is a greater chance of sound filtering through the walls in a wall-to-wall construction, where adjoining buildings share walls.

We can also set up a set of double doors at the studio entrance, so that people entering the studio have to open the first door, close it, and then open the second door to come in. The space between the two doors then acts as an additional layer of insulation, and is called a **sound lock**. The doors themselves can be made of layers of plywood in a wooden frame, with glasswool or thermocol sheets sandwiched between the outer layers. This makes the door thick and sound-absorbing, but light. Rubber gasketing around the edges creates a air-tight and sound-proof seal for the doors, so that sound doesn't enter through any cracks. A glass porthole fitted in the studio doors at eye level allows people to peer in, so that they do not interrupt a running broadcast or recording.

Figure 5.6 : *A studio entrance door. Note how the door fits into the jamb against the blue gasket, making a soundproof seal. Photo courtesy: N.Ramakrishnan/ Ideosync*

Lastly, all windows in the studio area opening on the exterior – and it is a good idea to have them, since this will allow natural light to come in – should be **double glazed**. This means the windows should have not one, but two panes of glass, each set in a rubber or silicone gasket. Each of the glass panes should ideally be at least 5 mm thick, with a separating air space of 5-8 cm between them. The two panes should be angled slightly towards each other, so that they don't set up any internal reflection of sound between them, causing the panes to buzz.

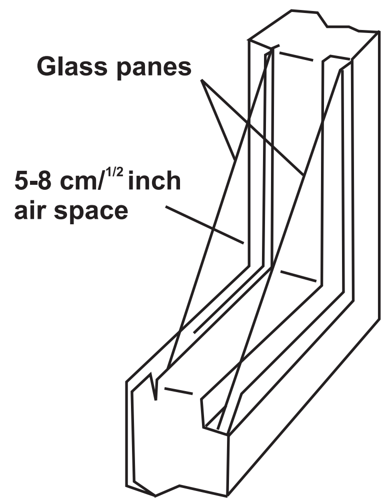


Figure 5.7: *A double glazed window: Cross Section*
Source: *CR: A User's Guide to the Technology, N.Ramakrishnan/UNESCO, 2008*

It is important to remember that sounds enter through the smallest gaps. So ensure that there are no unnoticed cracks or gaps in the studio walls, or any hidden ventilators. Any ducts or pipes passing through the space should be well grouted – that is, the gaps around it should be filled with cement or plaster of paris (POP), so that the gaps are closed.

The large window between the control room – the space where the recording is made – and the studio floor itself also needs some special attention. This is an important window, since the person doing the recording (in the control room) and the artistes or guests in the studio communicate through this window. We follow the same principle as what we saw for the exterior windows to create a double panel window with angled panes. Remember to put in some silica gel between the panes to prevent moisture from condensing between the panes, where it would be difficult to clean.

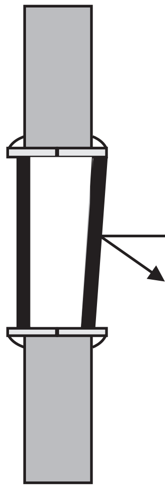


Figure 5.8: *The studio – control room partition (cross section). Note the angled pane which reflects sounds downwards and away from the source.*
Source: *CR: A User's Guide to the Technology, N.Ramakrishnan/UNESCO, 2008*

Acoustic treatment

Now it is time to pay attention to the techniques and materials which we will use to cut down (or "dampen") reverberation in the studio space. Some of this will be achieved by the angled window panes themselves, which will cut down sound reflection from the window spaces.

A professional grade studio uses a wooden frame over each wall, fitted with large fibreboard or corkboard tiles. The tiles are fitted over packed layers of glasswool, and each tile has variably sized holes drilled through it. Once fitted, the holes let the sound pass through, where the glasswool dampens it, and absorbs it. Other studios use angled wooden sections fitted to the walls to reflect the sound unevenly. Floors and ceilings may be mounted on absorbent materials like cork, or cushioned by spring systems or rubber runner. All these techniques are quite expensive, and are usually charged by the installers on a 'per square foot area' basis.

Community radio station budgets calls for use of local materials in an intelligent way, so that we can achieve the same purpose with less expense. Note that this does not mean compromising on the quality of acoustic treatment, or the resulting audio quality.

One way to start is to establish the studio area in a space where the walls do not exactly parallel each other on all sides: parallel walls create maximum reflections. Walls that have insets and bends can often help reduce the problem to a great extent.

A simple way to cut reverb down sharply is to attach materials to the wall and break up the hard surface. The low cost and easy way to do this is to use cardboard egg trays – the kind used by grocery shops to store eggs. Use a strong glue to paste these trays on the vertical walls and ceiling in even rows, so that the indented surfaces point inwards facing the studio. The soft papier-mâché material of the tray, along with the uneven surface give a striking reduction in audio reflection from the walls. Remember to treat the trays with a strong insecticide before you paste them on to the walls.

Figure 5.9*: Egg tray covered walls in Gurgaon Ki Awaaz CRS, Gurgaon*
Photo courtesy: N.Ramakrishnan/Ideosync

Some studios have successfully used sheets of cane matting hung from the ceiling in front of each wall. Others have used thick curtains on rails all around the studio space – the folds in the curtains and the materials absorb and deflect sound and the curtains can be opened selectively to reveal sections of the reflective wall in order to change the audio characteristics of the space.

While the above description has given you a fair idea about 'acoustic treatment and sound proofing', you will learn about it in detail in Module 3 under the head, "Studio Acoustics".

Activity 5.2

Visit the following kinds of rooms, and examine the audio reflections and reverberation level in each (you may have to clap or make a sound to check):

1. A tiled bathroom;
2. A regular living room space with furniture and curtains;
3. A large hall (a marriage hall or closed canteen space);
4. An auditorium meant for music performances. Which has the most reverberation? Where do you think the reverberation will be useful, and where is it not so useful?

5.4.3 Other considerations

Beyond matters like the layout of the station and studios, and the sound proofing and acoustic treatment of the recording spaces, there are a few further decisions we need to take before we get around to the actual configuration of equipment within the station. Let us look briefly at some of these arrangements.

Dust-proofing the studio

One of the greatest challenges of working with technical equipment, especially the electronic ones in tropical countries, is the climatic and environmental conditions that the equipment has to face. And of all these conditions, the biggest enemy of equipment is dirt and dust – so much so, that a large proportion of breakdowns and maintenance issues happens simply because we do not have procedures in place to prevent dust collection.

Since the studio spaces are expected to be used by multiple individuals and members of the community, the only realistic way to keep the spaces dust-free is to encourage a sense of belonging and ownership of the space by everyone, so that keeping it neat like one's home becomes second-nature for everyone. Shoes should be left outside the main entrance – a shoe rack and a signboard there are good ideas. The rubber gaskets we discussed in Section 5.4.2, can also play a dual role: they can provide a seal that prevents dust from entering the studio, if everyone can follow the simple procedure of keeping the doors closed at all times.

Many spaces that are used by CR stations are not originally designed for use as studios and broadcast stations. As a result, they often have inconvenient windows and doors that provide multiple entry points for dust and dirt. If you are faced with this situation, replan your layout so that you minimize entry points into rooms and studios. Windows and doorways can be bricked up, or sealed with double paned glass in order to preserve the natural light. Make the station spaces as easy to clean as possible – leave as few nooks and crannies where dust can gather as possible.

Air conditioning: Should we or shouldn't we?

To start with, let us be clear that air conditioning a CRS is not mandatory. It may not even be necessary. If your station is housed in an old traditional building with high ceiling, or one with floors above, or in the hills or by the sea, it may already be cool enough.

However, if your station is set in a building with an exposed terrace, or in a place with a really hot climate, air conditioning may become necessary. This may be compounded by our attempts to keep dust out, as this may mean we may have blocked several natural vents for the circulation of air. Some equipment can also heat up a lot in use – transmitters, for instance, or poorly ventilated computers.

If air conditioning is necessary, the best kind are split AC units, where there is an internal blower unit, and an external compressor unit, with pipes connecting the two. These are better, because the compressor unit is noisy, and by keeping it out of the studio, we are avoiding unnecessary ambient noise. A window AC would not do, since exterior noise would come through the AC's internal mechanism into the studio. Ducted systems that cover the whole station space would be best, but are often too expensive for CR stations.

When installing a split AC within a studio, ensure that the hole in the wall where the piping and tubes go through is properly grouted and sealed. Also ensure that the compressor unit outside is installed with sufficient space around it, and off the ground. Remember that in humid conditions, water can drip from the interior unit. There should be a drainpipe leading out of the unit which is also directed outside the studio along with the other piping.

In conclusion, it may feel good to have cool air within the studio, but AC units come with their own downsides:

1. They consume a lot of power, which can mean large recurring power bills for the station. It also means that if your station is in a power poor area, the investment may not be worth it.
2. They require regular maintenance to run at peak efficiency, which means an additional task for the CRS team – not to mention servicing and maintenance costs.

Estimating the station's AC requirements

The cooling capacity of ACs are rated in BTUs (British Thermal Units) or more usually in tons (1 ton = 12000 BTU per hour). The ton measure refers to the volume of air that can efficiently be cooled by the AC, and 1 ton, 1.5 ton and 2 ton ACs are most common.

Divide the cubic feet volume of your room by 600 to arrive at the basic tonnage capacity required.

Add 0.5 tonnes for every 10 people occupying the room at the same time.

Similarly add 0.5 tonnes for every 1500 watts of appliances or lighting present in the room (A computer would consume about 300 watts and a regular bulb, 40 to 60 watts).

Calculate the volume of your space on a similar basis for a rough estimate of the AC capacity that you need.

Selecting appropriate studio furniture

Installing studio equipment means, of course , that we also need to have some furniture to place our equipment on. Once again, the key concepts to remember are: hard wearing, and modular. Essentially, a CRS needs furniture which can withstand heavy use, and which we can re-order into a different pattern as per our requirements. It would also be best to have a reasonable idea of what equipment you are going to buy before finalizing the furniture, so that we can be sure that the dimensions are correct. Depending on what is more convenient, furniture can be ready-made, or made to order by a carpenter.

Office furniture is probably the easiest to set up and arrange. Plan for a couple of working desks, a few computer tables, and storage units for files, papers and stationery.

Studio furniture needs some special attention in terms of design. The traditional professional studio configuration is to have a half-moon shaped or U-shaped desk, in the middle of which the compere or recordist sits. The idea is to have all parts of the table within easy arm's reach, so that the compere can simultaneously attend to multiple devices as he or she speaks into the microphone. But given our purpose, and the low-cost philosophy, almost any furniture configuration can be put to good use.

Keep in mind that:

- Even desks carrying various pieces of equipment should allow you at least some working space which you can use to hold notes or write on. If the desk is so covered with equipment that you cannot move for fear of knocking something off, it is hardly a practical arrangement.
- Studio chairs should be sturdy, and must not squeak or groan when sat upon. Most importantly, they should be comfortable to sit on for extended periods of time – so get the best chairs you can.
- In the control room, the furniture should be set up in such a way that the recordist can easily look through the window onto the studio floor without straining or getting up.

The studio floor itself can be kept as bare as possible, to allow it to be used flexibly. But a small round table with a couple of chairs is not a bad idea, as it will allow you to conduct interviews there. If you expect your studio floor to regularly be used for panel discussions though, by all means feel free to get a larger table that can seat four or five people.

Studios should also have plenty of shelf space for storage. You can never have enough storage! Shelves should preferably be closed, and must accommodate manuals, cables, accessories, and small ancillary equipment. Expensive items, especially those that are issued to team members on request, should be stored in locked cupboards for safety purposes.

Many modern studio equipment also come in ready– to-fit standard slotted racks. These racks are generally made to standard sizes in multiples of 44 mm (see Figure 5.9 below), allowing the stacking of recorders, patch panels and amplifiers, and making space-use more efficient.

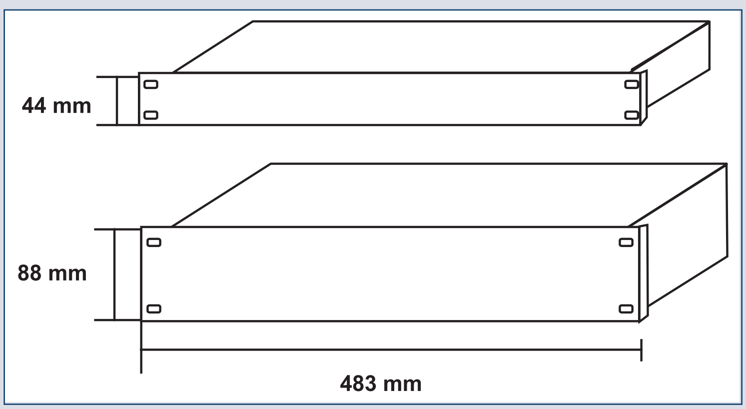


Figure 5.9: *Standard rack mount panels. These can be used to mount CD players and amplifiers vertically one above the other.*
Source: *CR: A User's Guide to the Technology, N.Ramakrishnan/UNESCO, 2008*

Always keep in mind that with imaginative use of furniture, you can easily obtain a far better alternative than buying a great deal of expensive furniture. Good planning, and a sensible carpenter go a long way in terms of making the best use of limited space!

Activity 5.3

Of the possible sites and spaces that you have identified in activity 5.1, select the best option as per the parameters in that activity. Now draw a plan of the existing structure there, and plan how you would adapt the spaces in order to establish a CRS in that space. Pay special attention to:

1. Creating studio space(s)
2. Creating a small work or office space
3. Existing doors and windows you may need to brick-up or double glaze
4. New windows, walls or access doors you may need to create.

5.5 Equipment for CR (schematic level only)

Now that we have learnt how to plan the layout and preparation of the CR stations' various work areas and studios, it is time for us to become familiar with the actual equipment in a CR station.

In this section, we will understand the basic categorization of the various pieces of equipment. We will also see a schematic layout of how the various components connect to each other. In later Units, you will get a detailed understanding of each piece of equipment, its various types, and its functions.

5.5.1 An overview of the programme production process

Before we move on to looking at the equipment, we need to understand the process by which a programme is made. This will help us understand the specific purpose of each piece of equipment, and the part it plays in our community radio station.

The process of making a programme is divided into four broad processes:

1. **Pre-production:** This is the preparatory phase, and includes the time spent on research, scriptwriting, scheduling of recordings, logistical arrangements and so on. This is the least technology based part of the process, as it is mostly about designing the creative inputs for the programme.

2. **Production:** This includes the actual process of recording the programme, in the field and in the studio. 'Recording' means the act of capturing the audio and storing it in a retrievable fashion on a computer, or SD card or cassette. 'Field recording' means all the portions of the programme that are recorded outside the studio, and usually on battery-operated portable recording units (field recorders). 'Studio recording' refers to all the recording that is conducted within the studio space. Production may be conducted in phases, over several days.
3. **Post-production:** This is the process of reviewing our recorded content, and editing it into a final programme which includes the various components that we have planned: music, sound effects, interviews, narration and so on. Editing is the process of collating the components in the correct order, as they will appear in the final programme – as well as a process of removing the parts we do not consider necessary. It is usually done on computerized editing systems, using software designed for the task.
4. **Mixing and Mastering:** This is the process of finalizing the programme, and includes adjusting the audio levels so that they are even throughout the programme ('mixing') and the export of a single, seamless programme from the various components we have stitched together while editing ('mastering').

5.5.2 A schematic overview of a field recording setup

Field recording equipment typically consists of a setup like this:

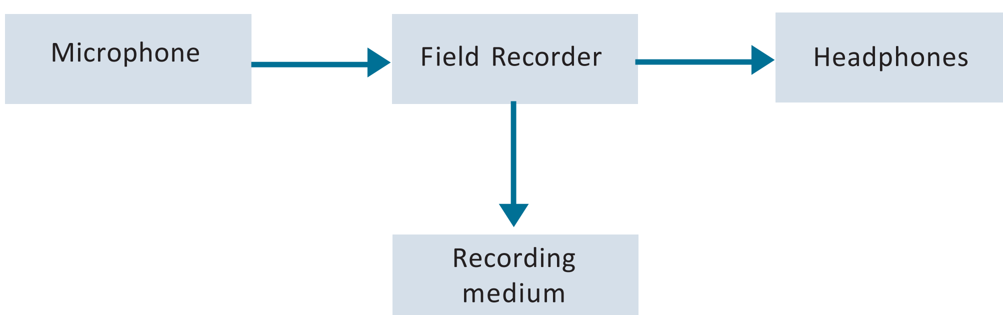


Figure 5.10: *An overview of field recording equipment. The direction of the arrows shows you the direction in which the audio is flowing.*

As you can see from Figure 5.10, the kit usually consists of a microphone; a field recording unit; headphones to listen to the audio as we record it; and a recording medium (also called a storage medium), something we store the recorded audio on. It could be cassettes; digital storage media, like flash memory; or optical media like CDs or DVDs. The direction of the arrows indicates the signal flow.

5.5.3 A schematic overview of the production studio

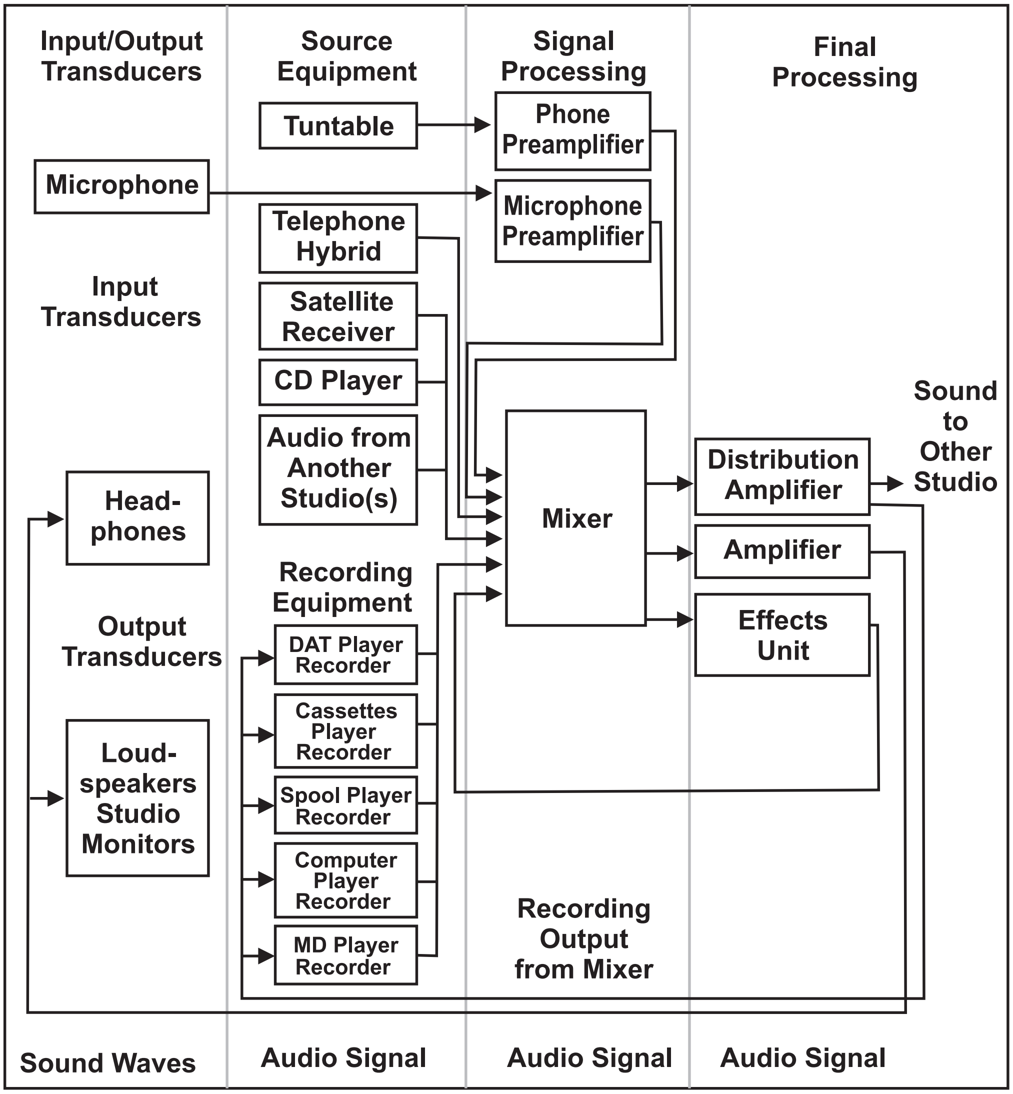


__Figure 5.11:__ A schematic overview of the production studio

As we have noted in a previous section, a production studio is a studio setup where we can record programmes and edit them, but which is not connected directly to the transmission or broadcast system.

Within this setup, the equipment falls into six broad categories:

1. **Input transducers**: This covers all the equipment that converts the sounds we want to record into electrical signals that can be recorded. In practical terms, this includes all the variety of microphones we use to record audio in the studio.

2. **Audio source units**: This covers all the equipment that we can play recorded audio content from in order to incorporate it into our programme. This includes: CD players, computers, cassette decks, LP turntables, MiniDisc players, and solid state players.
3. **Signal processing and management units**: This includes all the equipment we could use to combine or modify the audio signal that we are generating in the studio. Of these, the most important is the mixer unit, which lets us control the relative levels of various audio streams, and combine them into one consolidated output. It could also include any pre-amplifier units that we may use to boost signals from a telephone connection or from the microphones before we feed it into the mixer unit.
4. **Final processing units**: This includes amplifier units that lets us forward the signal to other studios; effects units that lets us add effects to the audio; and distribution amplifiers that lets us split the output audio for recording on multiple devices at one time – or for monitoring on headphones or speaker units.
5. **Recording units**: This includes any devices that we use to record the finalized audio, and includes computers (or Digital Audio Workstations – DAWs); MD (MiniDisc) or Digital Audio tape recorders; or flash based digital recorders, which record on SD (Secure Digital) cards or CF (Compact Flash) cards. Computer based recording systems are the most common nowadays, since the DAW also lets us do the editing function on the same unit.
6. **Output transducers**: This includes all the devices we use to listen to the audio that is being generated. It includes headphone units; as well as speaker ("monitor") units.

Look at the diagram in Figure 5.11 carefully to understand how all these components are interconnected, and how the signal flow is achieved. The diagram also shows you what form the audio is in at a given stage: Whether it is still in the form of sound waves, or whether it is in the form of an electrical signal.

5.5.4 A schematic overview of the broadcast studio

As we have noted in a previous section, a broadcast studio is a studio setup from where we can conduct programmes that can go live on air; or from which we can playback pre-recorded programmes for transmission. In some cases, the broadcast studio also includes facilities for recording and editing programmes – and in many small stations, there is only one studio which doubles as a production and broadcast studio.

Examine the diagram in Figure 5.12.

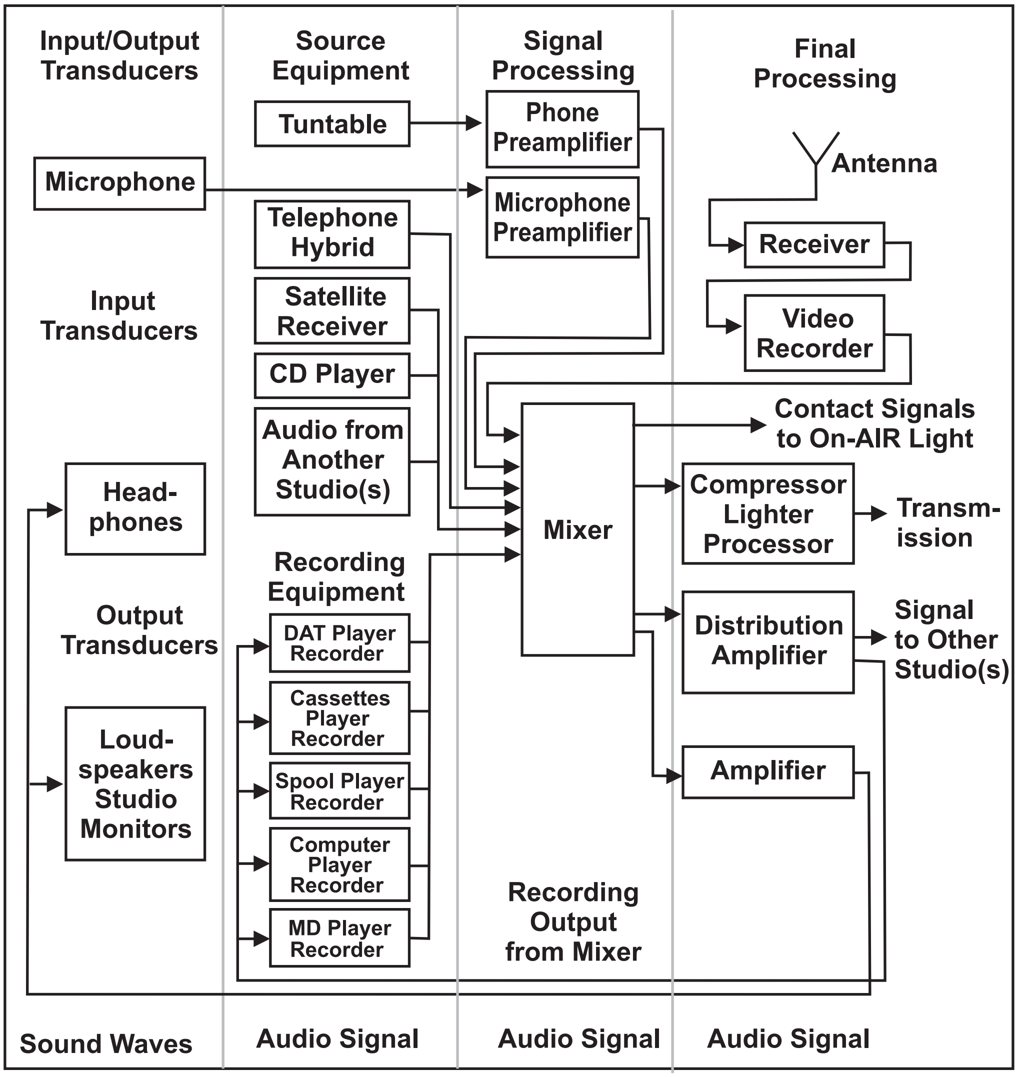


***Figure 5.12:** A schematic overview of the broadcast studio*

As you will notice, the basic structure of the devices is very similar to what you saw in the production studio. We have the same input transducers, audio sources, signal processing & management devices, final processing devices, and output transducers. We have only two principal additions in the broadcast studio over the production studio viz. a **Compressor/Limiter** and feed going to the transmitter.

The **Compressor/Limiter** is a device that limits the signal when it goes beyond a fixed level; and compresses the audio that exceeds this limit, by squashing it back into the defined limit. These are comparatively rare in CR stations, and are more commonly found in commercial radio stations.

Finally, there is a seventh category of equipment viz., **Transmission equipment** which transmits the programme on the assigned frequency of the station via the co-axial cable and the antenna. Within the studio, this usually means the transmitter unit, which actually does this task.

5.5.5 A schematic overview of the transmission setup

At this point, it is also worth looking briefly at the components of the transmission system itself.

Look at the diagram in Figure 5.13. As you can see, the audio signal from the broadcast mixer unit undergoes final processing, and is then fed through the Studio-Transmitter Link (STL) to the transmitter unit in case the studio and transmitter are not co-located. At most of the Community Radio Stations, however, Studio and Transmitter are co-located. As such ST Link is not required in most of the cases. The transmitter device generates the carrier radio wave, and combines the audio with the carrier so generated before sending it to the antenna unit. The process of combining the audio with the carrier is known as modulation, more details about which are given in Section 6.4.2.

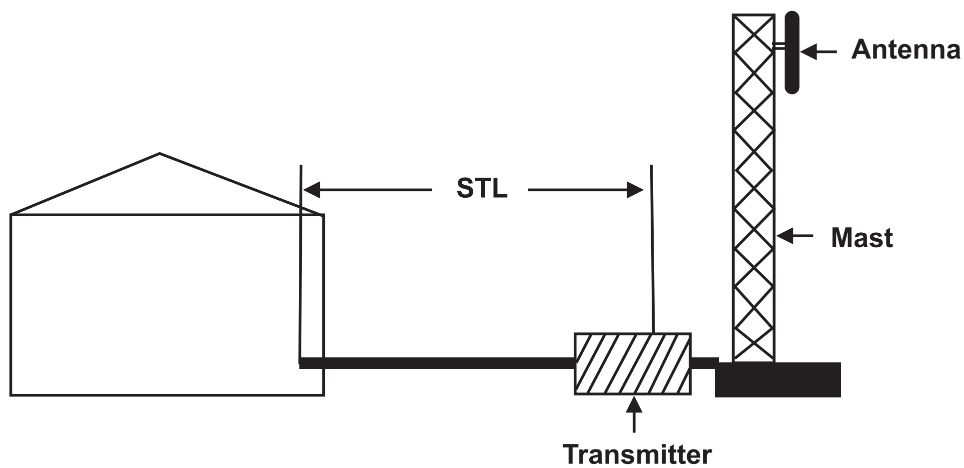


Figure 5.13: *A schematic overview of the transmission setup*

The signal reaches the antenna through the antenna cable, and is then dispersed into the air by the antenna, which is usually mounted on top of a tower or mast. This is shown in Figure 5.14.

At the reception or listener's end, this combined radio signal is received by the radio set, which carries its own little antenna to pick up the radio wave in question. Within the radio set, the radio wave is filtered out, and the audio signal stripped out. This is then fed to the speaker unit on the radio, from where we hear the original audio waves as shown in the second figure of Figure 5.14.

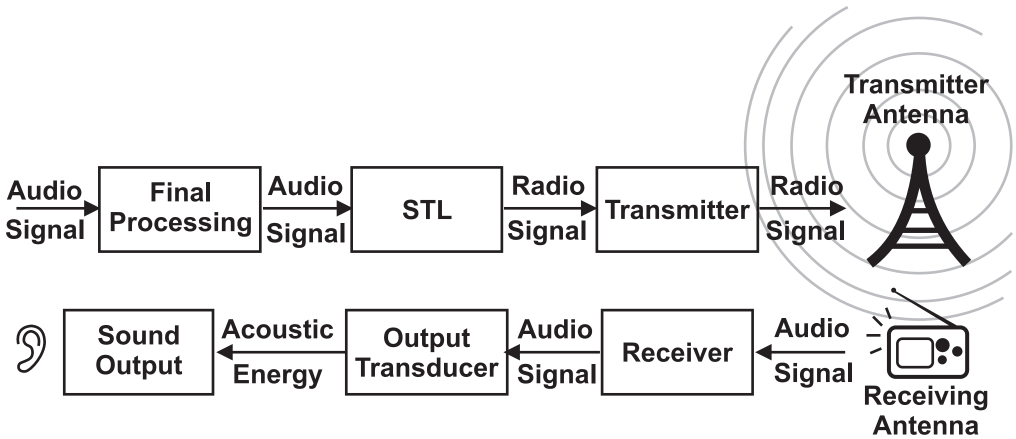
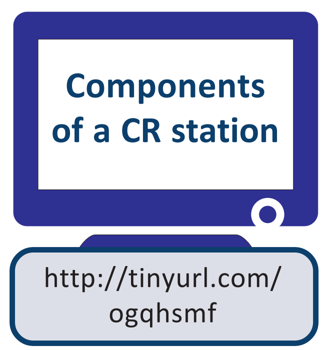


Figure 5.14: *Transmission: From studio to antenna*

5.6 Setting up a CRS: Activity and Video



Now that you have a good understanding of the components of a CR station, please see the video titled 'Components of a CR station', which is available at the Youtube site of CEMCA http://tinyurl.com/ogqhsmf.

The video provides you knowledge on the suitable location, studio design and walkthrough of a working CR station (Must Radio, Mumbai). In this video, you will examine the spaces used by the CRS; the studio designs; the acoustic treatment used; and the equipment the CRS is using. You will also see the CR station's transmission setup, including its mast, and the broadcast antenna. You will also see some animation based explanations of some of the key concepts that you have learnt.

Once you have viewed the video, complete the activity below.

Activity 5.4

With reference to the CRS that you saw in the video study material, write:

1. Three key features of the station that you feel would be appropriate for a CRS in your area;
2. Three key features of the station that you feel would NOT be appropriate for your area.

With each feature, write a short explanation of why you consider this feature appropriate or inappropriate.

5.7 Let Us Sum Up

This unit focused on the key decisions we have to take while choosing a location for a CRS, as well as on planning how to divide the available space into working spaces for the station. It also talked about the advantages and disadvantages of some sample layouts presented in the unit, along with the ancillary considerations (air-conditioning, furniture choice, acoustic treatment, soundproofing) that we must keep in mind.

We have also seen overviews of the field recording setup; the production studio; the broadcast studio; and the transmission system. We are also sure that you have understood the process of how the transmitted signal reaches the receiver/listener; and the process of programme production (pre-production, production, post-production, mixing and mastering).

Finally, we viewed a walk-through video of an actual CRS, and understood the practical application of many of these concepts.

5.8 Model Answers to Activities

Activity 5.1

A sample entry has already been completed for you in the table shown in the activity. Use that as a model to frame the rest of your entries.

Activity 5.2

The spaces with the least reverberations are the living room space and the large hall.

The spaces with the greatest reverbs are the tiled bathroom and the auditorium. The tiled bathroom's reverb is uncontrolled, since it is not designed as a space for audio. The auditorium's reverb is more controlled, since the hall has been designed to control and emphasize the reverb of certain kinds of reverb – typically, vocalists and instrumentalists on the stage.

Activity 5.3

Since the space that you will redesign in this activity is something you will select from a real location, there is no standard answer that can be presented here. Remember that your diagram/plan should look something like those given in Figures 5.2 – 5.5, and must clearly show what you intend to change and how.

Activity 5.4

Note: This exercise is based on your practical exposure of a community radio station. Please go through the Video available in the CEMCA's YouTube site and then try to answer from yourself.

UNIT 6

Radio Waves and Spectrum

Structure

6.1 Introduction

In previous Units, we discussed a range of issues relating to community radio. These issues were about the philosophy guiding the concept of community owned and community managed media; the policies governing the establishment of community radio stations in India; the factors we need to keep in mind while deciding a location for the station; and the various considerations we need to address while designing and setting up a CRS.

It is now time to take a pause and look at a fresh set of basics to sharpen our understanding further: what are radio waves, and where do they come from? How does the process of radio broadcast actually happen? When did it start? In this Unit, you will learn about the science behind radio broadcasting, and the natural phenomenon of electromagnetism. You will also learn about how the usage of radio waves are governed in this country. For studying this Unit, including working on the various Activities, you may need around 40 hours of study.

6.2 Learning Outcomes

After working through this Unit, you will be able to:

- discuss radio waves and their implications for CR.
- explain the broadcasting spectrum for radio.
- describe different frequencies of operation of radio broadcasting.
- analyze issues related to regulation of radio waves, spectrum and frequency.

6.3 Electromagnetic Spectrum and Radio Waves

Before we begin to understand what radio broadcasting is all about, and how this process takes place, it is important that we first understand some fundamental facts and measures related to the science behind radio broadcasting. For this, we must go back to some of the basic physical properties of waves, energy and radiation.

6.3.1 Basic characteristics: Amplitude, Frequency and Wavelength

You must all have thrown a pebble into a pool or puddle of water at some point in your lives. What happens? The stone causes a series of ripples that start at the point where the stone hits water, and spreads out in concentric circles or rings

from that point outwards. Simply put, the energy which the flying pebble possessed at the moment it hit the water surface, has been converted into the up and down movement ('oscillation') of the water particles, which have now formed WAVES. Hope you are now able to visualise the concept of waves. Here, you can watch a small video, which will help you to understand the concept of waves more clearly. Please visit at http://tinyurl.com/p5kykyc for the video titled 'Introduction to Radio Waves'.

So a 'wave' is an up-and-down or side-to-side movement of the particles in a medium. We usually represent waves graphically as given in Figure.6.1.

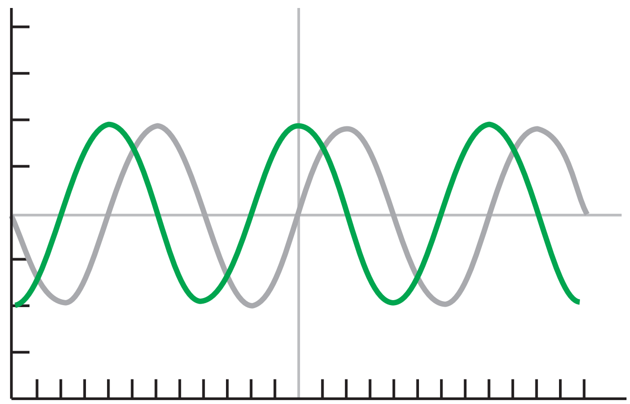


Figure 6.1: *Waves: Shape and propagation.*

Note that the green waveform represents the wave when it starts. The grey waveform shows the same wave an instant later, when it has 'moved' to the right.

There are three key qualities of a wave that we must become familiar with. These are:

1. Amplitude: This is the difference between the highest ('peak') and the lowest portion ('trough') of a wave, and is a measure of the strength of the wave. The larger the amplitude, the higher the energy of the wave, and the greater the distance it will travel. In terms of sound waves or audio waves, the larger the amplitude, the louder the sound. The concept of amplitude and frequency is illustrated in Figure 6.2.

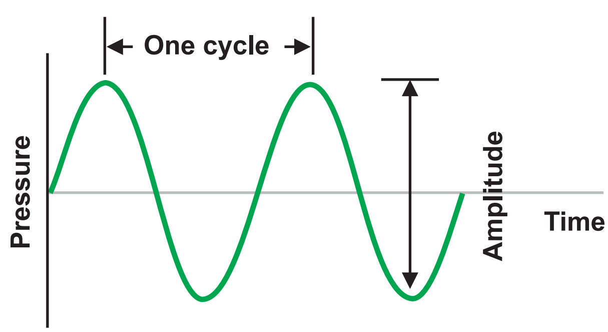


Figure 6.2: *The amplitude of a wave / One 'cycle'*

2. Frequency: Frequency refers to the number of waves that pass through a given point in space every second as shown in Figure 6.3.

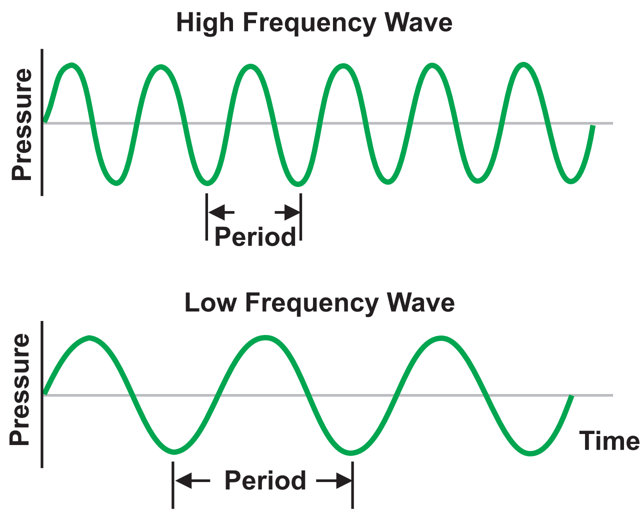


Figure 6.3: *High frequency and low frequency waves*

If you look at the diagram in Figure 6.3, the wave on top has a greater number of cycles within the same distance as compared to the lower wave. Thus, you will see that if we choose any one point on the horizontal line, and imagine both waves moving to the right at the same speed, more cycles of the wave on top will have passed that point after one second than for the lower wave. The upper wave could thus be said to have a 'higher frequency' and the lower wave a 'lower frequency'.

Frequency is measured in Hertz (Hz). One Hertz (1 Hz) corresponds to one cycle crossing at a given point in space every second. (By extension, a wave with a frequency of 100 Hz would have a 100 cycles pass that point every second.)

3. Wavelength: Wavelength refers to the distance between two successive waves, as shown in Figure 6.4.

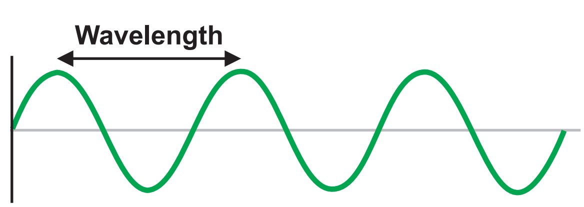


Figure 6.4: *Wavelength of a wave*

This distance can be measured as the difference between two adjoining peaks, or two adjoining troughs.

Frequency and wavelength have an inverse relationship, which means the greater the frequency of a wave, the shorter the wavelength; and vice-versa.

6.3.2 Radiant energy and Electromagnetic Spectrum

Have you ever stood in the sunlight and felt its warmth on your skin and face? But the Sun is a ball of hot gas millions of kilometres away from us, across the vast empiness of space. How could its heat reach us across this vast distance and through a vacuum?

The answer is that every object gives off energy in various ways. Objects at a higher temperature give off more energy and objects at a lower temperature give off less. The Sun, being a superhot ball of gas where nuclear reactions are going on continuously, gives off energy in a number of different ways. This 'giving off' of energy is called **radiation**; and the energy so given off is termed **radiant energy**.

Radiant energy could be in the form of light, or heat, both of which we can immediately sense with our eyes and our skin respectively. Then again, it could be in the form of such waves that we cannot see or hear, or even feel directly with our limited senses, but which can be detected by devices that we build. One example is X-Rays, the invisble rays that are used by medical science to look through skin and flesh to see parts of our skeleton. Together, all these kinds of radiant energy are often called **Electromagnetic Wave Radiation**, since the energy is actually radiated in the form of waves, and has properties linked to both, electricity and magnetism. (**Electricity** is the phenomenon of the flow of charged particles from one point to another in a conducting medium, such as a copper wire; and **magnetism** is the phenomenon whereby some material can attract or repel other objects.)

Waves in water, or sound in air are both examples of waves which need a medium to travel through: water and air, respectively. Electromagnetic wave radiation, on the other hand, can travel across vacuum, without any medium. (They may, however, be impeded or affected by any electric or magnetic material or conductors in their path.)

Unlike water or air, which can move physically – up and down or side to side – when set in motion, electromagnetic wave radiation does not physically move any particles. Rather, an electromagnetic wave may be understood as the change in the levels of electromagnetic charge in a given point in space over a period of time.

All electromagnetic waves travel at the speed of light in a vacuum. The speed of light is a constant 299,792,498 metres per second – which is very fast indeed! For all practical purposes, over short and medium ranges, this is almost instantaneous, which is why even if a bulb is switched on a long distance away, you see it immediately – because the time taken for the light to reach you is so short that you cannot perceive the gap.

Electromagnetic wave radiation is mostly classified on the basis of the frequency of the waves that are radiated. They range from comparatively low frequency waves (in the **KiloHertz** or thousands of Hertz range) to comparatively high frequency waves (in the **GigaHertz** – or millions of Hertz – and **TeraHertz** – or billions of Hertz, or higher range). Together, all the frequencies of electromagnetic waves are called the **electromagnetic spectrum**.

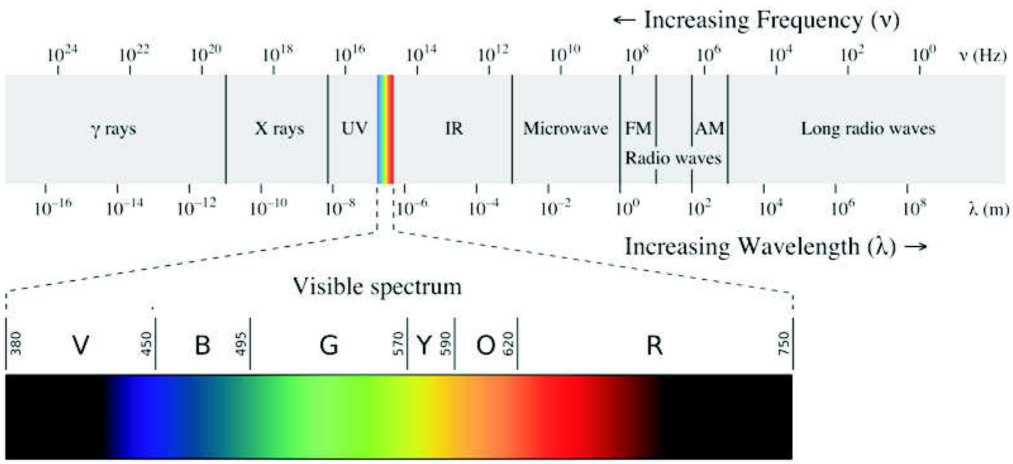


Figure 6.5: *The electromagnetic spectrum, with inset showing visible light. Note the direction of increasing frequency of the electromagnetic waves.*

As you can see from Figure 6.5, **Visible light** forms one part of the electromagnetic spectrum which is perceivable by us with our eyes. This portion of the electromagnetic spectrum is, appropriately, called the visible spectrum, and is composed of the familiar colours Violet, Indigo, Blue, Green, Yellow, Orange and Red (known by the acronym VIBGYOR), which we see in a rainbow; or when sunlight is split by a prism. In the visible spectrum, red is at the lower frequency end, and violet at the higher frequency end. Above the blue end of visible light – that is at higher frequencies than blue light – lie **Ultraviolet Rays**, **X-Rays** and **Gamma Rays**. Below the red end – that is, at lower frequencies than red light – lie **Infra Red Rays**, **Micro Waves** and **Radio Waves**.

6.3.3 The Radio Spectrum

Radio waves are those electromagnetic waves that typically fall within the 3 Kilohertz (kHz) and 300 Gigahertz (GHz) range of frequencies.

They can occur naturally – the Sun and other astronomical bodies, as well as lightning are sources of radio waves. Radio waves are used for location beacons, and to generate direction signals for radio location. They are also used for broadcasting, which means producing them by artificial means, so that they can carry an audio signal of our choice to a distant place.

The following table (sourced from Wikipedia) shows the entire gamut of radio frequencies and how they are categorized.

DESCRIPTION OF RADIO WAVE BAND	FREQUENCY RANGE
Extremely Low Frequency (ELF)	3 Hz/100 mm – 30 Hz/10 mm
Super Low Frequency (SLF)	30 Hz/10 mm – 300 Hz/1 mm
Ultra Low Frequency (ULF)	300 Hz/1 mm – 3 kHz/100 km
Very Low Frequency (VLF)	3 kHz/100 km – 30 kHz/10 km
Low Frequency (LF)	30 kHz/10 km – 300 kHz/1 km
Medium Frequency (MF)	300 kHz/1 km – 3 MHz/100 m
High Frequency (HF)	3 MHz/100 m – 30 MHz/10 m
Very High Frequency(VHF)	30 MHz/10 m – 300 MHz/1 m
Ultra High Frequency (UHF)	300 MHz/1 m – 3 GHz/100 mm
Super High Frequency (SHF)	3 GHz/100 mm – 30 GHz/10 mm
Extremely High Frequency (EHF)	30 GHz/10 mm – 300 GHz/1 mm
Tremendously High Frequency (THF)	300 GHz/1 mm – 3 THz/0.1 m

Different frequencies of radio waves have different propagation characteristics in the Earth's atmosphere. Longer waves may cover a part of the Earth very consistently through ground wave propagation. Shorter waves can reflect off the ionospheric magnetic layer of the atmosphere, and travel around the world. Much shorter wavelengths bend or reflect very little and travel on a line of sight.

Different parts of the radio spectrum are used for different radio transmission technologies and applications. Radio spectrum is typically government regulated in developed countries and, in some cases, is sold or **licensed** to operators of private radio transmission systems (for example, cellular telephone operators or broadcast radio and television stations). Ranges of allocated frequencies are often referred to by their provisioned use (for example, 'cellular spectrum' or 'television spectrum'). Some parts of the radio spectrum are unlicensed – for example, the frequencies used for **Wireless Fidelity** or **WiFi** internet, or **Citizen Band (CB)** radio. Cordless telephones also use an unlicensed part of the radio spectrum.

Activity 6.1

Visit an office that has a WiFi connection. If there is no such office nearby, you can visit a store that stocks router and computer equipment. Examine the WiFi router available, and check the radio frequency range used by it. Note the name of the router, the WiFi band it is using (802.11b, g or n), and the frequency range.

6.4 Frequency Bands for Radio Broadcasting

For practical reasons, radio spectrum is subdivided into smaller sections called **Bands**, which are further subdivided into specific frequencies called **channels**. Each of the ranges you see in the table above is actually a Band (VHF Band, UHF Band, and so on).

By international convention, certain bands have been reserved for certain kinds of broadcasting, as we have noted previously. In this section, we will understand the primary bands assigned for radio broadcasting globally.

6.4.1 Medium Wave (MW) and Shortwave (SW)

In most countries across the world including India, the band between 535 kHz and 1605 kHz is reserved for **Medium Wave** radio broadcasting. Medium Wave is often shortened to **MW**, the letters you see on a radio tuner dial. 'Medium Waves' refers to the size or wavelength of the corresponding radio waves, which range from 560 metres to 187 metres. (This means each wave in a medium radio wave is 187 metres or more in length – upto a maximum of more than half a kilometre!)

One of the key characteristics of medium waves is that their principal mode of propagation is through ground and they follow the curvature of the ground well. They can also get reflected from the atmosphere's ionosphere at night allowing medium-to-long-range broadcasting. Some of the countries of the world are using medium wave transmitters upto 2000 Watts (2 MW) power, covering a range of several hundred kilometres radius. MW transmissions, however, suffer from night time shrinkage of service because of interference from sky wave signal, which is otherwise absent in daytime. All India Radio is making use of the Medium Wave band for its domestic broadcasting and also for service to neighbouring countries with transmitters ranging from 1 KW to 1000 KW.

Shortwave as a medium of radio communication received its name because the wavelengths in this band are shorter than 200 m (1500 kHz) which marked the original upper limit of the medium frequency band first used for radio communications. Short wave is also known as HF (High Frequency) that covers the range of 3-30 MHz for radio broadcasting.

Initially thought to be useless, shortwave radio is used for long distance communication by means of reflection from the ionosphere. This mode of propagation is also known as **skywave** or **skip propagation,** allowing communication around the curve of the Earth. It is therefore mostly used for international broadcasts by various countries including India. In India, however, Shortwave (HF) is also used for supplementing its domestic MW services by virtue of special dispensation given to it by being a tropical country.

Medium Wave and Shortwave broadcasting is conducted in Amplitude Modulation (AM), regarding which you will read more in the section below.

6.4.2 Amplitude Modulation (AM) & Frequency Modulation (FM)

Radio broadcasting can be categorized not only on the basis of the frequency bands that are used, but also by the precise method used for creating the radio signal. Let us understand this in greater detail.

As we have understood in a previous section, radio broadcasting is achieved by combining the source audio (the audio signal) with a radio carrier wave. A signal is any electronic stream that carries information. A carrier wave, as the name suggests, is a high frequency radio wave on which the audio signal can be mounted, or with which, you can say, it can be combined, in order to carry the audio signal much further than it would otherwise go. (Just as having a vehicle can let you travel comfortably over larger distances, the carrier wave carries the audio signal over a greater distance owing to its higher energy and greater capacity to travel over a distance without being dissipated). The process of combination of the carrier wave with the audio signal is called **modulation of the carrier wave**.

One of the ways in which this can be done is through **amplitude modulation** or **AM.** In AM, the modulation of the carrier wave results in the creation of a wave with the frequency characteristics of the radio wave, but whose amplitude varies according to the audio signal.

Consider the diagrams in Figure 6.6:

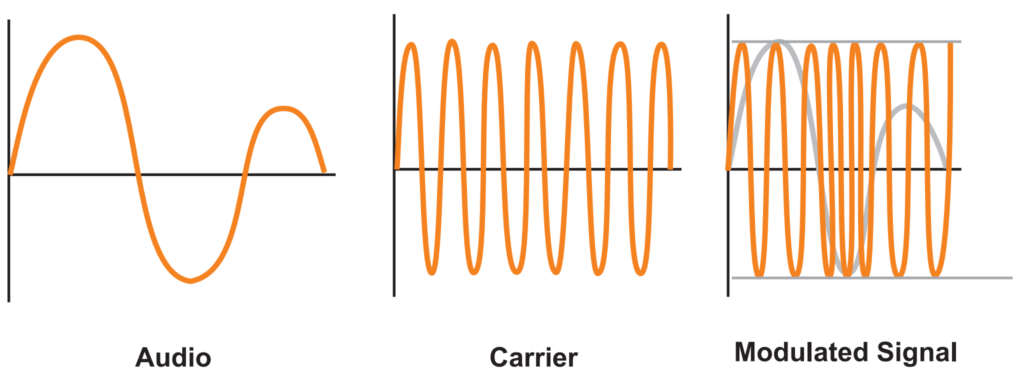


Figure 6.6: *Amplitude Modulation. Note the shape of the final output wave.*

As you can see, the output radio signal continues to have the carrier wave's frequency, but now has an amplitude variation that resembles the original audio. AM broadcasting continues to be the modulation technology used for MW and SW radio broadcasting.

The key challenge of AM broadcasting is that it is easily disturbed by natural phenomena like lightning, or by the sparkplugs from motor cars; or even high tension electrical cables, which generate strong magnetic fields around themselves.

Frequency Modulation, or **FM**, was a modulation technology that was developed subsequent to the invention of AM. In the case of FM, the modulated wave continues to have the same amplitude as the original carrier wave, but now has variations in frequency that correspond to the frequencies of the audio signal, as shown in Figure 6.7. You will learn more in detail about Frequency Modulation in Module-7, Unit 23.

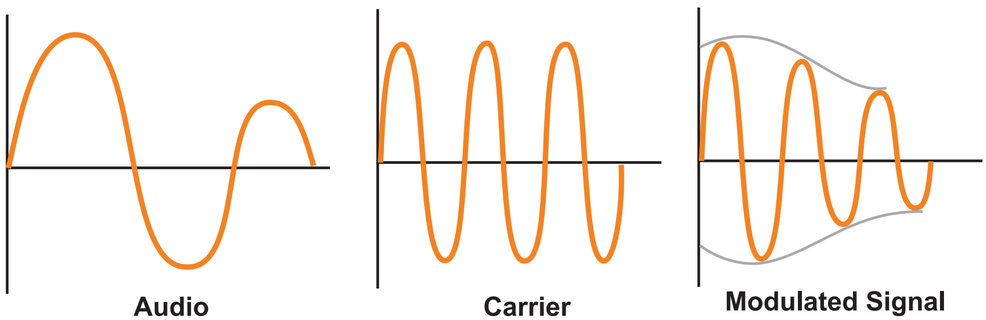


Figure 6.7: *Frequency Modulation. Note the varying frequency of the final output wave.*

Frequency modulation provides excellent high fidelity audio, and the ability to broadcast stereo audio – discrete signals for the left and right speakers – with comparatively few complications. It is also not disturbed by atmospheric or electrical phenomena, making it well suited to urban broadcasting. The advantages of FM over MW (AM) have already been given in Module-1. It is because of those advantages that it has been chosen for Community Radio. FM broadcasting is primarily a line of sight (LOS) propagation, although propagation also takes place beyond LOS by means of diffraction, scatter and ducting. You will learn more about frequency modulation and radio propagation in Module-7, Units 23 & 26. However, the summary of various modes is given below:

AMPLITUDE MODULATION (AM)			
Mode MF/MW	Total Band 300-3000 KHz	B'casting Band 526.5-1606.5 KHz	Propagation Ground wave (Day & Night) Sky wave (Night)
HF/SW	3-30MHz	3-30 MHz	Sky wave (Day & Night)
FREQUENCY MODULATION (FM)			
Mode VHF	Total Band 30-300 KHz	B'casting Band 40-230 MHz FM Band 87-108 MHz	Propagation Direct wave with ground reflected wave upto L.O.S. Diffraction, Scatter and Ducting beyond L.O.S.

Activity 6.2

Compile a list of all the radio stations that can be heard in your area. Present them as a table divided by type of modulation: FM and AM. Within AM, indicate if the station is MW or SW (if available). Include the frequency of broadcast for each channel.

6.5 A Brief History of Radio Broadcasting

Before we conclude this Unit, it is now time to take a quick look at the history of radio and radio broadcasting a part of which you have already learnt in Unit-1.

6.5.1 The International Experience

Radio waves were first predicted by the British physicist James Clerk Maxwell as part of his calculations on the wave theory of electromagnetism in 1865. Maxwell suggested that light and electromagnetism were connected phenomena. The first successful radio transmission was made in 1879 by James Edward Hughes but it was only in 1889 that the German physicist Heinrich Hertz proved conclusively that Hughes' experiment involved the transmission of electromagnetic (radio) waves. It is after Heinrich Hertz that our measure of frequency, the Hertz, is named.

By 1892, the physicist Nikola Tesla had demonstrated the transmission of energy through radio waves and predicted that it could be used for the transmission of information. This was subsequently demonstrated by the Italian physicist Guglielmo Marconi, who made the first practical radio transmission system capable of transmitting a signal over a range of one to two kilometres. (Though Marconi is widely regarded as the first radio broadcaster, there were a large number of researchers on radio by then, and this status is disputed. Indian scientist J.C.Bose is now co-credited in many publications as the inventor of radio broadcasting.) Marconi would later set up a company to explore the military and commercial possibilities of radio.

Though there are many claimants to the title, it is often quoted that Reginald Fessenden made the first radio broadcast on Christmas Eve in 1900, from Massachusetts, USA. Shortly thereafter, Marconi made the first experimental radio transmission across the Atlantic Ocean (London to New York) in 1901. Within the next twenty years, formal licensing of stations began on both sides of the Atlantic. Companies like Telefunken in Germany, NESCO in the USA, and British Marconi and American Marconi began to establish strong presence for radio; and radio began to be used for entertainment, music and education.

By the 1930s, Edwin H. Armstrong had invented FM transmission, which overcame several of the issues that plagued AM transmission, as we have seen in the previous section. By the 1940s, FM transmission was a commercial reality in Europe and America. During World War II (1939 – 1945), radio played an important part in propaganda broadcasts, as well as early warning systems for air raids.

By the 1950s, television had begun to replace the radio as the chief source of information and entertainment in the United States. Early TV stations developed during the 1930s, but only became really popular following the war years. But radio received a renewed resurgence in 1960, when Japan's Sony Corporation invented the first **transistorized pocket radio**, one that could be powered by small AA batteries. Radio suddenly became the portable medium everybody could enjoy as they moved about. And, with the resurgence of popular music in that country, radio became the young people's medium for music.

Radio underwent a decline through the 1980s and 1990s, in the face of changing listening habits. The increasing presence of television globally, as well as the increasing emphasis on live TV coverage of sports and public events meant that radio became a niche music medium. However, Video Cassette Recorders (VCRs) and Compact Discs (CDs) meant media could be increasingly consumed in a non-broadcast per-convenience basis, which disturbed traditional models. FM radio, in particular, began to rely on a core audience of commuters who listened to radio in cars while driving.

However, the 1980s and 90s also saw an increasing sense of localization which meant there was also a new interest in volunteer driven community radio, with countries such as Australia, Bolivia, and Colombia showing a resurgence of small stations broadcasting in local languages. Many countries have reserved frequencies for educational and civil society/non-profit radio.

The 2000s heralded a new beginning in the history of radio with three new developments: **streaming radio** stations on the internet, which use internet protocols to offer music and content globally; **mobile telephones** with FM radio receivers built in; and **satellite direct-to-receiver broadcasting**.

6.5.2 Radio Broadcasting in India

As you have learnt in Unit-1, radio broadcasting in India, though initially started as a private enterprise in 1927, had mostly remained in government hands till the year 2000, when it was opened to private broadcasters by offering to allot 108 channels in 40 cities. You have also learnt about the formation of Prasar Bharati and emergence of private Broadcasting & Community Radios in quite some detail there. Here we will recapitulate the brief history of Community Radio Scheme and learn about the technological journey of radio transmissions in brief.

Besides the decision to invite private participation in radio broadcasting as mentioned above, the Government also introduced the scheme of Community

Radio Stations. To start with, the government vide its notification made in December 2002, opened this scheme to established educational institutions/ organizations recognised by the Central and State Governments. Later in 2006, it broadened the policy by bringing it into the ambit of Non-Profit organizations in order to allow greater participation by civil society, specially on issues related to development and social change, thus giving birth to the Community Ratio Stations in their present form, about whose concept and evolution you have already learnt in Unit-1 of Module-1.

In terms of technology, Medium Wave (MW/MF) ably supported by Short Wave (SW/HF) remained the mainstay of domestic broadcasting in the country till FM was introduced on a large scale in All India Radio in late eighties. Although, FM was brought into the AIR network on an experimental basis, between 1977 and 1984 by installing 10 KW transmitters in four metros – the first one coming up in Chennai on 23rd July, 1977 – it was introduced in a big way only in late eighties when it was decided to install 100 FM Transmitters across the country. FM has been assigned as a technology for both Private Broadcasting and also for Community Radios.

Activity 6.3

How many CR stations are currently operational in India? Compile a current list of operational CR stations. Include details of the name of the licensee and which state the CRS has been set up in.

6.6 Regulatory Bodies and Processes

Any discussion of the radio waves would be incomplete without a discussion of the key regulatory bodies that govern broadcasting i.e. use of the radio waves for broadcasting globally and within India.

As we have seen, in the West, radio came up through a series of entrepreneurial and research experiments. By 1926, the government of the United States felt a need to create a regulatory body that could oversee adjudication as well as use of frequencies by competing entities, which resulted in the setting up of the **Federal Radio Commission** that year. The commission was expected to regulate radio use “as the public interest, convenience, or necessity” required.

By 1934, however, the commission was replaced by the newly constituted **Federal Communications Commission** which oversaw all communications related decision making from a regulatory and adjudicatory point of view. This was a far reaching thought in the early days of mass communication as we now see it today; and was the core model adopted in many countries as time passed.

Internationally, the UN body known as the **International Telecommunications Union (ITU)** oversees spectrum allocation agreements and conventions across its member countries. Originally established as the International Telegraphic Union in May 1865 – and thereby predating the UN as an organization – it was envisioned as a cooperative body for establishing standards for the then nascent telegraphic system.

Today, it is a specialized UN agency of the United Nations that is responsible for issues that concern all information and communication technologies. The ITU coordinates the shared global use of the radio spectrum, promotes international cooperation in assigning satellite orbits, works to improve telecommunication infrastructure in the developing world, and assists in the development and coordination of worldwide technical standards.

ITU also organizes worldwide and regional exhibitions and forums, such as ITU TELECOM WORLD, bringing together representatives of government and the telecommunications and ICT industry to exchange ideas, knowledge and technology.

The ITU is active in areas including broadband Internet, latest-generation wireless technologies, aeronautical and maritime navigation, radio astronomy, satellite-based meteorology, convergence in fixed-mobile phone, Internet access, data, voice, TV broadcasting, and next-generation networks. Within it, the ITU-R subgroup is responsible for decisions regarding global radio communications (including the decision on bands allocated for special services, frequency allocations to global zones and individual countries, and so on.)

ITU is based in Geneva, Switzerland. Its membership includes 193 Member States and around 700 Sector Members and Associates.

Within India, the key decision making body is the **Wireless Planning and Coordination Wing (WPC)** of the Ministry of Communications & Information Technology of the Government of India. The department is responsible for issuing amateur radio licenses, allocating spectrum, and monitoring the use of allotted spectrum. The WPC is headquartered in New Delhi and has regional branches in Mumbai, Chennai, Kolkata and Guwahati. WPC is divided into major sections like **Licensing and Regulation (LR)**, **New Technology Group (NTG)** and the **Standing Advisory Committee on Radio Frequency Allocation (SACFA)**.

WPC is responsible for the following key functions:

1) To make rules in India for wireless transmission.
2) To follow international wireless communication rules.
3) Conduct radio telephony and telegraphy exams in India.
4) Monitor illegal use of frequencies.
5) Conduct frequency management, i.e. allot frequencies to Indian wireless users and clear interference in wireless.

SACFA makes the recommendations on major frequency allocation issues; formulation of the frequency allocation plan; making recommendations on the various issues related to the International Telecom Union (ITU); and siting clearance of all wireless installations in the country.

As far as community radio is concerned, applicants approach WPC for the allocation of a frequency (issued in the form of a **Frequency Allocation** or **FA letter**), and permission to set up a wireless broadcasting station (given in the form of a **Wireless Operating License**, or **WoL**). The annual spectrum fee, currently Rs.19,700/- annum, is also payable by the allottee to WPC. Permission to set up a transmission system at a specific location is given by the SACFA wing, in the form of a **siting clearance letter**.

6.7 Let Us Sum Up

Through this Unit, you have been introduced to the concept of waves, and their characteristics: frequency, wavelength and amplitude. You have understood electromagnetism as a natural phenomenon, and the related concepts of radio waves, and radio spectrum. You have also learnt about the division of radio spectrum into bands, and then into channels/frequencies.

We have also seen overviews of the modulation processes used for radio broadcasts: Amplitude Modulation (AM) and Frequency Modulation (FM). Finally, we have understood the role of key regulatory bodies, national and international, that decide issues ranging from frequency allocation to spectrum management: the ITU (and its subsector, the ITU-R); the WPC of the Govt. of India, and its various wings, including the SACFA wing.

6.8 Model Answers to Activities

Activity 6.1

WiFi routers use an unlicensed part of the radio spectrum. These frequencies lie in the 2.4 GHz band, and usually range from 2.4 GHz to 2.4835 GHz.

The router that I checked is a Micronet 980 PS, which can operate on the 802.11 b and g bands, in the 2.4 GHz range.

Activity 6.2

S.No.	Station	Frequency Modulated (FM) or Amplitude Modulated (AM)	Frequency of broadcast
1.	Vividh Bharati (AIR) (Delhi)	AM (MW)	1368 kHz
2.	Radio Mirchi	FM	98.3 MHz
3.	Hit FM	FM	95 MHz
4.	AIR FM Gold	FM	106.4 MHz
5.	AIR FM Rainbow	FM	102.6 MHz

Activity 6.3

A current list of CRS licenses issued by the Ministry of Information & Broadcasting, Govt. of India, is available at this link: http://www.mib.nic.in/linksthird.aspx. Use this as a basis to make a list as follows:

S.No	Name of CRS licensee	State
1.	Abid Ali Khan Educational Trust Radio Mirchi	Andhra Pradesh
2.	Keshav Memorial Education Society AIR FM Gold	Andhra Pradesh
3.	Boon Education, Environment & Rural Development Society	Andhra Pradesh
4.	Deccan Development Society	Andhra Pradesh
5.	University of Hyderabad	Andhra Pradesh

UNIT 7

Basics of Electricity

Structure

7.1 Introduction

In Unit 5, you have studied that power supply switch gear is required to connect power to all the audio recording, editing, playback, transmitting and ventilation equipment. Size and ratings of components of power supply switch gear depend on the connected load and number of hours the equipment are kept ON. In the next Unit 8, you will learn about the sources of backup supply and process of voltage stabilization. Knowledge of electrical basics that we will discuss in this Unit shall help in operation, maintenance and servicing of power supply equipment. In this Unit, we shall focus on the following topics:

- Electrical basics
- AC/DC current
- Load distribution
- Power consumption and conservation

In the video on electrical basics and power supply backup systems, you will also get a chance to study the visual representation of these basic concepts including graphical representations of AC/DC voltage and current waves as described in this Unit. The glossary given at the end shall be helpful in understanding the content of this Unit.

You may require about 10 hours to complete this Unit including solving the questions given in the Activities.

7.2 Learning Outcomes

After working through this Unit, you will be able to:

- list and describe the fundamentals of electrical basics.
- describe phase, neutral and earthing.
- differentiate between AC/DC currents.
- analyse the colour coding of wiring.
- explain load distribution and balance.

7.3 Electrical Basics

Any person, for example, an engineer or a technician dealing with power supply equipment must have a clear understanding of the electrical basics such as current, voltage, and power. Touching any terminal or wire without knowledge may be even fatal. In this section, you will learn the fundamentals of the following terms:

- Electrical Current, Voltage and Power
- Phase, Neutral and Earthing.

Let us now define electrical current, voltage and power.

7.3.1 Electrical Current, Voltage and Power

As you are aware that all equipment are specified for its power, voltage and current. For example, a 100 watt bulb means it will consume 100 watt of power when connected to 230 V mains supply. When a particular voltage is applied to the equipment, amount of current flowing through it will depend on its resistance. In this subsection, you will learn about the basic concepts of current, voltage, resistance, power and energy. You will also learn about the fundamental Ohm's law which gives the relation between current, voltage and resistance.

Current (I)

The term 'current' is used to denote the rate at which electricity flows. It is the quantity of electricity which passes through a given point in one second. The magnitude of the current depends not only upon its operating voltage but also upon the nature and dimensions of the path through which it circulates. The symbol 'I' is used to denote current and its unit of measurement is called an Ampere (A). The current flows from a point of high potential (+ve) to a point of low potential (-ve).

Electromotive force (E) / Voltage (V)

Voltage is defined as electrical pressure or electromotive force which causes the flow of current in any circuit. It is called as Electromotive Force (EMF). Symbol E/V is used to denote it. Voltage is sometimes referred to as potential. The unit of electromotive force/voltage is volt. Volt is defined as the potential difference across a resistance of one ohm carrying a current of one ampere.

Resistance (R)

Resistance is defined as that property of a substance which opposes the flow of electricity through it. It is represented by R. The unit of resistance is Ohm (Ω). Ohm is the resistance of a circuit in which one ampere current flows when potential of one volt is applied across its two terminals. Its bigger unit is megaohm which is equal to 10^6 ohms. Its smaller units are microohm (10^{-6} ohm) and milliohm (10^{-3} ohm).

Resistance of a Conductor

Cables and wires are used for connecting voltage to the load which can be any equipment or machine. These conductors or wires have a definite resistance which cause drop in voltage till it reaches the equipment.

Resistance of a conductor varies:

- Directly as its length (i.e. as conductor length increases resistance increases).
- Inversely as its cross section (i.e. as cross section of conductor increases the resistance decreases).
- With temperature depending upon the temperature coefficient of a particular material of a conductor.

Resistivity (ρ)

The resistivity of any material is the resistance of a piece of material having a unit length and unit sectional area. Its symbol is ρ (rho) and unit of measurement is ohm-meter.

Power (P)

Power is defined as the rate of doing work. The electrical unit of power (P) is the Watt (abbreviation W). Bigger unit of power is called kilowatt (kW) which is equal to 1000 watts.

Power is also defined as the product of voltage and current.

Using the symbols, we can write;

1W = 1Vx1A or W =V x I

Energy

Energy can be defined as power x time. Energy = V x I x t, where t is the time in seconds. The unit of energy is Joule, which is equivalent to flow of 1 ampere of current at 1 volt for 1 second. The practical unit for energy is the kilowatt hour and is given by:

Watts x hour/1000 = kWh. 1kWh is equivalent to 1 unit of energy or power consumed.

Ohm's Law

Ohm's law is the most fundamental and basic law which defines the relationship between voltage, current and resistance. Ohm's law states that the current in a DC circuit is directly proportional to the applied voltage and is inversely proportional to the resistance of the circuit.

Using the symbols I, V and R to represent the current, voltage and resistance respectively, Ohm's law can be written as: I = V/R or V= I x R

7.3.2 Phase, Neutral and Earthing

In this subsection, you will learn the basic concepts of Phase, Neutral and Earthing commonly used in AC power supply distribution system.

Phase Voltage

In case of single phase supply, the phase voltage used is 230 Volts with respect to neutral. In case of three phase supply system, the voltage between any one of the three phases with respect to neutral is 230 V. Voltage between any two phases out of three phase is 400 V ($\sqrt{3}$ x 230 V= 1.73x 230 = 400 volts).

The rating and size of switch gear, cables, MCBs etc. depend upon the power, voltage and currents that they can safely handle. You will learn about load distribution on single or three phase supply and circuit breakers in Section 7.5.

Neutral

The second or return terminal of each load/equipment is connected to the neutral. When phase supply is connected to the load through a switch, the current flows from phase, passes through the equipment and returns through its neutral.

For small loads like bulbs, fans and tube lights, switches are not provided in the neutral wire. However, for a group or large loads neutral is provided through linked switches/MCBs. For a single phase working, the size of neutral wire is same as that of phase wire. Whereas for three phase balance loads, size of neutral is usually half the size of phase wires.

Earthing

Earthing is a process by which all metallic parts of any appliance or instrument are connected to an earth electrode buried deep in the ground to maintain them at zero potential.

Earthing is necessary to:

- Protect operating personnel from electric shock during short circuit or leakage of phase.
- Protect operating personnel, equipment and building during lightning.

Earth resistance is the minimum resistance in ohms provided by the earth system. It should be as low as possible (preferably less than one ohm).

As per Indian Electricity Rules, double earth is to be provided for all those equipment working on three phase supply, power supply switch boards and three phase motors of 5HP and more.

Earth resistance of the earth pit is measured by using the earth tester. You will learn more details on checking the earth conductivity in Unit 28 of Module 8.

Activity 7.1

To do this activity, you may need about 20 minutes to write down the answers in the space provided. This activity will help you in understanding the basics of electricity including the relationship between the voltage, current, resistance and power.

Question 1: Define power in an electrical circuit. What is its unit of measurement? When a voltage of 100V (DC) is applied to a heater, a current of 10A flows through it. How much do you think will be the power of that heater?

Question 2: A wire has a resistance of 10 ohms. Find out the resistance of another wire of same material but having thrice the length and twice the cross-section area.

Question 3: Define Ohm's law and its application to electrical circuit. A circuit has a resistance of 50 ohms. How much current will flow through it when a voltage of 200 V is applied across it?

Question 4: What is earthing? Why is it necessary to run earth wire along with phase and neutral to connect supply to the equipment rack? What can happen if there is a break in earth wire?

7.4 AC/DC Current

In this section, you will learn some of the commonly used electrical basics relevant to AC and DC circuits. Here, you can watch a video at http://tinyurl.com/pdqcrgt. This video is explaning about the basics of electricity, AC-DC currents, electrical phase load balancing, power inversion and voltage stabilisation, colour coding of the wires etc.

Power Backup for CRS

http://tinyurl.com/pdqcrgt

Alternating Current (AC)

AC means alternating current in which current or voltage changes its direction and magnitude with time. Variations of current and voltage take the shape of a sinusoidal wave. The graph of the AC voltage is shown in Figure 7.1.

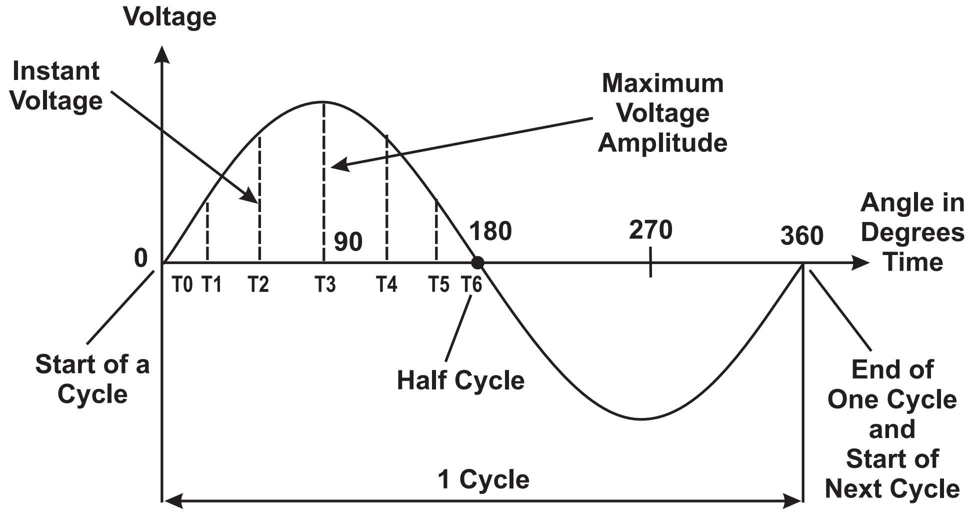


***Figure 7.1**: Graphical representation of AC voltage*

As may be seen in Figure 7.1, the X-axis represents the angle in degrees covered in time 't' by a voltage/current wave and Y-axis represents the amplitudes of voltage and current. The voltage varies from zero to maximum (at 90 degrees) and back to zero (at 180 degrees) in half cycle. In the second half cycle, the voltage becomes negative, goes to minimum value (at 270 degrees) and then comes back to zero (at 360 degrees) thereby completing one cycle. The amplitudes v_1 to v_5 represent the instant values of voltages at times t_1 to t_5.

The important characteristics of this sinusoidal AC voltage wave with reference to Figure 7.1 are as follows:

- A complete change in value and direction of alternating voltage is called one cycle.
- The time taken to complete one cycle is called its period.
- Number of cycles that this sinusoidal wave travels in one second is called its frequency.
- The frequency of AC supply used in India is 50 cycles/second.
- The maximum value attained by the voltage in half cycle is called its amplitude or maximum value.
- Voltage value at any instant of time in the cycle is called its instantaneous value.

Relation between voltage and currents in AC circuits

When a sinusoidal AC voltage is applied to the equipment, the current varies according to the type of load. The load may be resistive, inductive or capacitive. Figure 7.2 shows the graphical representation of relationship between the applied voltage and the resultant current produced by it for various types of loads.

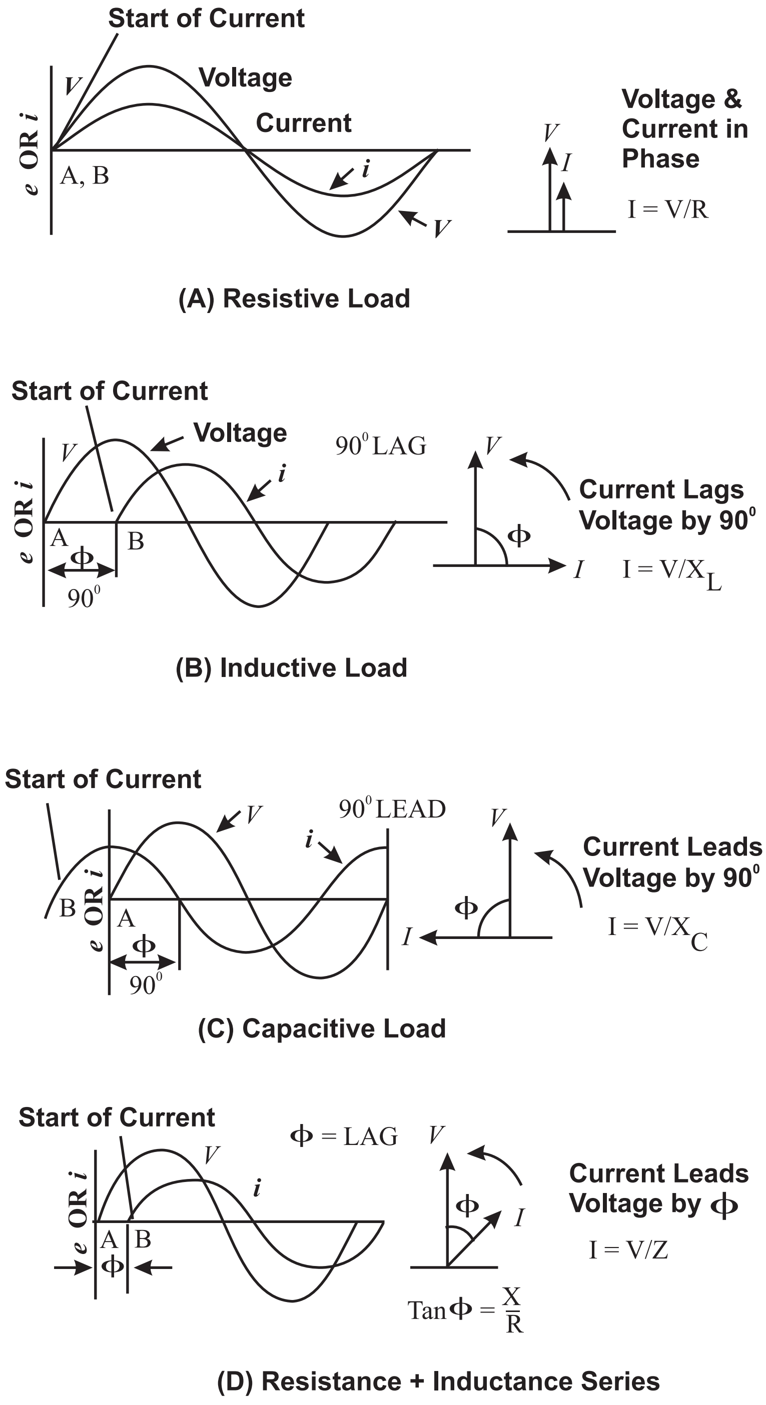


Figure 7.2: *Graphical representation of voltage for different types of load.*

In Figure 7.2(A) to 2(D), X-axis represent the angle travelled in degrees and Y-axis represent the amplitudes of both voltage and current waves. The location of start of voltage cycle (**point A**) and start of current cycle (**point B**) in Figure 7.2(A) to 2(D) may be *noted* for different types of loads. When the load is pure resistive, the current is in phase with the applied voltage (*both A and B are together*). If load is a pure inductive, the current lags behind the voltage by 90 degrees (*B starts after a delay*). If load is a pure capacitive, the current will lead the voltage by 90 degrees *(B starts before A*). Figure (D) illustrates the practical case where the load used is a combination of resistance and inductance, which is found in almost all the equipment. Here also current starts after a delay by an *angle ö* which depends on ratio of resistance to its impedance value.

Power factor

As seen in the Figure 7.2 above, when AC voltage is applied to any load which is not purely resistive, the current produced may not be in phase with the applied voltage. Current may lead or lag from the applied voltage by some angle. Usually the angle is represented by symbol φ (phi). *Cosine of this angle (cosφ) is called the power factor of that load.* Ideally, power factor (P.F) is unity for a pure resistive load ($\varphi=90^0$, cos 90 = 1). It is less than unity for reactive (non resistive) loads. Low power factor reduces the true power thereby reducing the efficiency of the system.

Direct Current (DC)

DC means Direct Current. It does not change its direction and magnitude and is steady at all the times. For example, the voltage generated by battery cells, accumulators and dynamos is pure DC. Most of the modern equipment such as portable recorders, small power transmitters and computers work with regulated DC power supplies. This DC power supply is however, obtained by rectifying the AC supply by use of AC to DC adaptors. Equipment operating on 2-wire DC requires a source of supply which can give constant desired rated voltage. Conventional current flows from positive (+) terminal marked red to negative (-) terminal marked black or blue. All the relations between current, voltage and power including ohm's law mentioned above in section 7.3 are fully applicable to DC circuits.

Activity 7.2

To do this activity, you may need about 15 minutes to write down the answers in the space provided. This activity will help you understand the difference between AC and DC supplies and their applications.

Question 1: What do you understand by AC or DC supply? Give one example of each type.

Question 2: Explain the difference between average current and RMS current. Which of these currents is used for calculating the power in AC circuit?

Question 3: What do you mean by the term power factor in AC supply? What is its ideal value? How power factor can be improved.

7.5 Load Distribution

Before applying for power supply connection, it is necessary to estimate the total load requirements of a Radio Station. Based on this load, a single phase or three phase power supply connection is obtained. Load distribution circuit is planned by using suitably rated cables, switches and circuit breakers. In this section and the sub-sections that follow, you will learn the following:

- Single Phase and Three Phase Distribution
- Balancing of Loads
- Circuit Breaker(MCB), Isolator and ELCB

Let us first proceed with single phase and three phase distribution system.

7.5.1 Single Phase and Three Phase Distribution

Single phase distribution

As the power supply load requirement of a Community Radio Station is small, of the order of 5 to 10kW, single phase distribution is normally used. In this system, all the equipments of the station are divided into different groups and the single phase supply (240V) is connected to respective equipment of the group through properly rated switches. The size and rating of cables and MCBs depend on the amount of current flowing through them. Figure 7.3 illustrates a single phase power supply distribution arrangement for a typical Community Radio Station.

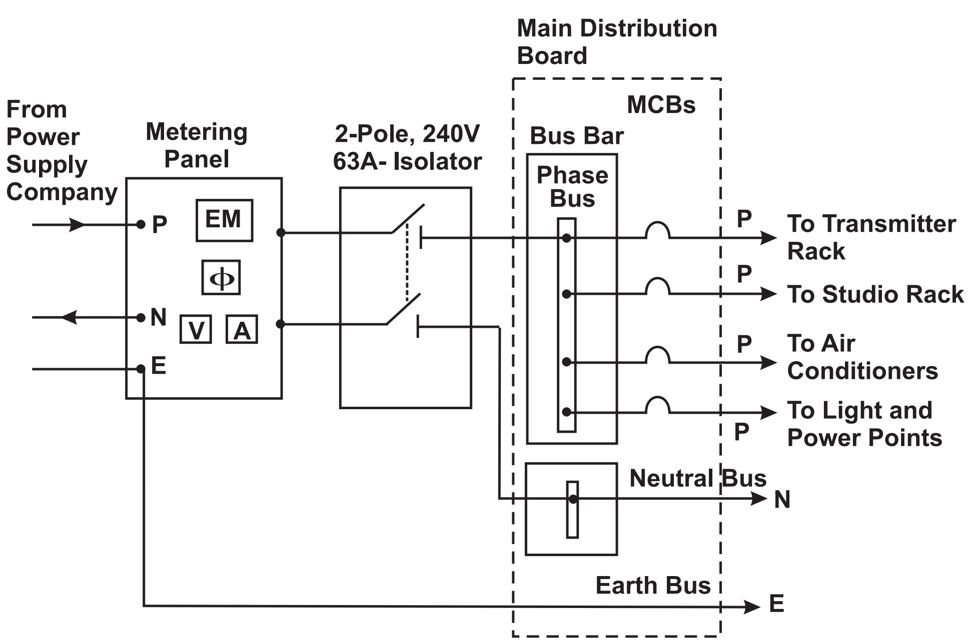


Figure 7.3: *Schematic showing the single phase load distribution*

In Figure 7.3, you will note that in case of single phase distribution, the input supply is terminated at the metering panel having energy meter, voltmeter and an ammeter. The output of metering panel is connected to main distribution board via an isolator switch. This switch is used to disconnect the power supply to the distribution board while servicing or making connections in bus-bar for further distribution. The output of the main distribution board is divided into different groups such as transmitter, studio, air conditioner, light and power loads by use of properly rated MCBs. The further distribution to each equipment is given through three-pin sockets or individual switches. This type of distribution reduces the size and rating of cables, MCBs etc. You may also note that neutral and earth wire to individual equipment is not provided through switches.

Three phase distribution

In large installations, where the total connected load is more, it is advantageous to take 3 phase supply from the electric company. Three phase 3-wire system is suitable if the load is fully balanced (such as three phase motors). However, in most of the cases, the station load is mixed i.e. some of the equipment including lights and fans may operate on single phase whereas some others may operate on three phase supply. In such cases, three phase 4-wire system is usually used. In this system, there are three 'lines' and a neutral. The voltage between any one 'line' and neutral is 240V and voltages between the 'lines' is 415V. Figure 4 illustrates the three phase 4-wire distribution system for a typical Radio Station.

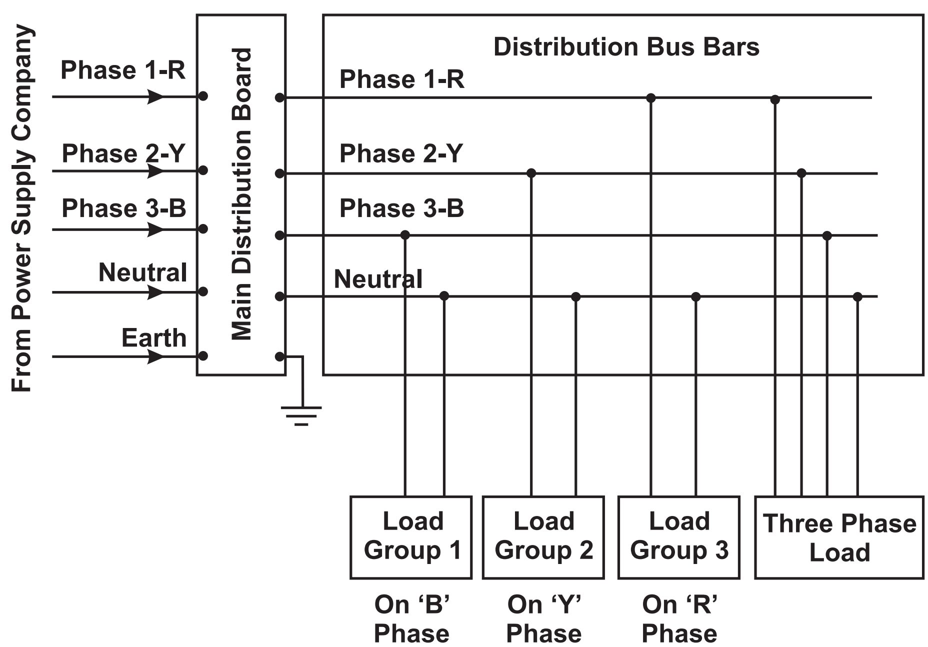


Figure 7.4: *Schematic of three phase 4-wire distribution*

As seen in Figure 7.4, three phases and neutral are first terminated on a metering panel similar to that of single phase distribution. The output of metering panel is connected to a bus-bar system through an isolator switch. The output of bus-bars is connected to a distribution board having MCBs for each group of load. The equipment and machines operating on single-phase are connected to one of the phase (R, Y, or B) and neutral. Equipment working on three phase supplies such as high power transmitters and motors are connected to three lines marked 1, 2, 3, and neutral. While distributing the loads, it is necessary that all electrical wiring at any installation is done in accordance with the relevant Code of Practices issued by Bureau of Indian Standards. Separate insulated and colour coded wires and cables are used for phase, neutral and earthing.

The colour code used for identification of these wires in case of single phase distribution is as follows:

- Red for phase
- Black for Neutral
- Green for Earth

In case of a three phase power supply distribution system, the colour code for three phases is R (Red), Y (Yellow) and B (Blue). Black and Green are used for neutral and the earth respectively.

7.5.2 Balancing Load

In this sub-section you will learn what is balancing of loads.

In case of three phase distribution system, if the power factors and the phase (or line) currents of the three phases are not equal then the load is called unbalanced load. It is therefore, necessary that all the equipment operating on single phase are connected to each phase in such a way that phase (or line) currents of each phase are nearly equal. Inductive loads reduce the power factor, therefore, special care is taken for balancing the inductive loads. This is done by checking the current and power factor of each phase separately. Low power factor, if noted, is to be improved by providing suitably rated power factor correction capacitors.

7.5.3 Circuit Breaker (MCB), Isolator and ELCB

In this section, you will learn the functions and use of the following:

- Circuit Breaker (MCB)
- Isolator
- ELCB

Let us start first with Circuit Breakers.

Circuit Breaker (MCB)

A circuit breaker is a device which connects the phase (phases) of supply to the distribution boards or individual equipment under normal conditions. However, during overloads and fault conditions the circuit breaker automatically trips the power supply to whole or part of the circuit depending upon its position in the distribution circuit. It can be reset manually once the fault is cleared.

Miniature Circuit Breakers (MCBs) are now being used widely as protective devices in consumer premises for group switching and individual circuits. MCBs are available in a wide range (0.5A to 100A) for the desired applications.

Selection of MCB for a particular application depends on the following:

- Power rating of load (i.e. Wattage indicated on equipment/ appliance)
- Switching currents
- Normal running currents
- Breaking currents
- Operating time requirements

Isolators

Isolators are conventionally used switches which are provided at input of main distribution board. They are usually manually operated switches and are used to isolate the main supply while doing repairs and servicing. For example, a TPN (Three Phase Neutral) switch is provided at the first input stage of the Main Distribution Board to isolate/switch off the supply before doing any repair or maintenance in the Distribution Board.

ELCB (Earth Leakage Circuit Breaker)

ELCB is a special type of a circuit breaker which detects the unwanted potential in the earth circuit. All the metallic components of any switch or distribution board are connected to earth and there is no potential or voltage at these points. However, due to some fault or leakage, if a sufficient potential (usually greater than 50 V) is developed in the earth circuit, then ELCB detects this fault (normally called earth leakage fault) and trips the main supply before it causes any damage to the equipment and the personnel.

Activity 7.3

To do this activity, you may need about 20 minutes to write down the answers in the space provided. This activity will help you understand the difference between AC and DC supplies and their applications.

Question 1: Why three phase distribution is better than single phase for higher and balanced loads?

Question 2: How can we know that the loads in three phase system are not balanced?

Question 3: What is the difference between MCB, Isolator and ELCB with respect to their field of application?

We will now proceed to learn the practical aspects of calculating power consumption and steps to conserve power as required in field.

7.6 Power Consumption and Conservation

In this section, you will learn what is power consumption and conservation.

Power consumption means the amount of power (energy) consumed by the user. Monthly consumption is noted from the energy meter installed by the electric company at the premises of the user. Power consumption is noted in number of units. One kilowatt hour is equivalent to one unit. For example, if one kilowatt of load is kept on for one hour, power consumed will be equal to one unit.

The power consumption of a Radio Station depends on the following points:

- Total connected load or contract demand.
- Maximum demand (load of all those equipment which are kept on simultaneously during transmissions).
- Duration for which the loads are kept on.
- Power factor of the load.

Consumption is calculated by noting how much load was kept for how many hours. Calculations for connected load and maximum demand can be clearly understood from the data given in Activity 7.4 for a typical CR Station. Power consumption and bill can also be worked out.

Power Conservation

Power conservation means saving energy by using highly efficient and energy saving techniques. Some electric companies motivate energy users to reduce their consumption by giving certain concessions.

Since the transmitter and most of the studio equipment are all solid state, the power consumption is very small. Most of the consumption is due to air-conditioning units and lights and fans. Power consumption can be reduced by taking suitable measures as described in the following page.

Steps for conserving power:

- Use minimum possible air-conditioners and that too with energy saver modes.
- Use Compact Fluorescent Lights (CFL) instead of incandescent light bulbs.
- Switch off all equipment such as mixers, recorders, computers and other equipment when not in use.
- Use transmission time efficiently.
- Use maximum possible natural light.
- Use thermally insulated walls and ceiling to have a maximum efficiency of cooling system.
- Use slogans to remind people to be cautious in conserving energy, such as
- Help conserve energy. Turn off lights when leaving.

Activity 7.4

Power supply loads of a particular CRS are given in the Table below. On the basis of load and hours of operation shown against each item, calculate the total daily and monthly consumption. Also calculate the monthly power supply bill by taking rate at Rs 5 per unit (1 kWh).

Sl. No.	Equipment	Load (Wattage)	Qty.	Hours of Operation	Total consump-tion in kWh (units) per day	Total monthly consump-tion (30 days)
1	50 W Transmitter operating at 50% efficiency	100 W	1	10		
2	Equipment rack with audio processor/ exhaust fan and power amplifier etc.	500 W	1	10		
3	Audio mixers/ consoles	500 W	1	10		

4	Computers/ audio work stations	500 W	2	10	
5	Air conditioners (1ton)	1500 W	2	10	
6	Tube lights	40 W	8	10	
7	Fans/exhaust fans	60 W	2	10	
8	Street light/ office lights/ corridor lights	60 W	4	12	
9	Total monthly consumption				
10	Total monthly Bill @ Rs 5 per unit				

To do this activity you may need about 30 minutes to write down the answers in the space provided. This activity will help you in calculating and analyzing the power consumption bills. Proper analysis will help you in understanding the importance of power conservation. By taking suitable measures you can conserve a lot of power.

7.7 Let Us Sum Up

In this Unit on Electrical Basics you have learnt:

- That knowledge of electrical basics is essentially required for understanding the operation, maintenance and safety of equipment and operating personnel.
- The definitions of basic terms such as current, voltage, resistance and power. When any voltage is applied to the equipment current flows through it. The quantity of current depends on the power rating of that equipment.
- That the Ohm's law is a most fundamental law which decides the relation between current, voltage and the resistance offered by the equipment. According to this law the current in any circuit is directly proportional to the applied voltage and inversely proportional to the resistance of a circuit.

- That in case of single phase 2-wire system, supply from the electric company is connected to the consumer's premises by two wires. One wire which is having a potential of 240 V is called a phase wire or a 'live' wire. The second wire is called the neutral or the return wire. In order to protect equipment and the operating personnel from electric shocks due to leakage or short circuits, a third wire called earth wire is also provided.
- To differentiate between AC/DC currents and their applications. Generation, transmission and distribution are much easier and economical on AC supplies. (However, DC supply is more suitable for DC motors, battery chargers etc.)
- Load distribution on single phase and three phase systems along with identification of colour codes of wiring. (The specifications and code of practice have been standardized by Bureau of Indian Standards).
- To balance the loads in case of three phase distribution system.
- Method to calculate the power consumption for a typical Community Radio Station. (A Lot of power can be saved by using efficient and energy conservation techniques).

7.8 Model Answer to Activities

Activity 7.1

Question 1: Power is defined as rate of doing work. Its unit of measurement is watt. Power = voltage x current = 100x10 =1000watt =1kW

Question 2: Resistance of second wire = Resistance of first wire x ratio of length / ratio of cross-section

= 10 x 3 /2 = 5 ohm

Question 3: Ohm's law states that current in a circuit is directly proportional to the applied voltage and inversely proportional to its resistance provided other conditions like temperature are same.

I= V/R = 200V/50 ohms = 4 Amp.

Question 4: Connecting a metallic part of a body of equipment to the low resistance earth pit is called earthing. It is necessary to keep the equipment at zero potential. If earth wire breaks, voltage can develop on metallic parts. Any person touching the rack can get electric shock during leakage or short circuit faults.

Activity 7.2

Question 1: In AC supply, its voltage and current alternate in magnitude and direction at a certain frequency with time. In DC supply, voltage and current are of constant value and do not vary with time. Power supply received from Electric Company is AC where as a car battery gives DC supply.

Question 2: Average current is the mean value of instant currents in half cycle of AC supply and is equal to sum of instant values divided by number of instant values. RMS current is the root mean square value of an alternating current. RMS value is used for calculating power in AC circuits.

Question 3: Power factor is the cosine of angle of lead or lag of current from the voltage in the non resistive equipment like induction motor. Its ideal value is one. Power factor can be improved by connecting suitably rated capacitors in parallel to non resistive load.

Activity 7.3

Question 1: Power consumption in three phase system is less for same load. Transmission and distribution losses are less. Size of the conductors required are smaller.

Question 2: If the power factors and the phase (or line) currents of the three phases are not equal, we can say the loads are unbalanced.

Question 3: MCBs are used to trip the power supply under overload conditions. Isolators are used to isolate supply during servicing or repairs. ELCBs are used to protect the system during earth leakage faults.

Activity 7.4

Sl. No.	Consumption per day in kWh (Units)	Consumption per month in kWh (Units)(30 days)
1	1000 watt-hours = 1kWh	30 kWh =30 units
2	5000 watt-hours = 5kWh	150kWh = 150 units
3	5000 watt-hours = 5kWh	150 kWh = 150 units
4	10000 watt-hours = 10kWh	300kWh = 300 units
5	30000 watt-hours = 30 kWh	900 kWh = 900 units
6	3200 watt-hour = 3.2 kWh	96 kWh = 96 units
7	1200 watt-hour = 1.2 kWh	36 kWh = 36 units
8	2880 watt-hour = 2.88 kWh	86.4 kWh= 86 units
9		Total consumption per month = 1748 units
10		Total monthly bill @Rs. 5/unit = Rs 8740

UNIT 8

Power Backup and Voltage Stabilisation

Structure

8.1 Introduction

In Unit 7, you have learnt about electrical basics including current, voltages, and power, and the difference between AC/DC currents. You have also studied about load distribution and balancing of loads with regular power supply input. In this Unit, you will learn about the sources of power backup and voltage stabilisation and their necessity in a Community Radio Station. You will also learn how power distribution gets modified by adding backup power supplies. In the sections/ subsections that follow, the need for backup supply and various sources of backup supply will be described under the following heads:

- Power Backup and Voltage Stabilisation
- Inverter
- UPS
- Generating Sets
- Voltage Stabilisers and CVTs
- Alternative Sources of Energy (solar, wind, hybrid)

In the video on electrical basics and power backup system, you will get a chance to study the visual representation of electrical basics which you have studied in Unit 7 such as AC/DC voltages and currents, load balancing, and colour coding of wires through graphics and animation. Video will also include the explanation of power backup systems, power inversion and voltage stabilization including alternate power generation systems which you are going to learn in this Unit. Glossary given at the end of this Unit will help you in understanding the content of this Unit.

You may require about 10 hours to complete this Unit including solving the questions given in the Activities.

8.2 Learning Outcomes

After going through this Unit, you will be able to:

- define various terms used in connection with backup supplies.
- list and describe the backup supplies used at a typical Community Radio Station.
- examine the process of UPS, Inverter and Genset and use them in CRS.
- analyze and compare the pros and cons of using different types of backup supplies.
- access various alternative sources of energy and apply some of these sources at the CRS.

8.3 Power Backup and Voltage Stabilization

In this section and the subsequent subsections that follow you will learn about the following:

- Power Backup and Voltage Stabilisation
- Inverter
- UPS
- Gen-sets
- Voltage Stabilisers and CVTs

Before going to start with Power Backup, you can again watch the video, which you have already got the reference in the previous unit (http://tinyurl.com/pdqcrgt). This video gives explanation of key electrical concepts and power backup systems through graphics and animation. The video also explains alternate power generation systems including photovoltaic, solar, thermal and wind.

As you are aware, the AC main input supply provided by the State Electricity Boards at most of the stations is not stable and reliable. Large variations and fluctuations in voltages are very common. In order to run a smooth transmission without any breakdown in service, it is necessary to have a standby or backup source of power supply which can be used during failures of AC main input supply. Similarly, voltage stabilisers are necessary to control the variations and fluctuations in incoming voltages.

In Unit 7, you have also learnt that before applying for power supply connection with the Electricity Department, you have to intimate the connected load and maximum demand required for Community Radio Station. Power supply load is usually calculated in terms of KVA (Kilo Volt Ampere) or in KW (Kilo Watt). Since generation of electricity through generators and other alternate sources is costlier than the supply received from Electricity Departments, it is therefore, necessary to know the minimum essential load that has to be switched on during mains supply failures.

In a typical Community Radio Station, essential load is of the order of about 3KVA (Kilo Volt Ampere). The second criterion is to know the duration for which the backup system should be able to generate 3KVA output. It is a normal practice to plan a battery backup for about an hour or two depending upon the failure rate of AC mains supply at that station. If the durations of power supply failure are longer and frequent, provision of diesel generator becomes more economical.

Figure 8.1 shows the block schematic of single phase power supply distribution along with power back interconnection for a typical Community Radio Station.

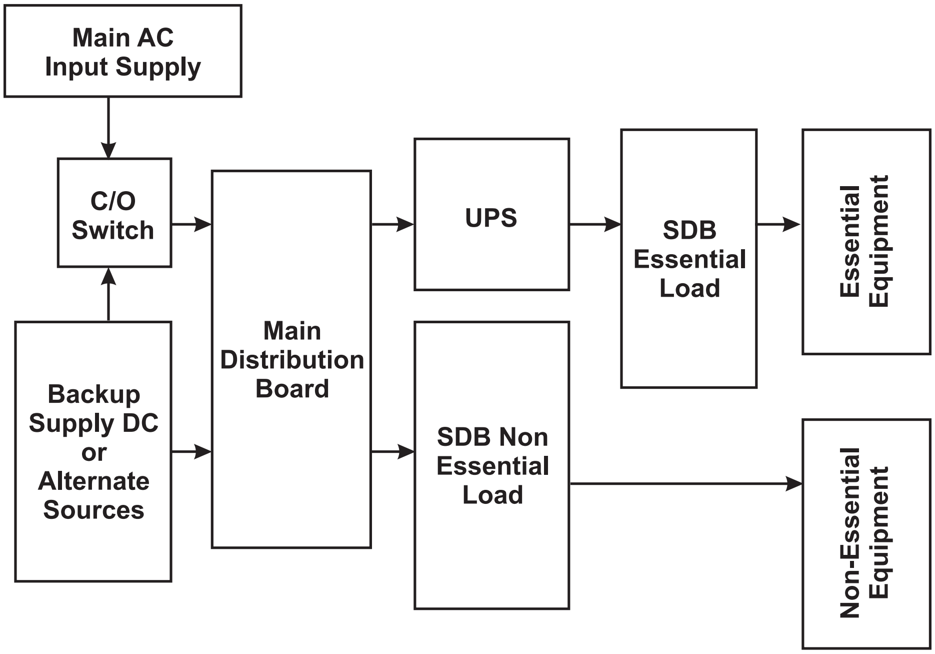


Figure 8.1: *Block schematic showing single phase power supply distribution including backup*

As may be seen in Figure 8.1, UPS system is added only for the essential loads. During prolonged failure of mains supply, standby supply can be extended through a second feeder, inverter, diesel generator or any alternate source. In subsections that follow, you will learn more about various backup power sources in detail.

Let us begin with the Inverter.

8.3.1 Inverter

In this subsection, you will learn about the inverter. An inverter is a device that converts DC voltage supplied either by a rectifier or the battery into AC voltage. Inverters are also used to supply AC power from various DC sources such as solar panels or wind turbines. Inverters are classified into different categories according to the output wave form generated by it. The main types include: square wave, modified sine wave and the pure sine wave. Square wave and modified sine wave inverters have high harmonic content and therefore, are not suitable for electronic equipment like tape recorders and transmitters. Pure sine wave inverters produce nearly perfect sine wave and are compatible with AC mains supply. The design is more complex and per unit power costs more.

Figure 8.2 below shows the schematic arrangement of the inverter which will help you in understanding its principle of operation.

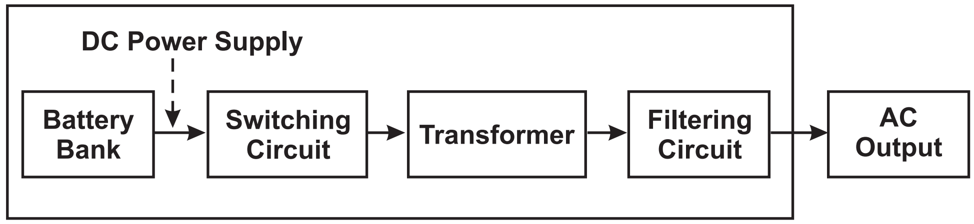


Figure 8.2*: Schematic arrangement of Inverter.*

It can be seen from Figure 8.2 that inverters are made up of appropriate transformers, switching and control circuits to give required output voltage at 50 Hz. A filtering circuit is provided at the output to remove the harmonics and to get the pure sine wave.

The DC power is connected to the centre tap of primary of a transformer through a switch. The switch is turned on and off at a specific frequency to produce alternating pulses in the primary winding. The alternations in the primary winding induce alternating current in the secondary winding. Primary to secondary turn ratio of the transformer decides the AC output voltage of the inverter and filtering circuit is used to remove harmonies.

Solid state inverters have no moving parts and are used widely for applications to computers and other electronic equipment. In case of electronic inverters, the 'On/Off' switching operation is performed by transistors and other forms of semiconductor devices. Inverters are also the main component in the UPS.

Inverters are normally specified in terms of KVA ratings and back up durations. The backup time for which the inverter can provide rated output depends on the ampere-hour capacity of the battery used in the inverter. The ampere-hour capacity is the maximum current it can deliver for one hour (see Box 1 below).

Box 1

For example, if capacity of a typical maintenance free 12 V battery is 50 Ah (ampere-hours), it means it can deliver 50 A of current for one hour or 25 A for two hours or 12.5 A for four hours. Series parallel combination of number of such batteries is used to give the desired backup period for the rated load. Putting two batteries in series doubles the voltage whereas Ah capacity remains the same. Putting two batteries in parallel keeps the voltage same but doubles the Ah capacity.

Activity 8.1

What is an Inverter? What are its important components? Briefly describe the function of each component. To do this activity, you may need about 15 minutes to write down the answers, in about 150 words, in the space provided. This activity will help you in understanding the principle of operation of the inverter.

8.3.2 Uninterrupted Power Supply (UPS)

In the preceding subsection you have learnt about the inverter. In this subsection, you will learn the most important backup source called UPS in which inverter is the main component. UPS, as the name suggests is a system of power supply that can continue to give uninterrupted power supply in the event of mains failure to various equipment connected to it for the duration it has been designed.

Uninterrupted Power Supply (UPS) systems have now become an essential requirement for almost all the Community Radio Stations so as to maintain continuity of broadcast transmission during failures or shut downs of regular power supply. It also acts as a buffer for voltage variations and fluctuations.

The capacity of UPS is normally specified in VA (volt amperes) or KVAs (kilo-volt amperes) and requirement is based on the essential load to be kept on during power supply failures. Standard low power units of 1KVA to 5KVA rating which are suitable for CRS are available in the market.

Power rating/capacity of UPS depends on maximum load of all equipment that are essentially to be kept switched 'ON' and for how much duration. As most of the CRSs are located in remote localities where AC mains supply is either not available during most of the time or it is erratic with a lot of fluctuations and variations in voltages, UPS becomes a necessity and are to be procured according to the requirement. It must be remembered that higher the rating of UPS, higher will have to be the battery capacity and therefore the cost increases. At places, such as university campus where power supply is fairly steady and breakdowns are minimum or places having a diesel generator backup, the size and rating of UPS can be small.

Components of UPS

A UPS system comprises of following essential components:

- A Rectifier and filtering circuit
- A Battery Bank
- A separate battery charger
- An Inverter

- On/Off and By-pass switches
- Harmonic Suppression Circuit
- Control and Protection Circuits
- Status and Fault Indicators

The functions of all the above components of UPS are explained in the paragraph given below and also in the paragraphs giving the description of types of UPS.

Input AC mains supply to UPS is first stepped down and rectified. It is filtered to remove the ripples and connected to a DC bus where battery is also connected. A separate charger is also provided for charging the batteries. The DC output from rectifier or the battery is connected to the inverter which converts the DC voltage back to AC voltage. Harmonic Suppression filter removes the harmonics to give a pure sine wave output voltage. Control and protection circuits are used to protect the UPS and the equipment against short circuits and over loads. Bypass switches are also provided to isolate batteries and input power supply during trouble shooting and maintenance. Applications of UPS vary depending on the type of UPS and method of use.

Types of UPS

Depending upon the required application, Uninterruptible Power Supply units can broadly be divided into three categories:

- On-line UPS
- Off-line UPS
- Line-interactive UPS

Let's briefly describe each of the three types of UPS.

On-line UPS

In On-line UPS, the load is always connected at the output of Inverter. The schematic arrangement showing the principle of operation is illustrated in Figure 8.3.

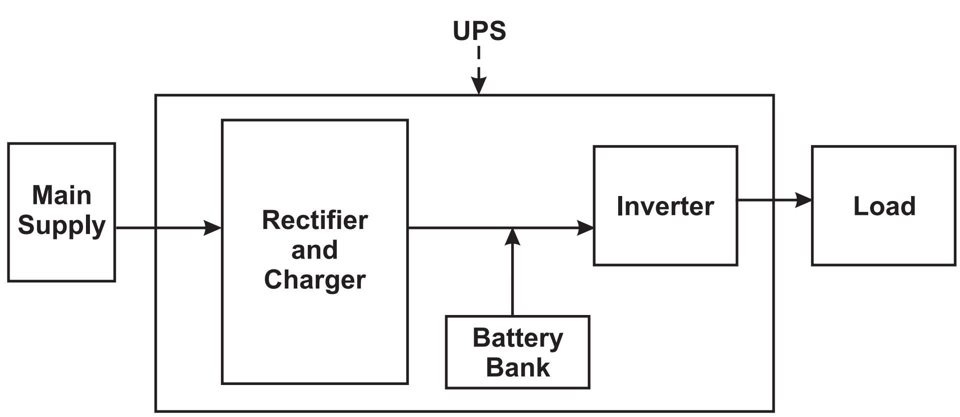


Figure 8.3: *Block schematic of on-line UPS*

As seen in Figure 8.3, AC main supply is first rectified and filtered to remove the harmonics or ripples and is connected in parallel to a battery bank. DC output of a rectifier and a battery is connected to the inverter circuit which reconverts the DC supply to AC supply. When main supply is off, DC supply of battery remains connected to the Inverter unit which continues to supply AC power supply to transmitter or studio equipment without any interruption. In this system, the transmitter or equipment remain on till the battery gets discharged.

The salient features of on-line UPS are:

- Inverter is on all the time and supplies output power even if main AC supply is available.
- Running time of the inverter on battery is generally less (half an hour to one hour) and depends on ampere hour capacity of battery.
- Batteries remain charged as long as AC main is through. It gets discharged during mains failure and gets recharged on restoration of main supply.

Off-line UPS

As seen in Figure 8. 4, the equipment is kept energized with mains supply. A charger operating from AC mains keeps the battery charged. The output of the inverter is normally not connected to the load. It gets connected to load through a manual or automatic change over switch as desired.

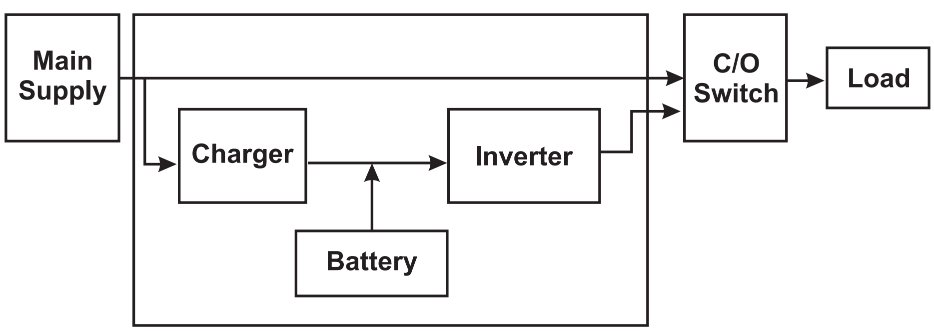


Figure 8.4: *Schematic arrangement of off-line UPS*

The salient features of off-line UPS are::

- Power for equipment is directly derived from AC Mains.
- Inverter is off when the mains supply is present.
- Batteries remain charged.
- Inverter turns on only when the mains supply goes off.
- Off-line UPSs provide no inherent protection from spikes which are dangerous for electronic equipment.

- They are more appropriate for areas with minimal power problems.
- They are the cheapest among the three types in terms of costs.

Line-Interactive UPS

A schematic arrangement showing the working of line-interactive UPS is illustrated in Figure 8.5.

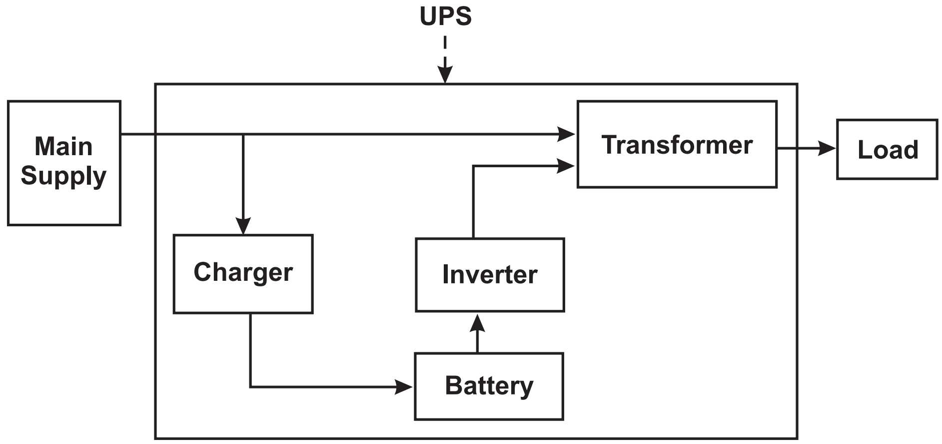


Figure 8.5: *Schematic arrangement of line-Interactive UPS*

As shown in Figure 8.5, AC supply is directly connected to the load via a transformer. Battery is not connected in parallel. However, it gets charged through a separate charger operated from the mains. Inverter supply is also on and connected to the load. Both the supplies are sharing the load. In case of mains failure, inverter continues to keep the system on. It is called line-interactive because it corrects the line voltages or switches to backup supply when variations are more and beyond the correction range.

The salient features of line-interactive UPS are:

- Battery power is only utilized when mains supply is not available.
- Line-interactive UPS is useful when voltage fluctuations are of more concern than breakdowns.
- An electronic circuit monitors the dips and spikes of mains input supply.

Activity 8.2

You are working in a Community Radio Station where power supply breakdowns are frequent. You are asked to suggest a suitable UPS for your station. What are the important points which you must consider before suggesting a particular type of UPS for your station? To do this activity you may take about 15 minutes, to write down the answers in about 150 words, in the space provided. This activity will help you in understanding the requirements and functioning of various types of UPS.

8.3.3 Generator Sets

In this subsection, you will learn another important back up source called Genset. The 'generator' is opposite of 'motor'. A motor converts electrical energy into mechanical energy whereas the *generator* converts mechanical energy produced by fossil fuels to electrical energy.

Because of the limitations of Ah (ampere hour) capacity of batteries, UPS cannot deliver output voltages especially when the power supply breakdowns are for longer durations, since the batteries get discharged.

Alternative source of AC supply is therefore, necessary. UPS with higher capacity of batteries become very expensive. Initial cost of generator may also be high but they are essential where breakdowns in power supply are for longer durations.

Generators of various sizes and types are available. Like UPS, generators are specified by KVA (Kilo-Volt Amperes) ratings. Portable generators can generate electricity by using kerosene, petrol or diesel. However, higher rated generators usually run on Diesel and hence are named as diesel generator.

Rating of DG set is decided on the load of CRS. If CRS is an independent isolated set up, the rating of DG is decided on the basis of maximum load requirement of equipment that are to be kept on during failure of normal power supply. However, when CRS is a part of a larger set up like university campus, where higher capacity DG sets may already be available, separate smaller DG sets may not be required. A separate line for DG supply can be extended.

Principle of operation of DG set

Every generator set has got basically two parts; the engine and the alternator. Like any other car engine, fuel energy is converted to mechanical energy which rotates a magnet. This rotating magnet, called the rotor, turns within a stationary set of conductors wound in coils on an iron core, called the stator. The rotating magnetic field induces an AC voltage in the stator windings. An automatic voltage control device controls the field current to keep output voltage constant. The output frequency of an alternator depends on the number of poles and the rotation speed used.

The salient features of Gen-sets are:

- Most commonly used as standby sources where power supply breakdowns are of longer durations.
- Suitable where fuels required for the Gen-set are available.
- Emit harmful exhaust gases.
- Initial costs are high.

Activity 8.3

Under what conditions do you feel Gen-set is necessary even if UPS has been provided at a particular Community Radio Station? Compare the functions and limitations of each.

To do this activity, you may need about 15 minutes to write the answers, in about 100 words in the space provided. This activity will help you in understanding the functioning and necessity of Gen-sets as well as UPS.

8.3.4 Voltage Stabilisers and CVTs

You might have observed that electronic equipment get damaged due to fluctuations in power supply.

In order to protect them, it is essential to use Voltage Stabilisers. In this subsection, you will learn functions and use of Voltage Stabilisers and Constant Voltage Transformers (CVTs).

Voltage stabilisers are the devices which control the variations/fluctuations of the main AC input power supply.

Basically three types of voltage stabilisers are used:

1. AVRs (Automatic Voltage Regulators)
2. CVTs (Constant Voltage Transformers)
3. EVRs (Electronic Voltage Regulators)

Automatic Voltage Regulators (AVRs)

In AVRs, input voltage is sensed and a control circuit provides a command to a motor which changes the tapping on the secondary winding to set it to the preset value. AVR has got certain limitations. It takes finite time to sense the variation and then to change the tapping of transformer. Its response time is therefore, higher. Presently servo stabilisers are most commonly used. Single-phase stabilisers usually employ only one variable auto-transformer driven by a motor and one sensing circuit. Servo mechanism automatically controls the tap changes in auto transformer by moving wiper on taps of transformer.

Constant Voltage Transformers (CVTs)

CVTs are also used to give constant voltage output. Its principle of operation is different from that of AVR. It works on the principle of magnetic saturation. When the iron core of a transformer is in saturation, large changes in winding current due to variations in input supply, result in small changes in output voltages. These transformers use LC (Inductor–Capacitor) 'tank circuit' tuned to the AC frequency of the supply to filter out the harmonics.

Saturating transformers provide a simple rugged method to stabilize an AC power supply. However, the operation in saturated region has the disadvantage of poor efficiency and sine wave distortion.

Electronic Voltage Regulators (EVRs)

EVRs use power semiconductor devices for regulation and are better than mechanical voltage regulators because of higher performance and speed of regulation. They are suitable for low voltage (< 600 V). A large range of EVRs are available in the market giving variety of useful features (see Box 2 below).

Box 2

Specifications of a typical Electronic Voltage Regulator:

- Microprocessor based closed loop control system.
- Digital voltmeter to read input and output voltages.
- Digital ammeter to read out current.
- Timer with delay of usually 5-10 seconds to avoid nuisance tripping.
- Output cutoff protection for over voltage and under voltage.
- Efficiency better than 98%.
- Use of Semiconductor devices in place of relays and switches.
- No effect of load power factor

Activity 8.4

Differentiate between the working principles of an Automatic Voltage Regulator (AVR), a Constant Voltage Transformer (CVT) and Electronic Voltage Regulator. Why Electronic Voltage Regulators are more suitable for CRS than AVRs and CVTs?

To do this activity, you may need about 15 minutes to write down the answers in about 150 words in the space provided. This activity will help you in understanding the functioning of different types of voltage stabilisers.

8.4 Alternative Sources of Energy

In this section, you will learn about the alternative sources of energy that can be used for generating power at places where regular power supply is either not available or very unreliable. Because of the depleting fossil fuels and increasing fuel costs, Government of India is giving special incentives/concessions for the development and use of alternative energy sources. The use of renewable power generation systems reduces the use of expensive fuels, allows cleaner generation of electric power and also improves the standard of living of many people in remote areas.

These alternative sources of power generating systems include:

- Solar Energy System
- Wind Turbines
- Hybrid Power System

Let us start with solar systems.

8.4.1 Solar Energy System

In this system, electricity is generated by using the light energy of the sun. A solar cell or photovoltaic cell is a device that converts light into electric current using photovoltaic effect. Solar cells produce direct current (DC) power, which fluctuates with the sunlight intensity. For practical use, this usually requires conversion to certain desired voltages or alternating current (AC) through the use of inverters. Multiple solar cells are connected inside the modules. Modules are wired together to form arrays connected to an inverter, which produces power at the desired voltage.

In developing countries like India, batteries or additional power generators are often added as backups to the solar power.

Such stand-alone power systems permit operations at night and other times of limited sunlight.

Concentrated photovoltaic (CPV) systems employ sunlight concentrators to focus more light on the surface of photovoltaic cells. Solar concentrators of all varieties are used, and these are often mounted on a solar tracker in order to keep the focal point upon the cell as the sun move across the sky. Concentrated Photovoltaics are useful as they can improve efficiency of PV solar panels drastically.

The salient features of solar power generators are:

- Photovoltaic systems use no fuel.
- Modules typically last for 25 to 40 years.
- Cost of installation is almost the only cost, as there is very little maintenance required.
- Unlike fossil fuel based technologies, solar power does not lead to any harmful emissions during operation.
- Solar power is seasonal, suggesting the need for long term storage system.
- Use of solar energy for operating CRS at a remote location is the most feasible option where making availabie, of mains supply, is not economical.

8.4.2 Wind Turbines

Wind is another alternate source of energy which is used to generate electricity. Wind turbine is a device that converts kinetic energy of the wind into mechanical energy and then to electrical energy. You might have seen a large number of turbines rotating especially near the sea coasts where high winds are continuously blowing throughout the year. These are called wind farms. A large wind farm consists of hundreds of individual wind turbines which are connected to electric power transmission network.

Principle of operation

Large size blades mounted atop a tower are connected to a turbine via a gear box. When a strong wind blows, the turbine rotates a rotor of an induction generator causing production of an alternating current. The mechanism in the gear box controls the movement of rotor at a constant speed. The output from a single turbine can vary greatly and rapidly as local wind speeds vary. When more turbines are installed over a large area and connected together, the average power output becomes less variable. The electricity generated by each turbine is coupled to transmission lines for distributing to the users.

The salient features of wind power are:

- Generation of electricity through wind is restricted to the areas/zones where constant winds are blowing during most of the time.
- It is a source of clean energy without any harmful emissions.
- The effects on the environment are generally less problematic than those from other power sources.
- It has low ongoing costs, but a moderate capital cost.
- With the improvements in wind turbine technology, the generation costs have also considerably reduced.

Small domestic wind turbines can be used to provide electricity to isolated locations normally not connected by regular power supplies. Isolated communities, that otherwise rely on diesel generators can use wind turbine as an alternative source. Individuals may purchase these systems to reduce their dependence on grid electricity for economic reasons. Wind turbines have been used for household electricity generation in conjunction with battery storage over many decades in remote areas.

8.4.3 Hybrid Power System

As you are aware, generation of electricity both from solar and wind energies is intermittent due to seasonal changes. As such they can't be accepted as a reliable supply. Wind power and solar power can, however, be profitability used as complementary to each other due to there being more wind in winter and more sun in summer.

On daily to weekly time scales, high pressure areas tend to bring clear skies and low pressure winds, whereas low pressure areas tend to be windy and cloudy. This effect has led to use of a hybrid power system using both solar and wind energies simultaneously. A combination of both Hybrid power systems by definition contain a number of other power generation devices such as photovoltaic, micro hydro and/or fossil fuel generators. In addition battery banks can also be used in parallel to store the energy for its later use.

Figure 8.6 illustrates the schematic diagram of a small scale hybrid power station. They are generally independent of large centralized electric grids and are used in remote areas as stand–alone projects.

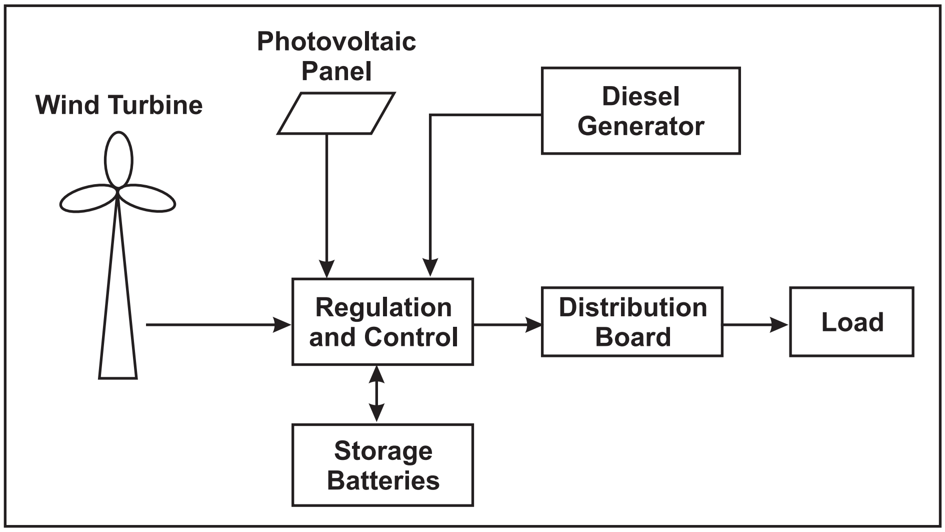


Figure 8.6: *Schematic showing the hybrid power system*

As seen in the Figure 8.6, electricity generated by the wind turbine, photovoltaic and diesel generator has been combined along with storage batteries. At a time, any of the sources can be used depending upon the availability of wind, sunlight or the diesel. In some remote areas even the electricity generated by micro hydro system can be combined with either the wind or solar power.

These hybrid power systems are very useful and suitable for community radio stations, media centres and repeaters for mobile towers especially for remote and isolated locations where extending of centralized electric grids are not feasible due to economic reasons.

Activity 8.5

What is hybrid system of power Generation? Enumerate the conditions where the use of hybrid power generation system is more reliable than any other single alternate source of energy.

To do this activity, you may need about 15 minutes to write down the answers in about 150 words in the space provided. This activity will help you in understanding the functioning and importance of alternate sources of energy.

8.5 Let Us Sum Up

In this Unit on 'Power Backup and Voltage Stabilisation', you have learnt that:

AC mains power supply provided at most of the remote locations is either not available or is not steady. In order to broadcast continuous transmissions from a Community Radio Station without any interruption, backup power supply sources are necessary. Most commonly used backup power sources include: inverter, UPS and Gen-sets. In remote locations where extending of centralized supply grid is economically not feasible, alternate energy sources such as wind and solar energy can be used to generate required power. Fortunately, the power consumption of a typical Community Radio Station is very less, therefore, conventional backup supply sources such as Inverters, UPS and Gen-sets as well as alternate sources like Sun and Wind power can easily be used. Inverter converts DC power supply of battery to AC voltage required for operating the electronic equipment. Voltage regulators are used to control variations in the input AC supply to give steady supply. UPS provides uninterrupted power supply to equipment at the rated voltage during failure of main supply. You have learnt three types of UPS along with their salient features depending upon their applications. Small DG sets are used to supply power when the duration of break downs in main supply are longer and beyond the capacity of UPS battery. Batteries are the critical components of Inverters and UPS. Capacity of battery is specified in terms of Ampere-hour which means how much maximum current the battery can supply for one hour before getting discharged. Backup durations of Inverter and UPS are therefore, limited to the Ampere-hour capacity of battery bank.

You have also learnt the process of power generation by alternate sources like Sun and Wind. In solar power systems, light energy of the sun is converted into electrical energy by use of Photovoltaic cells. Wind turbines convert kinetic energy of wind into electrical energy. Since both the Sun and Wind power systems provide intermittent supply due to seasonal variations, a hybrid power system combining power generated by two or more sources can provide a constant supply to meet the load requirements of a Community Radio Station.

8.6 Model Answers to Activities

Activity 8.1

Inverter is a device that converts DC voltage of battery to 240 V/50 Hz AC supply.

Important components of an Inverter with their functions are given below:

(i) Battery Bank acts as a source of DC supply.

(ii) Switching circuit interrupts the DC supply at a specific fixed frequency to produce alternate pulses in the primary winding of a transformer.

(iii) Transformer converts the changes in primary to give 240V/50 Hz AC supply in the secondary by using its fixed primary to secondary turn ratio.

(iv) Filtering circuit at the output of the transformer removes the harmonics to give pure sine wave output.

Activity 8.2

Following important points are to be considered before deciding the type and rating of UPS:

(i) Total essential load in KVA that is to be powered through UPS to decide the power rating of UPS.

(ii) Pattern of power supply failures to decide the duration for which the uninterrupted power supply is required.

(iii) Ampere-hour capacity of battery bank to decide how much load in KVA is to be kept 'ON' and for how many hours.

(iv) Salient features of each type of UPS to suit to the specific requirement. Since the breakdowns are for longer durations in this case, on-line UPS will be more suitable.

(v) Availability of metering, control and protection circuits.

(vi) Availability of a rated capacity UPS from a branded company providing adequate Guarantee/Warranty and after-sale service.

(vii) Cost factor to suit to available budget.

Activity 8.3

Provision of the Gen-set is necessary at all those isolated or remotely located stations where the regular AC main supply is either not available or is not reliable due to low voltages and frequent variations. Gen-set works as a standby back-up source during non availability of regular power supply. Gen-set is required even to charge the battery of UPS which might have got discharged after a few hours of use during mains failure. The limitations of Gen-set include: pollution, noise, wear and tear, and necessity to store enough fuel.

The function of UPS is different than that of Gen-set. UPS is provided to give a constant voltage supply to the system under normal working conditions as well as during power fluctuations and failures. The limitation of UPS is its Ampere-hour capacity. It requires charging of battery after each discharge. Life of battery is limited.

Activity 8.4

An Automatic Voltage Regulator (AVR) works on the principle of automatically changing the tapping of the secondary winding of a transformer depending upon the input voltage to give a preset rated output voltage. Since it is a mechanical regulator its response time is higher.

A Constant Voltage Transformer (CVT) works on the principle of magnetic saturation. Here, an iron core of the transformer works in a saturated condition where the output voltage remains practically constant even with a large change in the input supply voltage.

An Electronic Voltage Regulator (EVR) uses semiconductor devices to control the variations in the input. They are very fast in response as compared to mechanical regulators using motorized tap-changers. The efficiency and performance of an EVR is much better than an AVR and a CVT. The EVR is therefore, more suitable for the protection of the electronic equipment used in a CRS.

Activity 8.5

Generation of electricity by alternate sources such as sun and wind is mostly intermittent due to seasonal changes in environment. In hybrid system, two or more alternate power generation sources are connected in parallel. Either of the two is sufficient to give the required power supply. Usually battery bank is also used to store the energy for later use. The hybrid system can give uninterrupted power supply throughout the year.

The use of hybrid power generation is more suitable under following conditions:

i. Where the AC main supply is either not available or completely unreliable.

ii. Where the supply generated by a single alternate source is intermittent due to seasonal changes.

iii. Where maintenance of continuous supply using alternate sources is required throughout the year.

iv. Where extending the centralized grid to isolated or remotely located places is either not feasible or economical.

Glossary

Siting	The process of deciding a location for a community radio station, or for the transmission setup within a CRS.
Radio shadow zone	An area where a radio signal cannot be received, usually on account of a geographical or man-made obstacle that blocks radio waves.
Ambient noise	Any unwanted sound in an area where a recording is conducted.
Effective Radiated Power (ERP)	The net output power of a transmission system, usually a combination of the basic output strength of the transmitter, adjusted for the gains and losses provided by the transmission cable and antenna system.
Broadcast studio	A studio space dedicated for the purposes of conducting 'live' broadcasts, or from which programmes may be transmitted.
Production studio	A studio space dedicated to conducting recordings which can be edited later on.
Reverberation	The phenomenon of perceived extension of a sound due to reflection from nearby surfaces. Typically, the phenomenon is called reverberation when the reflection time is 0.1 – 1 milliseconds. Also see Echo.
Echo	The phenomenon of hearing a succession of reflections of an original sound that steadily decrease in amplitude. Typically there is a clearly perceptible gap between the original sound and its reflection.
Acoustic treatment	The process of reducing reflection of audio in a given space, through the use of audio absorbing materials.
Sound proofing	The process of using materials and construction techniques to keep ambient noise out of a recording space.
'Clean' and 'muddy' sound	'Clean sound' refers to sound where there is clarity throughout the frequencies it is made up of. Muddy sound refers to sound where the constituent frequencies are indistinct, leading to a perceived loss of clarity in the sound.
Sound lock	A space created between a studio room's internal and external doors, in order to minimize the intrusion of external noises.

Double glazing	The technique of using two panes of glass or acrylic sheet in a window, with an air space sandwiched inbetween. Used for minimizing the transmission of external sounds, as well as temperature control.
"Dampening" reverberation	The process of using sound absorbent materials to absorb or reduce ('dampen') reverberation in a space.
Dust proofing	The process of preventing the penetration of dust into a device or a space.
Air conditioning	The process of controlling the temperature in an enclosed space through the use of refrigeration or heating devices.
Programme production	The process of making an audio programme. ***Pre-production:*** Preparatory work, including scripting. ***Production:*** The actual recording of the programme in the field and in the studio. ***Post-production:*** Including editing and the addition of components like music and sound effects. ***Mixing:*** The act of adjusting the relative levels of all the audio components so that the programme is easy to hea.r ***Mastering:*** The act of combining all the components into a single mixed audio file or programme.
Field recorder	A portable recording instrument for conducting recordings in the field.
Microphone	An instrument to convert acoustic (sound) energy into electrical signals that can be recorded onto a medium.
Recording medium	Any medium (magnetic tape, flash memory, magnetic disks) which can be used to record and retain a set of electronic or digital information for playback at a later time.
Headphones	A pair of wearable speaker (or audio monitor) units, typically fitted on a band that can be worn over one's head.
Input transducer	A device that can convert an input sound or audio signal to another form of energy. The most common type of input transducer is a microphone, which converts audio (acoustic) energy into an electrical signal.
Audio source	Any object or individual which can act as a generator of acoustic energy. A singer in a studio and a CD player are both audio sources.
Audio management	The process of controlling, manipulating and directing an audio signal.

Signal processing	The manipulation of an audio signal in order to adjust various parameters including its mix of frequencies, amplitude, and level of reverb (to name a few).
Final processing	The process of making final adjustments to an audio signal before the conclusion of editing or mastering work.
Output transducer	A device to convert an audio signal to a different type of energy for monitoring or transmission. A transmitter and a speaker are both examples of output transducers.
Audio monitors	A device to hear an audio signal being edited or manipulated within a audio device. These could be headphones or speaker units.
Compressor	A device or software used to reduce the amplitude of the audio signal within a system in order to keep it within a pre-defined upper limit.
Limiter	A device or software control used to limit or cut off an audio signal at a pre-defined upper limit
Transmission system	A combination of transmitter, transmission cable and antenna typically used for broadcasting audio or video content using a broadcast medium.
Transmitter	A device that generates a carrier wave and combines it with a supplied signal in order to broadcast a combined signal.
Mast	A tall (usually metal) vertical pole or segmented structure on which an antenna can be mounted.
Antenna	A device to radiate radio frequency energy into the atmosphere; or to receive radio frequency energy from the atmosphere.
Studio-Transmitter Link (STL)	The connection between the studio and the transmitter. At its most basic, this is the cable connecting the audio output from the studio to the transmitter input. A more complex version uses a microwave connection between the studio and a remotely placed transmission system.
Carrier radio wave	The radio frequency wave on which the audio signal is mounted or combined to facilitate the broadcasting of radio signal.
Receiver	A device to receive radio signals, usually through an antenna.
Sound waves	The way acoustic energy spreads from its source in a repeating pattern of high-pressure and low-pressure regions

	moving through a medium. This is usually represented in the form of a wave.
Audio signal	Any stream of energy that carries the equivalent of an information bearing sound. Thus speech is an audio signal.
Waves	The phenomenon by which energy passes through a medium by the upward and downward or side to side oscillation of particles in that medium.
Frequency	The property of a wave that denotes the number of complete waves that cross a given point in space in one second.
Hertz	A unit named after the scientist Heinrich Hertz, indicative of one wave crossing a point in space every second.
Wavelength	A measure of the physical distance between two adjoining peaks or troughs of a wave.
Amplitude	A property of a wave indicative of the physical distance between the peak and the trough of the wave.
Radiant energy	The phenomenon by which energy is conveyed or radiated from one point to another, with or without a medium.
Electromagnetic Wave Radiation	The phenomenon whereby electromagnetic waves (radio waves, light) are propagated.
Electromagnetic spectrum	The range of all frequencies of electromagnetic waves.
Visible spectrum	The range of electromagnetic frequencies that humans perceive as visible light of all colours.
Radio Spectrum	The range of all radio frequency electromagnetic waves
Radio Wave Bands	The classification of radio frequency waves by groups of frequencies. (UHF, VHF etc.)
Medium Wave (MW)	Amplitude Modulated waves in the range from 560 metres to 187 metres.
Short Wave (SW)	Radio communication using the upper MF (medium frequency) and all of the HF (high frequency) portion of the radio spectrum, between 1,800–30,000 kHz.
Modulation	The process of combining two waves to result in a wave that has some properties of both of its constituents.
Amplitude Modulation (AM)	Modulation that results in a wave with the frequency properties of one wave (the carrier wave) and the varying amplitude characteristics of the second (audio signal).

Frequency Modulation (FM)	Modulation that results in a wave with the amplitude properties of one wave (the carrier wave) and the varying frequency characteristics of the second (audio signal).
Transistorized portable radio	A small portable radio receiver that uses electronic components called transistors.
Community radio	Radio stations owned, managed and run by community groups, focusing on local issues, local culture, and local dialects.
Streaming radio	The process of using internet protocols to transmit audio over the internet.
Mobile phones	Portable telephone units that work on cellular radio technologies. Also known as cell phones.
Satellite direct-to-receiver radio	Radio broadcast directly from satellites to radio units equipped with satellite antennas. Popular services like Sirius, XM and Worldspace (now closed) are examples.
Siting Clearance	Permissions from the Dept. of Telecommunications in India allowing the placement of a radio transmitter at a fixed location
Wireless Operating License (WoL)	Permissions from the Dept. of Telecommunications in India formally allowing a radio station to start broadcasting.
Apparatus	Electrical apparatus that includes all equipment, machines, fittings and other accessories using power supply for its operation.
Circuit	An arrangement of conductor or conductors for conveying energy.
Circuit Breaker	A device capable of making or breaking the circuit under all conditions and are designed to break the current automatically under abnormal conditions.
Conductor	Any wire, cable or plate used for conducting energy.
Cutout	A fusible cutout used for interrupting the transmission of power supply to the building or equipment.
Earth electrode	A pipe or plate buried deep in the pit to provide a low resistance earth connectivity for earthing the equipment.
Earthing system	An electrical system in which all the conductors are earthed.
Lightning arrestor	A device used for protecting the equipment, personnel or building during lightning.

Linked switch	A switch with all the poles mechanically linked so as to operate simultaneously.
AC mains supply	The normal AC (alternating current) supply connection provided by electricity department or company.
Ampere-hour	The unit to specify the capacity of battery.
Backup supply	Supply generated locally at a station to operate the equipment or appliances during failure or shutdown of normal AC mains supply.
Battery bank	The set of batteries used in series-parallel combination to give desired ampere-hour capacity from a backup power system.
Connected load	The total power consumption (as per name plate on the equipment) of all the equipment installed at a station.
Maximum demand	The maximum units of electricity required to operate the equipment simultaneously at any instant of time.
Power rating	Of an Inverter, UPS or Generator is the maximum kilo-volt ampere load it can deliver.
Ripple	The small unwanted residual periodic variations present in the DC supply after rectification.
Solar array	The set of number of solar panels used to generate electricity.
Wind farm	The area where a large number of wind turbines are located to generate electricity from wind.

C·O·L
CEMCA

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