MF and LF site Hazards and Precautions

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1.0	14/02/2022	Reissued with new reference number
2.0	16/02/2023	Removed references to retired form SHE-FT-013

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1 Purpose

This document seeks to inform about the specific hazards from MF and LF sites and gives general guidance on measures to be taken to reduce the risk from them. However, this document does not seek to remove the need for getting expert guidance or developing an appropriate detailed method statement in respect of planning specific tasks on site.

This document is applicable to all employees, contractors, site sharers and third parties working for or on behalf of Arqiva on MF/LF sites which are either owned or maintained by Arqiva.

2 Guidelines / Handbook

Arqiva has several sites which are used for Medium Frequency (MF) or Low Frequency (LF) transmission for broadcast radio. These sites pose significant additional risks due to the nature of the antenna and the frequencies they broadcast. The antennas may comprise of powered masts or wires strung between support structures and, in combination with the frequencies in use, these create the possibility of contact currents, arcing and radio frequency (RF) pick-up on metal objects in the vicinity. It is important that these additional risks and control measures are understood and applied by both Arqiva staff and others working on Arqiva sites.

Some of these effects may also extend beyond the Arqiva site boundary.

Detailed information is given in the following pages, but the key points are as follows:

- Voltages on MF/LF antennas can be several 1000 volts,
- Any long metal object (e.g. feeder, fencing, cherry picker) will induce a current and can cause a shock,
- MF/LF sites can cause ignition of flammable gases or explosives,
- RF working limits are different depending on whether control measures are in place or not,
- Only certain RF monitors and meters will work at MF/LF sites,
- Use of insulating gloves and work boots is necessary for some tasks,
- Earthing of feeders during installation, scaffolding, MEWPs and other equipment may be necessary,
- Excavation by hand is necessary in some locations to avoid damaging the earth mat,
- Submission of RAMS are needed for any work outside of buildings,
- MF and LF structures must be earthed before climbing them,
- Metal portable ladders should not be used on MF/LF sites,
- RF levels will be high at the top of any secondary towers on site,
- Special precautions are needed for installation of metal fencing,
- Special precautions are needed for use of test equipment on a structure with an MF/LF antenna,
- There are many different types of MF/LF antenna some of which may not be instantly recognisable.

2.1 The Hazards of MF and LF Sites

Due to the low frequencies and therefore long wavelengths of MF and LF, they are radiated from tall metal rigs – masts, towers or supported wires. Heights of the rig can be from 20 metres to 200 metres or more. The antenna system also incorporates an earth mat; this is a network of copper cables under the ground that acts as a reflector.

The RF voltages present on MF and LF sites can be substantially higher than those normally associated with the radiated powers. Even moderate powers dissipated in some MF/LF antennas can cause voltages on the live antennas to be more than ***4000 volts.***

It is important to realise that contact with high RF voltages will be perceived as touching a hot object, and the usual sensations associated with conventional electric shock will normally be absent. If the contact is prolonged, then local burning of the skin will occur, initially at the surface around the point of contact.

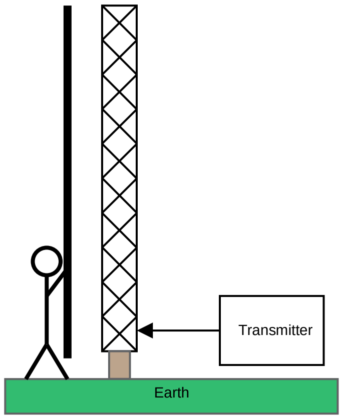
2.1.1 Shocks, Burns and Electrocution

Apart from the normal dangers associated with working aloft and on transmitter sites, the main danger with working on MF/LF sites is not so much RF radiation as may be the case with VHF/UHF/SHF, but the danger of electric shock, burn or electrocution.

It is not necessary to physically touch a live antenna to receive an electric shock, burn or to be electrocuted. Any of these can be caused by pickup, coupling or induction – all three terms mean the same thing: It is the transfer of electrical energy from one conductor to another without any live electrical connection between them. Even when two objects are electrically isolated, transfer of power can take place.

Example of pickup, coupling or induction:

Take a live mast. If a person carrying a long metal object gets close to the mast then current will be induced, or coupled or picked up by the rod and they would receive a shock because they form a link for the current to flow to Earth.

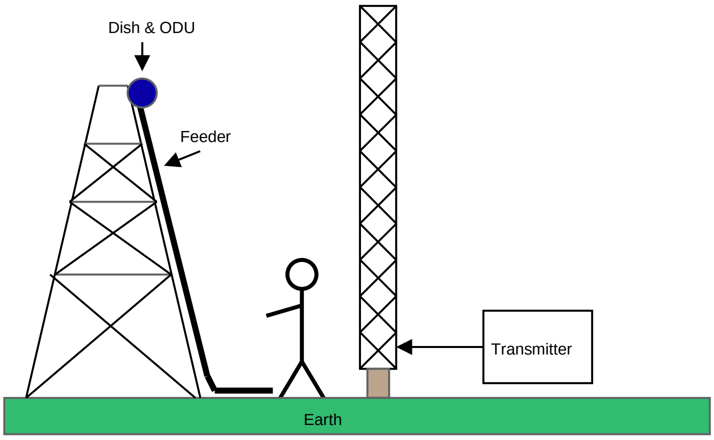


The severity of the shock will depend on several factors:

1. The transmitter power - the higher the power the more severe the shock,
2. Whether they are wearing gloves or holding with bare hands,
3. The transmitter power and distance of any other live radiators on the site or on a neighbouring site,
4. The conditions – if it is on wet ground and they are wearing wet boots and wet gloves, conductivity and therefore the severity of the shock would be greater because the person is better grounded.

The length of the object and the distance from the radiator are also important factors. If the object is shorter the shock would be less. If the distance is increased then the shock will be less, although on a site with multiple radiators then the distance to the next one will need to be considered.

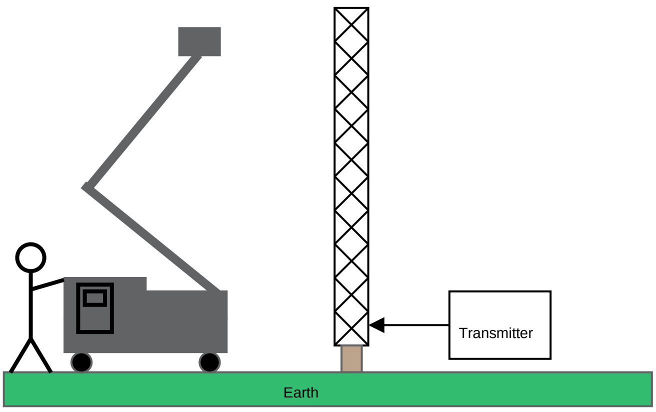
The pickup problem can occur when running feeder to closely sited (or co-sited) telecoms towers.



In this diagram, the feeder is lifted up outside of a permanently earthed telecoms tower. The feeder is being cleated in down the tower.

The person on the ground now picks up the bottom end of the feeder. They then take a knife to remove the cable jacket to fit the termination. As soon as the blade touches the outer conductor, the knife and the person will form the current path to earth and the person will receive an electric shock.

The problem with pickup also affects cherry pickers, cranes, pump up masts and other mobile hardware that may be brought to site.



In this diagram, an elevated cherry picker will have voltage induced from the live mast, assuming it has insulated rubber tyres and any out riggers are not on a good path to earth (e.g. wooden boards). If a person touches the cherry picker then they become the good path to earth and receive an electric shock.

Another two factors that need to be borne in mind concerns lightning and static build up:

If a mast / tower with an insulated base (and insulated stays, where appropriate) has no DC (direct current) path to earth, perhaps because of removal of the feeder conductor from the network used to power it, or if any static leak in the network is removed, then under dry conditions even a moderate wind will cause the structure to accumulate several thousands of volts of DC charge which could cause injury through electrocution. It should be noted that this accumulation of static would be considerably enhanced if a storm is present in the vicinity (within a mile or so) due to the presence, under these circumstances, of very large atmospheric potential gradients. On rare occasions these can be large enough to cause flashover at stay and base insulators. To avoid problems from static, the structure should always be securely earthed before any contact is made with it (or its associated matching network) directly after turning off all of the associated RF transmitters.

The hazards of a direct strike by lightning are well known, but because most MF/LF radiators are not normally earthed, the dangers are considerably higher. It is possible for some of the energy from a direct lightning strike on an MF/LF structure to be transmitted along the inner conductor of a buried coaxial main feeder to the transmitter, where damage to equipment and/or electric shock to any persons in the vicinity may occur. If the mast is earthed (e.g. during maintenance work) then the energy travelling back to the transmitter under such circumstances will be reduced, but it is unlikely to be completely eliminated.

2.1.2 Ignition of flammable liquids and explosives

These are a rare occurrence and normally of most concern where there is a large concentration of radar or high power LF, MF or HF (high frequency) antennas. RF fields can ignite flammable liquids and explosives through the induction of currents, particularly when lifting feeders, latch ways and winch bonds. All flammable liquids should be removed from site or placed in a secure building well away from where lifting is in progress.

The use of petrol driven equipment for maintenance is acceptable provided there are no electrical storms within two miles.

For further detailed information on Ignition of Flammable Liquids and Explosives refer to BS6656 and BS6657.

2.1.3 Ferrous objects in antenna tuning huts/units (ATHs or ATUs)

It is recommended that objects close to inductors in ATHs are made from non-ferrous material, as high temperatures may occur from eddy-current heating in the object, for example use of aluminium is preferred rather than steel.

2.1.4 Interference with electrical and electronic equipment

There are well-documented instances of equipment being interfered with by MF and LF sources. This can range from annoyance to close neighbours (which are managed on a case by case 'without prejudice' basis via Community Relations to help to resolve issues and hence be a good neighbour) to interference with vehicle ignitions and the controls of cranes and other plant brought onto site. These indirect effects can themselves cause hazards and hence need to be predicted and managed.

2.2 Site Specific Information – RF Safety Surveys

Radio Frequency safety surveys have been carried out at most MF and LF sites. The results of these can be found in the RF surveys folder on Livelink A-Z for the site in question. Any questions regarding RF surveys and results should be directed to rf.safetyteam@arqiva.com.

2.3 RF Working Limits

Arqiva policy is to work to the Control of Electromagnetic Fields at Work (CEMFAW) Regulations 2016. Arqiva has adopted the CEMFAW Action Levels for its company working limits. In the LF/MF frequency range, the Regs specify both low and high action levels, depending on whether control measures to mitigate against shocks and burns are in place.

The table below shows Arqiva working limits for frequencies in the LF/MF range. Where the control measures listed in this document are implemented, the higher working limit can be used.

Arqiva Working Limits at LF / MF sites

Frequency Range (f)	No control measures in place	Control measures as described in this document	
	Electric Field (E)	Electric Field (E)	Magnetic Field (H)
(MHz)	(V/m)	(V/m)	(A/m)
0.1 – 1	170	610	1.6 ÷ f
1 – 3.5	170	610 ÷ f	1.6 ÷ f

For areas where the general public have legitimate access, Arqiva policy is to work to both the EC Recommendation on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (1999/519/EC) and the International Commission on Non-Ionizing Radiation Protection (ICNIRP) Public guidelines. The reference levels for a subset of frequencies used in Arqiva are listed below but for full details of both reference levels and basic restrictions see: http://www.icnirp.net/documents/emfgdl.pdf and http://ec.europa.eu/health/electromagnetic_fields/docs/emf_rec519_en.pdf

Frequency Range (f)	ICNIRP public Electric Field (E)	ICNIRP public Magnetic Field (H)	ICNIRP public Power Density (S) (E;H Fields)
	(V/m)	(A/m)	(W/m²)
0.15 - 1 MHz	83	0.73 ÷ f	-----
1 – 10 MHz	83/√f	0.73 ÷ f	-----

2.4 Precautions Required for Work on MF and LF Sites

2.4.1 Selection of RF safety test equipment

High power and low power MF or LF radiation will swamp many of the VHF/UHF/SHF meters we commonly use. If working on a telecoms tower on an MF or LF site, the readings on these meters will often give rise to false alarms. This does not mean there is excessive VHF/UHF/SHF radiation; it is simply that these ultra-sensitive meters cannot behave or measure accurately when exposed to radiation that is well outside their operating bands. This will be especially true on the outside of the structure. Readings inside the structure will usually be much lower. This is the effect of MF or LF induction on the outside of the tower.

Also, even for equipment that is suitable for use on MF and LF sites, holding the equipment in the hand can increase the measured levels significantly (giving rise to false alarms). For some types of meter, a holding handle has been devised to reduce this problem.

Raham Meter

NBM 550 Meter

The only RF personal monitors approved for use on MF and LF sites are the Nardalert XT (D8862) and Nardalert S3, but both these models will false alarm when handheld and work most accurately when worn on the body as designed.

The preferred types of RF survey meters and probes to use on MF and LF sites are:

Manufacturer	Models
General Microwave	RAHAM model 4044-2
Wandel & Goltermann Meter	EMR 20, EMR 30, EMR 200, EMR 300
Wandel & Goltermann Probe	Type 8 (Type 12 **MF ONLY**)
Narda Meter	NBM 520, NBM 550,
Narda Probe	EF0392 (HF3061 **MF ONLY**)
Narda	EHP-200

For specific advice on selection of test equipment for use on MF and LF sites contact rf.safetyteam@arqiva.com.

2.4.2 Basic Personal Protection Equipment

Gloves will not offer adequate protection from touching antennas. However, the impact of localised RF burns and many of the low-level RF pickup effects on trunking, fencing etc. can sometimes be mitigated by use of gloves offering a degree of electrical insulation. The best type of glove would be a fully dipped and coated, water resistant type such as Traffi gloves TG142 and TG190.

It is also advisable to wear shoes which have insulating properties. In most situations normal work safety shoes or boots will provide appropriate insulation so these should be worn in preference to open sandals, which would not provide protection from slips, trips and other typical hazards to feet on a transmitter site anyway.

2.4.3 Earthing Techniques

In general, all items comprising of an installation, including support steelwork and feeder gantries, should be electrically bonded together. They should also be bonded to the earthing system for the structure and to the earthing system for the transmitting/receiving equipment. All earth points should be tested when connected.

Special precautions need to be taken when lifting feeders, Latchway wires and steel wire rope bonds into position. Where practicable, they should be flaked out on the ground and the bottom end securely grounded before lifting. When a jacketed cable is being lifted, the last 6 inches or so of jacket should be removed from the bottom end and this should be drilled/punched so a good earth connection can be secured through the outer and bonded to a firm earth point.

In many cases strong crocodile clips can be used to provide a temporary earth for short duration or while a more secure earth is being fitted. It should be noted that crocodile clips can easily become detached so the preferred method for securing an earth is to use overhead line clamps (or similar) attached to the nearest known good earth point.

2.4.4 Working with Mobile Elevating Working Platforms (MEWPs)

Once in position the MEWP will be earthed by a suitable earth spike of at least 300 mm in length.

Electronic controls of the MEWP may be affected by LF or MF. Ensure that manual controls are available for use if the electronic controls of the MEWP fail.

Before elevating the MEWP, it must be connected to the nearest good earth. The nearest good earth may be an earthed mast or the MEWP's own grounding spike. The earth should be applied by a shorting lead (15 mm cable with strong crocodile clips, but care must be taken to ensure these do not easily become detached and a more secure system adopted for longer duration work) ensuring that the MEWP is **grounded to the earth first** then the cable is connected to the structure. Gloves must be worn during this operation. RF EMF monitoring must be completed while working on such platforms.

Similarly, other large plant such as cherry pickers, HIABs, cranes, pump-up masts etc. must be earthed before the jib is lifted. Earthing should be from a known good earth point, or from an earth rod hammered into the ground.

If in doubt, seek advice from the engineering staff responsible for the site or rf.safetyteam@arqiva.com.

2.4.5 Excavations

Care must be taken to avoid underground feeders, mains cables, BT circuits, water, gas, drains, alarm cables, camera cables and the antenna's earth mat. Where there is a possibility of disturbing any of these obstructions then excavations should be by hand only, never by machine.

2.4.6 Running Feeders onto Telecommunications Towers Co-sited with MF or LF Antennas

When lifting a feeder up a tower on an MF or LF site, the following precautions should be taken:

- Avoid running feeders up the outside – induction will be far less if the feeder is run up the inside because of the screening effect of the tower itself.
- Flake the feeder out on the ground before lifting. Remove six inches of cable jacket from the bottom end. Hammer this bare section flat and either drill or punch it to take a nut and bolt. Firmly bond this nut and bolt to a known good earth point, via a length of thick earth wire or earth tape if necessary. Alternatively, a wire rope bulldog / Crosby clamp attached onto the lowest good earth point is fine. The lowest good earth point will often be a rung of the vertical ladder that is permanently attached to the structure.
- Crocodile clips, cable-ties, jump leads etc. should only be used for very short-term earthing measures as these can easily become detached. Jubilee clips are acceptable but a punched hole with nut and bolt is better. Lift the feeder into position; fit a feeder earth kit at lowest vertical point and preferably one near the antenna as well. Temporary earth bonds can now be removed.
- Avoid cable types that are difficult to earth (for example Belden type or anything with a braided outer), cables for which good proprietary earthing kits are available are preferred. An unearthed cable will cause problems as soon as the bottom connector is disconnected from the rack and people touching the cable will be at risk of electric shock. This applies particularly if the top connector has been disconnected for fault investigation.

The dangers outlined above also apply to installation of Latchway wires, the use of tirfor bonds, wire rope pilot bonds, wire rope lifting bonds, sala blocks, twin pair wires for measuring AGC volts on old SHF link receivers, steel tape measures and anything else long and metallic.

Furthermore, care should be taken if there are unused feeders on the structure that have been disconnected top and bottom, but where the vertical run is still in place. This particularly applies to unused mast lighting armoured cable on an MF structure. Even though the structure may be earthed down, the armour and conductors of this cable will not be earthed and there is a high risk of electric shock.

As a minimum, each feeder should be bonded to the structure at the top of its run and close to where it enters/leaves the structure at the bottom. Each feeder should also be earthed adjacent to the entry into the equipment accommodation.

Extra bonding should be provided such that distances between any earth bonds do not exceed 1/8 wavelength at the highest LF, MF and HF frequency present on the site.

2.4.7 Feeder Supports (Gantries), Interface Steelwork & Antennas and Outdoor Units (ODUs)

Feeder supports, such as gantries, between the structure and the equipment accommodation, should be firmly bonded to the structure and to the equipment earthing system at the respective end. This bonding may be by virtue of mechanical attachment, especially in the case of a gantry fixed to the structure, or via a bonding cable or metal tape.

Supporting posts for feeder gantries should be earthed at ground level.

All interface steelwork should be firmly bonded to the structure. This bond will usually be by virtue of the steelwork being physically attached to the structure. Where bonding cables or metal tape is used to improve the connection, they should be kept as short as possible.

All antennas and ODUs will be firmly bonded to the interface steelwork. This bond will be by virtue of the antennas and ODUs being physically attached to the mounting steelwork and by bonding cables or metal tape. The bonding cable and metal tape should be kept as short as possible and be directed to earth in the most efficient way possible i.e. direct and not returned to an earth tape that may be running around a building.

ODU supporting posts should be earthed at ground level, all the earths will be bond tested.

2.4.8 Installation Practices and Surveys

Any work carried out external to the equipment accommodation will require a written method statement supported by an appropriate risk assessment. Work should not commence until the Safety Health and Environment representative responsible for the site is satisfied that the necessary precautions are in place and has approved these documents in writing. Line of sight surveys, including those using an access platform, must also conform to this specification.

When an installation company is running out feeders or fencing, irrespective of size, on an LF or MF site, the installation supervisor must contact an engineer or manager responsible for the site for the correct earthing requirements. The longer the feeder run or fencing the greater the potential for the feeder or fencing acting as an antenna and picking up LF and MF power.

Details on earthing requirements for fencing is indicated in section 2.4.16.

In general, metal fences should not be used to enclose the mast base or Antenna Tuning Unit area of any structure radiating a MF or LF signal.

2.4.9 Working on Rooftops within the Vicinity of LF and MF Antennas

Suitable risk assessments and RF survey must be completed prior to any work on a rooftop on an MF or LF site.

Existing RF surveys are stored in the Sites A-Z in Livelink; however, for areas that have not previously been surveyed then a task-specific RF survey must be carried out or requested from the rf.safetyteam@arqiva.com.

The structure tip effect as described in section 8.14 can also be a problem with metallic equipment on rooftops of buildings on the Arqiva site, or on adjacent sites. On high power MF and LF sites high voltages can be found on the tip of vertical protruding metalwork, e.g. header tanks and expansion pipes in plumbing systems and/or central heating systems, roof-mounted air conditioning units, TV receiving aerials on roof-mounted poles – essentially the top of anything metal which is high up and where the there is a long metallic connection to ground. It also becomes a problem to adjacent sites.

One example is the Thames Water concrete reservoir tower next to Brookmans Park. Although it is a concrete tower, it has roof-mounted cellular equipment and associated cable-tray fixed externally down the outside of the tower. High voltages can also be measured on lightning finials on such installations.

2.4.10 Climbing Structures on MF/LF Sites

2.4.10.1 Telecoms structures on MF and LF sites

Some MF sites have telecoms structures co-sited with them. These are earthed and designed to be safe to climb. Normal precautions should be adequate; for example, use of Nardalert XT, risk assessment etc.

2.4.10.2 MF and LF antennas and their support structures

It is not permitted to climb an MF or LF antenna when it is ‘live’, these can only be climbed when the transmitter is isolated, and the structure earthed.

Some structures hosting the MF and LF antennas on MF/LF Sites are permanently earthed and some are not. Persons planning to climb these structures must ensure that they know which structure they plan to work on and whether it is necessary to isolate it. If it is then a transmitter engineer must be requested to undertake the isolation.

Climbers must ensure that the mechanical means of earthing the structure is visible to them and that nobody can tamper with the earth connection while the structure is handed over to them. Once the earth connection is made, the transmitter engineer will provide a certificate of isolation and demonstrate that the structure is no longer live by taking hold of it. Climbers must not attempt to approach the structure until this has been done.

Note: A Service Now permit is not a guarantee that the structure is safely earthed. The method of ensuring isolation and earthing for the duration of the climbing task must be covered by the method statement for the task.

2.4.11 Portable Ladders and Scaffolding (Fixed or Mobile)

The use of metal portable ladders is prohibited on LF and MF sites. Where possible, fibreglass or wooden ladders or steps should be used.

All large bodies of scaffolding or mobile towers must be earthed down. This earthing down should be of no greater distance of 20 m between points. If the scaffolding is taller than the building, then the scaffold must be earthed down via the building earth.

Measurements to indicate the earthing resistance of the structure should be taken on installation (using an earth loop impedance tester) and the earthing mechanism(s) should be inspected on a weekly basis alongside the scaffold inspection. The earth leakage test should be repeated periodically or if the visual inspection of the earthing arrangement gives cause for concern. Gloves must be worn when erecting scaffolding.

2.4.12 Cranes and Hiabs

When any working activity is required, which involves the use of a crane or Hiab then immediate advice will be required from the team leader or an engineer responsible for the site in question as powering down of services may be required. **Note:** powering down of services will require more than two weeks' notice prior to the planned work.

When working on nearby telecom and broadcast towers on these sites, specific method statements and risk assessments are required for this type of working.

Cranes / Hiabs required to work on an LF or MF site must:

- Not be of modern construction (electronic screens, microprocessors etc. as these may be affected by RF pick-up)
- Have adequate earthing points and suitable earthing cable
- Have an insulated strop capable of lifting the required load

Crane / Hiab drivers connecting earth leads must ensure that they connect using overhead line earths. These are heavy insulated earths that can be put on using insulated handles. This type of earth is the safest type as RF can arc through lightly insulated rubber and plastic, therefore car jump leads, and welders' clips should not be used except for very temporary measures whilst better methods are installed.

Wide, flat copper (or aluminium) tape is better than round cable of the same cross-sectional area, because at RF the skin effect means that the current is confined to a thin volume near the surface and so the circumference is important in minimising the resistance.

When landing something slung from a crane, for example steelwork or the next section of a partly built tower, or a cabin, the load should be contacted with an earthed lead before it is contacted by a hand (and the hand should be wearing a glove).

The work should be planned so that in the event of a burn, the risk of a secondary hazard, like dropping tools or equipment or falling from height is minimised.

2.4.13 The Use of Winches

When using winches on LF and MF sites, operators must be aware of the potential of induced current in the winch bonds. Induced current may be found on the winch bond even when the wire is placed on the ground.

When handling winches on LF and MF sites, operators must ensure that they are wearing suitable 'rigging' gloves to prevent contact with the induced current. If winch bonds are travelling up the structures, they must be earthed prior to touching the bond.

All loads being raised by a winch must be secured by an insulated strop suitably constructed for the load to be lifted. Any lifting activities carried out on an LF or MF site must be authorised by the Arqiva site access process. When any working activity is required which involves the use of winches, then advice will be required from the senior engineer responsible for the site in question. This is because powering down of services may be required.

2.4.14 Working Close to the Top of the Structure (Structure Tip Effect)

When working on very high power MF or LF sites, high RF levels will be registered on the very top of the structure – even on telecoms towers where all four legs of the tower are permanently earthed and where cable ladders, gantry poles etc. provide additional earthing. This effect can be known as 'Structure Tip Effect' and is normal. RF levels of over 1000 V/m can be measured at the top of such a structure.

Power is being absorbed by the earthed structure from the live MF or LF antennas nearby. Because there is no electrical connection between the live structure and the dead structure, the path the power is taking is a high resistance path. For power transfer to take place over a high resistance path, the voltage developed is huge. Once power is induced in the earthed structure current flows down the structure. Because the tower steel is a good conductor, current flows easily to earth with relatively low voltage levels.

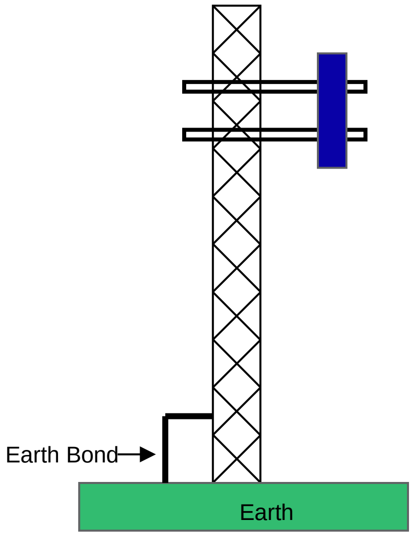
Structure Tip Effect can lead to electric shock and RF burns. RF burns will normally leave white pinpoint marks on the skin. However, the burn will have penetrated deeper in a similar way in which a long splinter enters the skin but only leaves a small area of visible damage. RF burns are normally third degree and should be treated in the same way as a cut to avoid infection. Because they are deep injuries, they need to heal from the inside outwards. However, the deep damage restricts the flow of blood to the affected area, so they take a long time to heal.

Because of Structure Tip Effect, equipment should not be installed at the top of structures on MF or LF sites. At times where it is necessary to work in these areas, and where reduced power on the MF or LF Transmitters is not enough, the voltage levels and hence the risk of electric shock can be considerably reduced by the temporary installation of 'Sacrificial Stubs'. These are simply metal poles, such as aluminium scaffold tubes attached just below the top of the structure and sticking vertically out the top of the structure by 2 metres or so. They should be firmly attached with Crossover Plates, Norstals or similar. These effectively increase the height of the structure for the duration of the work. The Structure Tip Effect will now occur at a point above the working area. Great care must be taken when fitting and removing sacrificial stubs.

Design of antenna installations should account for this effect and in general should avoid installations within 2 metres of the top of the structure.

2.4.15 'Sticky Out Metal Effect'

There is another effect similar in nature to the Structure Tip Effect but occurring in areas of the structure other than the top. It has been referred to as the 'Sticky Out Metal Effect'.



In the exaggerated sketch a cellular antenna has been fitted on two horizontal leg brackets on an earthed structure, a few metres below the top. This area of the structure was not known to have high levels of electric field before the installation.

The RF levels measured at the tip of the leg brackets will be very high. The leg mounts act as though the top section of the Tower was cut and rotated 90 degrees clockwise. This effect will also be found on protruding studding, SHF dish panning arms etc – anything metal that sticks out. The higher up the tower the installation is the greater will be the effect. Antennas and their steelwork should be kept as low down as possible and as close into the tower as possible. If there is no alternative the 'Sticky Out Metal Effect' can be considerably reduced with sacrificial stubs – this time horizontal.

2.4.16 Fencing

2.4.16.1 Safe Working practice for installation or repair of earthed Palisade Fencing

Where it is proposed to install new or repair existing palisade fencing there are four aspects to be considered:

1. The effect of the presence of the fence on the operation of the antenna
2. The risk of damage to the earth mat during installation work
3. Safety hazards during installation
4. Residual safety hazards once installation is completed.

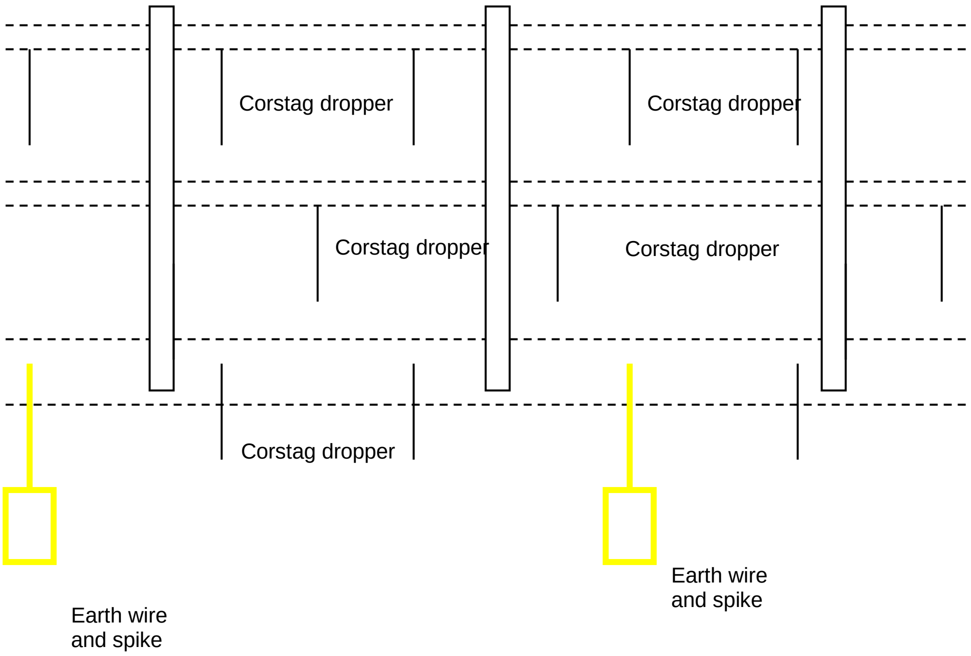
All of which must be considered in production of the risk assessment and method statement for completing the task. Details:

1. *The presence of an earthed conducting fence up to 3m in height should not adversely affect the antenna to any serious degree, but it might affect the antenna match and hence require some adjustment to the tuning. Therefore, this work must involve consultation with antenna engineers. This effect can be modelled theoretically and should also been checked by an antenna engineer on site particularly for high powered sites.*
2. *The installation work must avoid damaging the earth mat. If the wires of the earth mat must be disturbed by the work (for example to put in foundations) then the wires must be must be identified by hand digging carefully and then cut cleanly without pulling and then reconnected around the foundation, preferably by Cadwelding or hard soldering (not soft soldering or clamping). Hand digging must be done extremely carefully. A new perimeter earth should be added under the new fence and connected to the existing earth mat and radials.*
3. *The safety hazards during installation would include:*
    a. *Workers being in a situation where there is risk of touching the radiator. A good way to avoid this would be to build to the new fence on the outside of the older fence so that the old fence provides a physical barrier to the antenna radiator during construction. A shorter outage could then be arranged to remove the old fence, or it could be left in situ if there no absolute reason for its removal.*
    b. *At some high-power sites RF levels close to the existing fencing might be close* to the working *limit. Staff should wear appropriate personal monitors on the body in this case to monitor the RF in their working areas (See section 2.4.1)*
    c. *RF Pickup both on the fence and on vehicles especially on high power sites. There is thought not to be much evidence of this on low power sites in the past.*

4. *The residual hazards of having a metal fence are due to induced current and voltage if the fence is not earthed properly, leading to contact current and burns. The measure which controls this hazard is earthing, at regular intervals.*

2.4.16.2 Safe working practice for repair or installation for mesh and horizontal fencing

Where metal wire fencing is used on site boundaries it is important that it is correctly earthed. The following section gives detailed guidance on how this should be done.



Start from ground level and work up.

Materials required:

Appropriate PPE, RF Monitor, leather gloves, protective footwear, eye protection, high viz jacket and hardhat.

Barbed wire, plain wire, plain wire with (stock proof mesh), Corstag droppers various lengths, Corstag dropper clips, Corstag dropper tool, Wire tensioning tool, Fencing post mallet, wire cutters, safe method to transport waste and damaged materials to skip, binding wire. All wires must be galvanised. All waste must be removed from the area.

Procedure:

1. Drive in earth spikes to a minimum 300 mm, deeper if ground conditions are dry. Put on gloves, connect earth wire to spike, if not already connected, and then connect wire to lowest strand of fencing.
2. With gloves on, check soundness of lowest strand of wire, and clear out vegetation. If damaged, remove and put in appropriate container for safe removal from the area.

   Re-run new section by first attaching one end of the wire to the existing fence post, by wrapping the new wire around it with one turn, stapling it in place with a minimum of three staples and wrapping the tail around the existing good section wire, using binding wire to ensure it does not protrude. Measure out the length of wire, then use the wire tension to apply the appropriate tension, put a minimum of two staples in to hold the tension, remove the tool, cut the wire to allow for one complete wrap around the post, put in more staples and finish off as previously described.
3. If fencing is sound or in need of repair, 3 in No. Corstag droppers equally spaced should now be installed. These droppers should be the longest ones and driven into the ground, so they just protrude (60 mm) above the lower strand of fencing. Once driven into the ground they should be clipped to the lower strand with the appropriate clips and using the correct tool.
4. The same routine is followed on the second strand. Clip on earth wires, remove damaged section if required. In either event, there is now a requirement to install 2 in No. Corstag droppers equally space between the previously installed droppers on the lower strand.
5. The same routine is followed on the top strand. Clip on earth wires, remove damaged section if required. In either event, there is now a requirement to install 3 in No. Corstag droppers equally space between to match the line of the previously installed droppers on the lower strand.
6. Ensure area is clear of all debris and cuttings from vegetation are removed from the area and placed in the appropriate skips.
7. Unclip earth wires and pull out earth spikes.

- **Earth spikes and wires must be returned to Field Ops staff immediately on completion of work.**
- D**uring periods of electrical storms: all work should cease; staff should return to main building area, having first left the field secure.**
- **If there is livestock in the field, they must be kept away from the working area.**
- **Any breach in the fencing must be staffed at all times.**

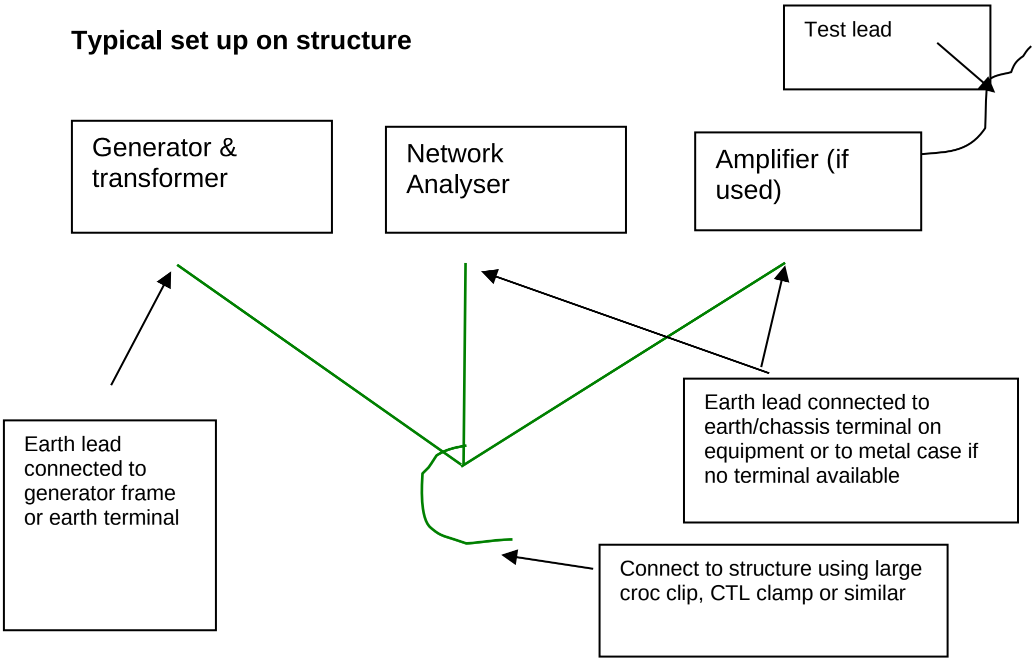
2.4.17 Precautions for use of test equipment on UHF/VHF broadcasting structures that also support an MF wire antenna

When using test equipment either on or in the structure or when located in the chair of the man riding rig, it is essential that the equipment is properly bonded to reduce the likelihood of RF burns to persons operating the equipment. In the majority of these cases the test equipment will be powered by a portable generator with an output of 110V via an isolating transformer and this bonding will also ensure additional electrical safety too.

Working on structure

Each piece of equipment (typically 110V generator and transformer, network analyser and amplifier) should have an insulated earth bonding lead (minimum cable size 6 mm square for generator and 1.5mm square for test equipment) connected from the earth terminal or socket (sometimes labelled as chassis) to a common point which should be insulated. A minimum 6mm square insulated lead should then be connected from this point to the structure, connection to the structure being made with a large crocodile clip, CTL clamp or similar (a car type jump lead can be modified for this purpose). If the equipment does not have an earth terminal or socket, then the lead must be attached to the metalwork of the case. It is important to connect the equipment bonding leads to a common terminal as shown to prevent any issues with circulating RF currents which could cause instability and compromise the measurement accuracy.

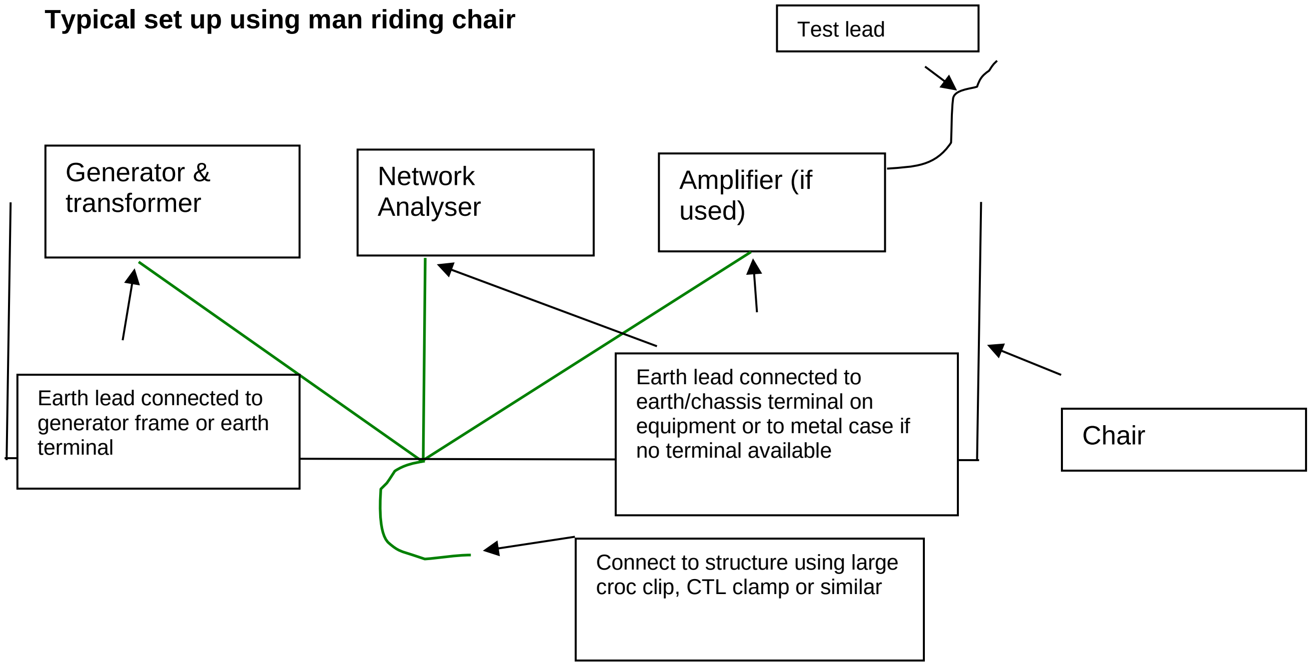
Typical set up on structure



Working with equipment in man riding chair

The set up when the equipment is located in the man riding chair is very similar to that when working upon the structure, except the bonding leads connect to a common point on the metalwork of the chair and then a flying lead is used to connect the chair to the structure. The earth leads from the equipment and the flying lead to the structure should all be connected to the same point on the chair metalwork. Cable sizes should be as per the setup for the structure.

Typical set up using man riding chair



2.4.18 Escalation

This document can only give an outline of the hazards and types of precautions that should be taken. However, every site and every job is different so site and job specific method statement must be written and approved for installation project work on MF and LF sites. Detailed guidance and support may also be sought from company experts within the Antenna Systems Group or SHE RF Safety Team.

2.4.19 Supporting Notes

Safety Signage: Detailed guidance on the Safety Signage that should be applied to MF and LF sites is included in sections T8, T9, T10 and T11of Site Signage Guidelines BOP260.

3 List of related documents

Document No:	Document Title:
External Document	The Control of Electromagnetic Fields at Work Regulations 2016 ICNIRP Guidelines (1998)
External Document	COUNCIL RECOMMENDATION on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (1999/519/EC)
BS6656 (External)	Protection against inadvertent ignition of explosive atmospheres by radio-frequency radiation at onshore hazardous installations
BS6657 (External)	Assessment of inadvertent initiation of bridge wire electro-explosive devices by radio-frequency radiation.

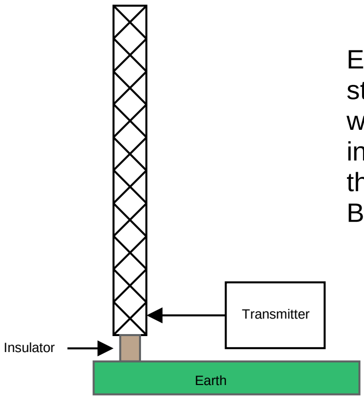
4 Definitions and Abbreviations

Item	Description
MF	Medium Frequency
LF	Low Frequency
RF	Radio Frequency
RAMS	Risk Assessment and Method Statement
MEWP	Mobile Elevating Work Platform
CEMFAW	Control of Electromagnetic Fields at Work Regulations 2016
SHE	Arqiva Safety, Health & Environment Department

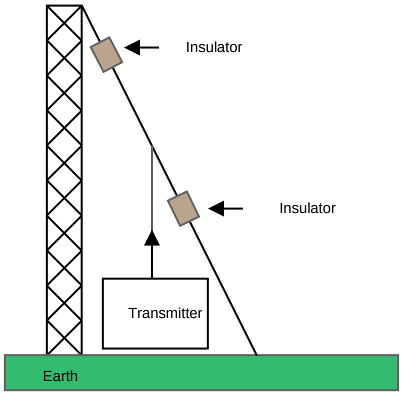
Appendix A Types of MF and LF Site

There are many configurations of MF/LF stations. Here are just eight examples from a vast number of possibilities and it is important to understand the configuration of any site where work is proposed.

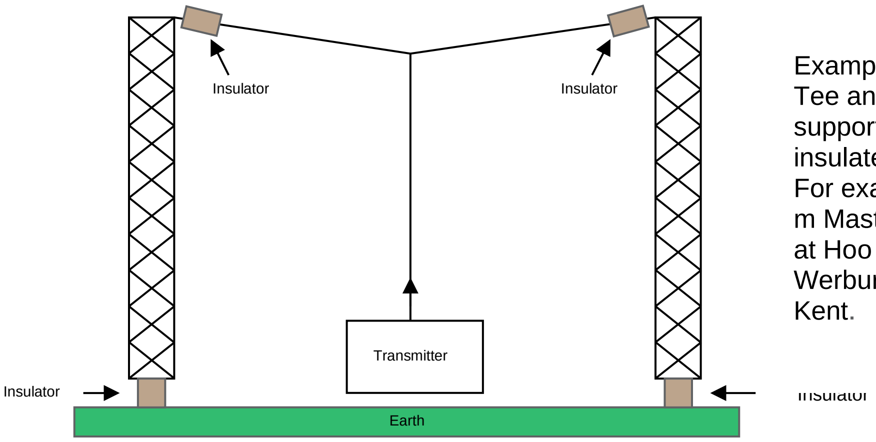
All the below will have a network of copper wires below the topsoil forming an ‘earthmat’, which acts as a reflector for the Radio Frequency signals from the antenna(s).



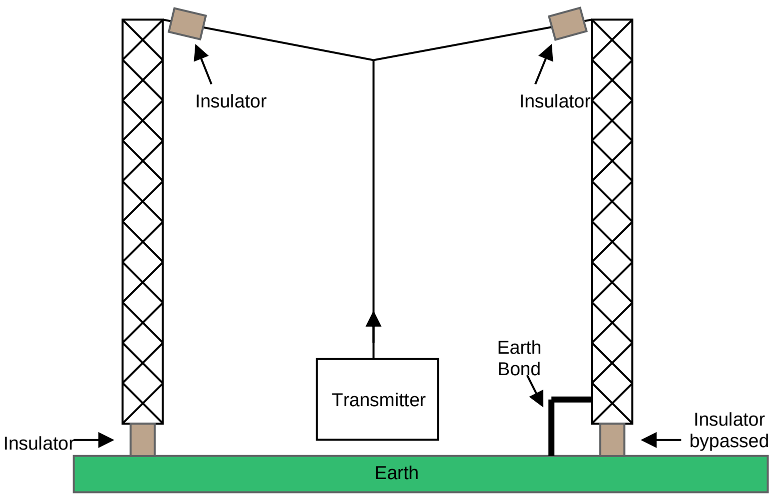
Example 1: Live mast standing on an insulator with the stays also insulated. For example, the 500-foot Mast at Brookmans Park.



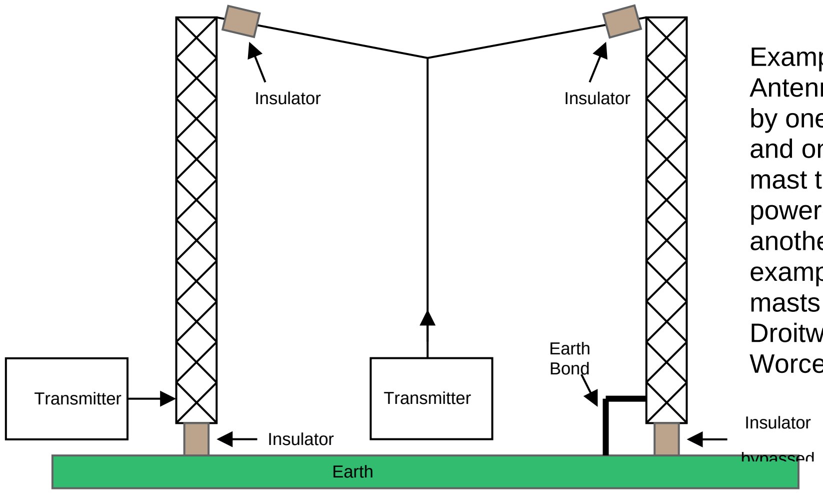
Example 2: Sloping wire supported by a permanently earthed mast or tower. For example, 110 m Sloping Wire on 200 m tower at Crystal Palace.



Example 3: Wire Tee antenna supported by two insulated masts. For example, 45 m Masts and Tee at Hoo St. Werburgh in Kent.

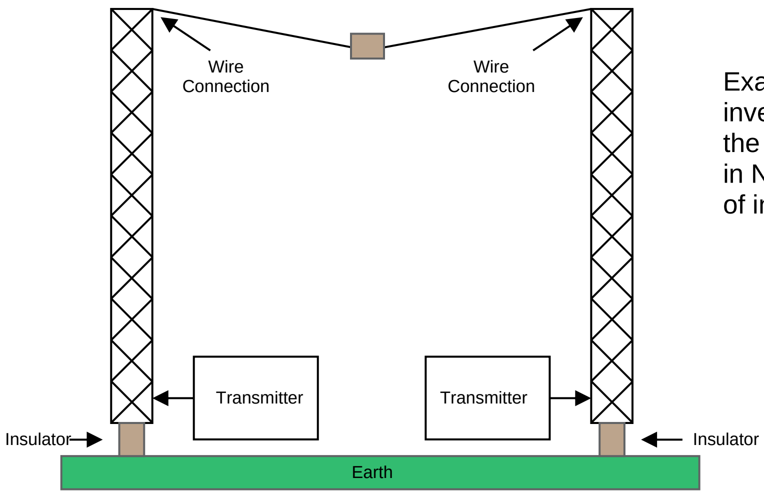


Example 4: Wire Tee antenna supported by one insulated and one earthed mast. For example, 45 m Masts and Tee at Folkestone and Bexhill.

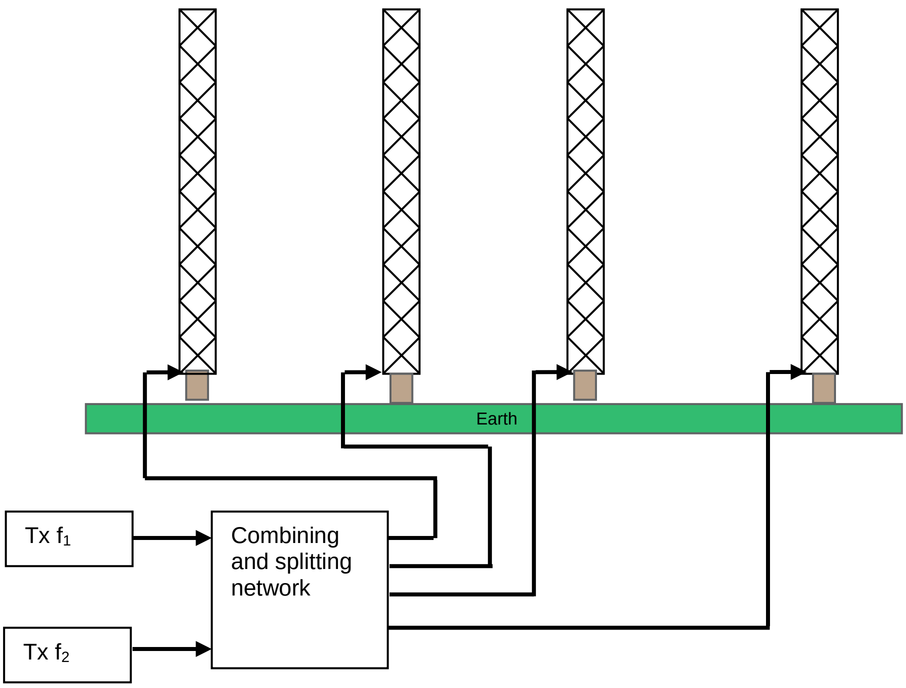


Example 5: Wire Tee Antenna supported by one earthed mast and one insulated mast that is being powered to radiate another service. For example, the 650-foot masts and Tee at Droitwich in Worcestershire.

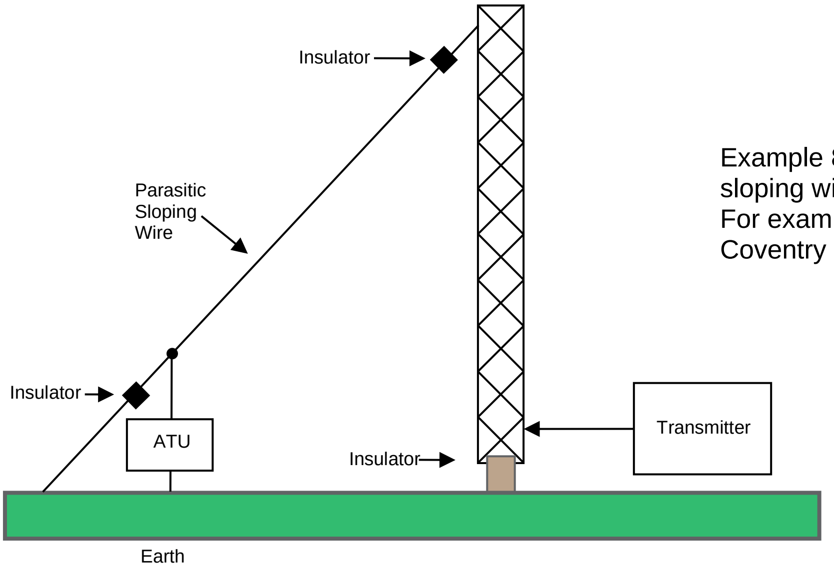
Tee radiates half a million watts of Long wave Radio 4, supported by both masts. One mast is earthed, and the other mast is insulated from ground but is being driven by another transmitter (mast radiates 150 kW of Radio Five Live).



Example 6: Pair of masts and wire inverted L antennas. For example, the 45 m masts & wires at Trowell in Nottinghamshire, forming a pair of inverted L antennas.



Example 7: multi-mast arrays. For example, Langley Mill, four masts on two frequencies.



Example 8: Mast with sloping wire reflector. For example, Coventry MF.