The Diocese of Chichester

Diocesan Advisory Committee

Advice Note 34

Audio and video facilities in Churches and Places of Worship

Contents

1 Introduction

1.1 Background

This document is intended to provide guidance to parishes on the factors which should be taken into account relating to the provision of audio and video facilities in churches where currently either no facilities exist or where the existing facilities are to be replaced and / or upgraded.

1.2 Inspecting architect

The DAC asks that you involve your inspecting architect on fabric and aesthetic matters, e.g. the positioning of loudspeakers and their method of mounting, video monitors, projectors and screens, the cable routes and methods of fixing, induction loop aerials and positioning, cable conduits, trunking and their methods of fixing.

1.3 System requirements

Where a new system is to be installed or an existing one is to be upgraded, it is important for the interested parties to clearly establish and agree a list of requirements, i.e. a brief.

The completed brief provides a clear method of enabling all involved to be sure that the individual and collective requirements have been covered.

Thereafter, the brief can be issued to a specialist contractor for a quotation or to a number of such contractors for competitive tender.

The use of a consultant may be helpful in some or all of the following stages - preparing a brief, identifying budget figures, designing the facilities, compiling a specification, commenting on contractors' submissions, evaluating their costs, supervising the installation and witnessing the commissioning of the system.

1.4 Faculty application

Along with the faculty application form, you should include the following:-

(a) Identify the make and model of the system elements (the manufacturers' detailed specifications are not required)

(b) Identify the unit cost for the items and the total system cost

(c) Provide full details along with costs (even if only budgetary) for any non-standard items, i.e. elements manufactured to meet specific requirements

(d) Include a drawing or sketch showing the location of the key elements, e.g. microphones, central equipment, loudspeakers, projection screen position, video projector location, video monitor positions, audio and video cable routes, along with the induction loop aerial cable route

(e) Include any photographic details showing how the elements are to be incorporated within the building

1.5 System elements

Under a series of headings which follow, factors which should be considered in relation to the various elements have been noted.

2 Procurement

2.1 Contractor / contractors

Once you are satisfied that you have a clearly defined brief, issue it to a preferred contractor or a number of contractors. It is essential that contractors visit the church so that (a) they can familiarise themselves with the building, (b) establish how you intend to use the facilities and (c) discuss any matters arising with the interested parties.

2.2 Cost breakdown

In order that meaningful comparisons can be made between the submitted figures, the contractors should be asked to provide a unit cost for each of the system's main elements, e.g. microphones, extension cables, microphone stands, lapel radio-microphones, hand-held / stand-mounted radio-microphones, equipment enclosure, audio mixer, CD player, power amplifier, induction loop amplifier, loudspeakers, cabling and installation. The installation figure should show how many days have been included and for how many persons.

Contractors should also state clearly whether or not their figures include / exclude VAT and whether or not they are VAT registered.

2.3 Exclusions

The contractor(s) should be asked to show clearly what elements they have excluded from their costs but which are essential for the implementation of the installed facilities, e.g. builder's work elements (i.e. lifting of floors and carpet, decoration and making good), additional mains power requirements and the provision of access equipment.

There should be a clear understanding and agreement with the contractor(s) and the other interested parties as to how such exclusions are to be addressed so as to result in appropriately installed and fully operational facilities meeting the requirements of the brief.

2.4 Contractors' proposals

If the contractor(s) feel that the requirements can be met by means other than those required by the brief, in addition, they should be allowed to propose alternative methods for fulfilling the requirements. This should only be done provided they indicate the cost increases and savings which result, along with any additional technical facilities or limitations which their proposals provide.

2.5 Equipment demonstrations

Contractors should be asked if they are prepared to mount a small scale demonstration of the actual (or comparable) key elements of what the parish has requested or what the contractor is proposing.

Whilst some of the larger contractors may offer to carry out such a demonstration free of charge, as a minimum, the parish should be prepared to make an offer of covering the contractor's expenses for such a demonstration.

As an alternative to a demonstration, parish representatives should visit churches where the same or equivalent items of equipment have been installed. This will give the interested parties a better understanding of what is involved and will help to highlight factors which they need to consider in relation to their own church.

2.6 Health & Safety

If you have a health and safety policy, ensure that you pass a copy of it to the contractor prior to the commencement of the project.

Identify any particular health and safety issues relating specifically to the project which you want him to take into account. This is especially so in the case of a church which will be open to the public during the implementation of the work.

In addition to any specific health and safety requirements, ensure the contractor takes account of all health and safety matters and that he will be complying with the requirements of the Health & Safety at Work Act.

Ensure that any health and safety matters are agreed and documented.

2.7 Insurances

Advise your insurers of the work which you are intending to implement. Establish with them any specific requirements they may have in relation to the work which you intend to carry out.

Check that the contractor has relevant insurance cover for the work he is undertaking, the area within the building in which he will be working and any specific requirements requested by your insurers.

If you believe that there are specific risks and requirements besides those identified by your insurers, advise the contractor of them and agree a solution.

In addition to contractor–related insurance, where electronic instruments and outboard equipment (e.g. keyboards, electric guitar amplifiers, synthesisers) are used, establish with your insurers the implications of damage resulting from interfacing such instruments with the church's facilities given that in most instances, the instruments will belong to the performers as opposed to being owned by the church.

Ensure that all insurance requirements are agreed and documented.
Your inspecting architect will advise on this matter.

3 Microphones

3.1 General

3.1.1 Polar responses

In order to maximise speech intelligibility especially in reverberant spaces and also minimise the risk of acoustic feedback, it is absolutely essential to ensure that all of the microphones within the system have an appropriate polar response, i.e. the microphone's angle of acceptance to the pick up of sound.

The commonly used microphone polar responses are - (1) omni – where sound pick up is in all planes, (2) cardioid – where pick up is lowest at the back whilst being slightly reduced on the sides and (3) hyper-cardioid (also known by some manufacturers as *'super-cardioid'*) – where there is virtually no pick up at the back and very little on the sides.

In addition to the above, there are microphones whose polar response is even narrower than that of a hyper-cardioid. They are usually referred to as 'rifle' (or shotgun) microphones. They are seen frequently with tv news crews as they are more directional than a hyper-cardioid. Their overall length determines their directional properties – the longer the microphone, the more directional it will be.

It is important to ensure that all of the cabled microphones have as narrow a polar response as possible. This is especially so in reverberant churches. In the case of a lapel radio-microphone, the capsule should have a cardioid response and not omni-directional which is the response supplied as 'standard'.

3.1.2 Positioning

In addition to ensuring that the microphone polar response is as tight as possible, it is also critical to position microphones correctly in relation to the users so as to maximise speech pickup whilst minimising feedback.

In the case of fixed microphones, every effort should be made to ensure that the microphone is directly in front of the person speaking and typically no more than 300 mm (12") away. For lapel radio-microphones, the capsule should be below mouth level but by no more than 200 mm (8") when the user is looking forward. Also, the capsule should be to one side, preferably the left-hand side.

3.1.3 Switching

In any sound system, each microphone which is 'On' will increase the risk of acoustic feedback unless the overall reproduction level is reduced. It is easy to reach a point where the system feeds back or the reproduction level is so low (to avoid the feedback) that it becomes inaudible to the listeners.

Also, microphones which are left 'On' even though they may not be in use, will have a serious impact on the potential performance of the system. Unused microphones will pick up the reverberant sound within the building and distribute it through the loudspeakers. Assuming the level is such that the system does not feedback, the situation will result in reduced speech intelligibility. In order to avoid this risk of feedback and to maximise speech intelligibility, it is essential to ensure that all unused microphones are always switched 'Off', i.e. faded down.

Switches which are integral to stand-mounted / hand-held microphones should in general be avoided as they are usually inconveniently located and often the direction in which the switch must be moved is confusing. Switching can be either local or remote from the microphone with the switch prominently located so that it is readily accessible. In addition, the switch should be clearly labelled in terms of the 'On/Off' position and preferably have an illuminating indicator to show its 'On' status.

3.2 Cabled microphones

3.2.1 Altar

It situations where it is necessary to use a cabled microphone at the altar, consideration should be given to the use of a boundary microphone as opposed to a conventional microphone on a table stand.

The use of a boundary microphone avoids the need for an unsightly table stand which often tends to get in the way and as a result is not always placed in the optimum location. Also, the boundary microphone's low profile means that it is less visible than a table stand-mounted microphone.

In order to maximise intelligibility and reduce the risk of feedback, the microphone should have a hyper-cardioid polar response. Consideration should be given to selecting a microphone which has an integral 'On / Off' switch and an illuminating indicator to show its 'On' status.

Such microphones and their cable are available in white, thereby making them less conspicuous when placed on the altar cloth. However, there is an advantage in using the black version as it is more easily seen by the user and the risk of it being accidentally covered over is greatly reduced.

3.2.2 Lectern, Pulpit, Stalls and stand-mounted

The microphone capsule should have a hyper-cardioid or narrower polar response. The use of a microphone having an integral gooseneck is neater and less visually intrusive. Also, the gooseneck enables the microphone to be easily adjusted so as to take account of the user's height.

The use of a microphone having a long gooseneck should be avoided as this can often result in the capsule being located so that it is far from the optimum position in relation to the user.

3.3 Method of mounting

In order to avoid fixings to the lectern, pulpit, clergy stalls etc and the need for any form of boom / floor stand, consideration should be given to the use of an inverted T-bracket (i.e. ^) which can be placed on the book rest of a lectern, pulpit, clergy stall, desk etc. The horizontal of the T rests on the bottom retaining ledge of the book rest. As the bracket relies on its own weight to keep it in place, there is no need for any form of fixing to the timberwork.

The vertical of the inverted T should have a clip fitted to it suitable for securing in place the microphone which is being used. When not required or for security reasons, the entire assembly can be easily removed for storage elsewhere without having to deal with fixings.

3.4 Floor stand

A floor stand with a circular base and having a clutch action (as opposed to the more usual friction action) should be considered. This means that the height is easily adjusted with one hand. Friction type stands require the use of two hands and people are often confused as to which way they need to twist the locknut to release and secure the stand.

The circular base is more compact and less of a potential trip hazard than the more commonly used tripod-based stands. However, where it is intended to use a boom arm on the stand, a tripod base may be necessary for reasons of stability.

3.5 Radio-microphones

3.5.1 General

Modern day radio-microphone systems operate in the UHF (ultra high frequency) spectrum and are therefore free from the various forms of interference which sometimes plague VHF (very high frequency) spectrum systems.

In addition, most UHF radio-microphone systems operate on a diversity basis where two receiving aerials pick up the transmitter signal. This results in the signal being more resilient thereby reducing the likelihood of signal drop-out, i.e. intermittent reception.

3.5.2 Licensed & licence-free implications

Until the end of 2012, UHF frequencies on which radio-microphones operated fell into two channels of the frequency spectrum, namely Channel 69 (854 to 862 MHz) which required a licence and Channel 70 (863 to 865 MHz) which was licence-exempt. Following the DSO (Digital Switch Over), at the end of 2012, the use of radio-microphones which operated on Channel 69 frequencies was prohibited.

Since the switch-over, Channel 70 remains available for radio-microphones on licence-exempt frequencies. However, it is essential to bear in mind that there is a risk when using Channel 70 licence-exempt frequencies. In the event of two radio-microphones on the same frequency being used simultaneously at venues in close proximity to one another, there will be interference between both systems.

Since the beginning of 2013, licensed radio-microphone frequencies are in general covered by Channel 38 (606 to 614 MHz) which replaces the withdrawn Channel 69. The Channel 38 licences are currently administered on behalf of OFCOM by the JFMG (Joint Frequency Management Group). JFMG allocate frequencies so that the risk of radio-microphone channels in venues which are in close proximity to one another being on the same frequency is avoided. This eliminates the likelihood of interference between the radio-microphone systems.

Careful consideration must therefore be given to the selection of radio-microphone equipment in terms of using Channel 38 licensed frequencies or Channel 70 licence-exempt frequencies. The use of Channel 70 radio-microphone equipment in a remotely located country church is unlikely to suffer interference problems from adjacent systems. However, in a town church where there may be venues in close proximity such as pubs, clubs, discos, auction rooms etc using radio-microphones, licensed frequencies must be considered.

If Channel 38 licensed frequencies are to be used, an application must be submitted to JFMG (www.jfmg.co.uk) who will allocate the frequency / frequencies to you. Thereafter, the licence will necessitate an annual payment for which you will be sent a reminder.

3.5.3 Lapel radio-microphone

Lapel radio-microphones are ordinarily supplied with an omni-directional capsule. The use of a cardioid capsule will improve intelligibility and significantly reduce the risk of feedback. However, the positioning of the cardioid microphone capsule on the user is extremely critical if best results are to be obtained.

As noted earlier, the capsule should be below mouth level but by no more than 200 mm (8”) when the user is looking forward. The capsule should be positioned so that it is vertical, i.e. with the cable exiting from the bottom of the capsule. Also, the capsule should be to one side, preferably the left-hand side.

In the case of chasubles (and other vestments) with high collars, ensure that the microphone capsule is not clipped to the collar. Otherwise, it will not pick up any direct speech. As a result, the speech level will be reduced and raising the reproduction level to compensate is likely to increase the risk of feedback. In addition, not only will the speech level be low, it will also lack clarity.

Care should also be taken to ensure that the length of the microphone cable is optimised. In some cases, the cable as supplied is in excess of a metre in length. As a result, it has to be coiled or more usually bundled into the user’s pocket. The contractor should be asked to supply the cable so that its length is suitable for use with the vestments / clothing being worn.

It is important for the transmitter to be correctly positioned on the user so that there is nominal line of sight to the receiving aerials. Putting the transmitter in a back pocket can have a detrimental impact on the radio-microphone’s performance. It is also essential for the transmitter to be orientated so that the aerial is vertical. Consideration should therefore be given to the use of shoulder or belt-mounted pouches to house the transmitter. They enable the transmitter to be positioned on the user’s left or right hand side. They also provide easier access to the ‘Mute’ switch on the transmitter and in addition, help to ensure that the aerial is kept vertical so as to optimise reception.

Care should also be taken when storing the lapel radio-microphone. Bundling of the microphone cable into a box or drawer should be avoided as over time this results in twists and kinks developing which can later lead to fractures in the cable. Instead, the cable should be carefully coiled or alternatively, the transmitter should be hung up so that the microphone and cable drops freely under their own weight, thereby avoiding the risk of possible damage to the cable.

3.5.4 Stand-mounted / hand-held radio-microphones

Consideration should be given to the need for a hand-held radio-microphone which can also be stand-mounted. This can be a floor stand or a table stand as the usage dictates.

Usually, the polar response of such microphones is cardioid. In order to maximise intelligibility and minimise the risk of feedback, it is essential to ensure the polar response is hyper-cardioid.

Often, hand-held microphones are used close to the mouth whilst in other instances, when stand-mounted, they may be some 300 mm away from the user. Care must be taken to ensure that when used close to the mouth, the internal sensitivity is reduced so as to avoid overloading the microphone's transmitter. Failure to do this will result in distorted sound.

3.5.5 Batteries

Depending on usage, the running costs for a radio-microphone can be significant. It is essential to use high power top of the range batteries. These will give a typical continuous running time of between 6 and 8 hours.

Re-chargeable batteries can be used. However, they must be high quality types as must the associated charger. The charger needs to be of the 'intelligent' type where it monitors the rate of charge, automatically switches 'Off' once the battery is fully charged etc. Such chargers and batteries are costly.

3.5.6 Receivers

A separate receiver is required for each radio-microphone. For security, the receivers should be located in the equipment rack and not be left free-standing on top of it or on a shelf nearby as is often the case.

3.5.7 Receiving aerials

In order to maximise reception, the positioning of the receiving aerials is critical. All too often, short telescopic aerials are connected directly to the rear of the receiver. In cases where the equipment rack and the receiver may be in a vestry, this means that the aerials are not even within the space in which the radio-microphone is to be used. In addition, if the equipment rack is of metal construction, reception will be further impaired. Also, the space inside the rack often results in the aerials not being mounted in the correct plane. All of these factors will have a serious detrimental effect on UHF reception and therefore the performance of the radio-microphone.

UHF radio-microphone reception operates on a nominal *'line of sight'* basis. Consequently, it is essential that the aerials are installed in the body of the church and in such a position that the radio-microphone user will have nominal line of sight to the aerials from the positions in which it is intended to use the radio-microphone.

For best results, the aerials should be at a sufficiently high level so that there are no obstructions between them and the areas where radio-microphones are likely to be used.

In addition to straight-line coverage of the Nave and Chancel, care should be taken to ensure that areas such as that surrounding the font and entrances (especially those used for funerals) have aerial coverage. This may necessitate the installation of additional aerials.

4 Central equipment

4.1 Location

The preferred location for the central equipment can present difficulties on account of the conflicts which can be created between security, ease of access and sightline requirements. Positioning the equipment at the rear of the church does mean that if there is a need to control elements of it, the operator has line of sight to what is taking place. Whilst a vestry might be more secure, ease of access and sightlines are usually less convenient.

4.2 Equipment enclosure

Regardless of where the central equipment is to be located, it should be installed in an enclosure based on the standard 483 mm (19 inch) rack format. This strategy has the advantage of providing a means by which all of the central elements can be securely mounted in the rack.

For further security, consideration should be given to the use of tamper-proof bolts such as *'System Zero'* to retain the equipment within the rack. This makes it more difficult for the opportunist thief to remove any of the equipment.

The rack format mounting uprights can be built into a timber cabinet. Alternatively, an off-the-shelf metal rack enclosure can be used and then be clad with timber.

Regardless of the enclosure format, it is suggested that it be fitted with a door for security and also to prevent tampering which can result when access to controls is readily available. Whilst a door with a 'perspex' panel enables controls and settings to be easily seen when the system is in use, a solid door provides better security.

4.3 Audio mixer

An audio mixer with an appropriate number of microphone channels (with phantom power) and line level channels should be installed in the central equipment rack. In addition to the individual level controls for each channel, there should also be a 'Master' level control along with a visual level indicator.

A suitable legend strip should be fitted to the mixer which will enable each channel to be labelled showing the microphone it controls.

Any controls not requiring user access (e.g. tone controls) should either be locked off or covered over such that they cannot be interfered with accidentally or deliberately.

4.4 Local volume control

Sometimes during the course of a service or other event, for comfortable listening, the variation in the microphone user's speech level may necessitate adjustment of the loudspeaker reproduction level.

Consideration should be given to having a local volume control which is readily accessible to the person taking the service or running the event. This will avoid the need to have somebody positioned by the central equipment to adjust the level.

The system should be configured such that the volume control operates over a limited range thereby ensuring that it cannot be set at too low or too high a level.

4.5 Graphic equaliser

Depending on the acoustics of the space and the loudspeakers used, there may be advantage in having a graphic equaliser so that the response of the system can be adjusted to take account of any anomalies in the building's acoustics and / or the loudspeakers being used.

Once set at the commissioning stage, a security cover should be installed on the equaliser so as to prevent tampering or adjustment by unauthorised persons.

4.6 Audio delay

Where loudspeakers are installed at intervals in churches having a long Nave, the inclusion of a digital delay unit in the system will help improve intelligibility. The unit will delay the audio signal so that sound from the loudspeaker nearest the listener and the natural progression of airborne sound along the Nave will be 'synchronised' when heard by the listener.

4.7 Power amplifier/s

A suitably rated power amplifier should be used. The power output of the amplifier must reflect the number of loudspeakers which are being connected to it. Some spare capacity should be included.

In some instances, it may be advantageous to use a multi-channel power amplifier so that there is independent level control over different loudspeaker zones, e.g. Nave, Side Aisles, Presbytery and Chancel. Where controls on the amplifier are readily accessible, tamper-proof controls or a security cover should be fitted.

Multi-channel power amplifiers tend to be fitted with a thermostatically controlled cooling fan. The fan will trip in and out depending on the heat being produced by the amplifier. Care should be taken to ensure that the fan noise does not exceed the ambient noise of the area in which the amplifier is located.

4.8 CD playback & recording facilities

Consideration should be given to including a capability for playing CDs as might be required for funeral and wedding services. It may also be appropriate to have background music replay capability when the church is being used for purposes other than worship. However, if copyrighted material is being used, the copyright, performing rights and Mechanical Copyright Protection Society implications must be taken into account and addressed.

If there is a likely need for services and other events to be recorded then a CD deck having a recording capability should be installed. Clearly, the deck cannot be used for CD replay and CD recording simultaneously. Also, the maximum continuous recording time on CD is limited to 80 minutes.

As an alternative to a CD player / recorder, a flash card recorder could be used. This extends the recording time up to a number of hours. However, any material to be played via the system would have to be transferred onto the flash card. Conversely, any recording made on the flash card would have to be transferred to CD or some other more widely used format for use by the listener. Although not a difficult process via a pc / laptop, it is cumbersome, especially if required in a hurry.

4.9 Auxiliary input & output

Consideration should be given to the inclusion of an auxiliary input thereby enabling additional equipment to be connected to the system. This could be used in situations where for example, there is a need to connect the audio output from a CD deck, DVD player, MP3 player, iPod, laptop computer etc enabling the signal to be reproduced through the loudspeakers.

Consideration should also be given to having an auxiliary output available thereby enabling additional equipment to be connected to the system. The output could be used for connecting external recording equipment to the system or for providing signals to external distribution equipment which for example might be required for ‘overflow’ facilities during special events. The output could also be used to provide independent audio signals, these to be used in conjunction with web cameras etc for relaying via the internet.

The inputs and outputs should be terminated with ‘phono’ connectors and also with jack sockets for maximum flexibility. In addition, they should be short-circuit protected so that in the event of the external equipment developing a fault, the permanently installed system will remain unaffected.

5 Loudspeakers

5.1 General

If good intelligibility is to be achieved, the correct type and positioning of loudspeakers is critical, especially in reverberant churches.

Line source (more usually known as column) loudspeakers give best results in reverberant spaces on account of their good directional properties.

Despite their poor directional properties, conventional cabinet type loudspeakers are often used as an alternative to column loudspeakers. The cabinets tend to be mounted at wall-plate or tie beam level. Whilst this strategy addresses aesthetic factors, there are significant performance disadvantages – (1) reproduction levels have to be increased on account of the distance involved, (2) as a result, the reverberant sound level is increased, (3) intelligibility is lowered, (4) the risk of feedback is increased and (5) the high mounting height of the sound source is distracting.

In order to maximise the performance of column loudspeakers, it is important that they are mounted at an appropriate height and angled correctly in relation to the listeners. Sometimes this can pose aesthetic problems.

In addition, a sufficient number of loudspeakers should be mounted at intervals so as to provide uniform coverage over the seating area involved.

In some instances, it is not possible to have the loudspeakers pillar-mounted or wall-mounted. Where this situation arises, there is no reason why the loudspeakers cannot be pole-mounted by means of a suitable base which is fixed to the floor.

5.2 Clergy & Choir Stalls

The location of Clergy and Choir Stalls often results in these areas not receiving any loudspeaker coverage whatever. In some instances, this can be more easily and satisfactorily achieved by using a number of small loudspeaker enclosures adjacent to or within the stalls - as opposed to wall-mounted loudspeakers.

The Choir Stalls' loudspeakers should be fitted with a local switch so that they can be switched 'Off' when the stalls are unoccupied.

5.3 Organist

Consideration should be given to the need for a loudspeaker in the vicinity of the console for use by the organist. The loudspeaker should be fitted with a local On / Off switch and local volume control which can be operated by the organist.

5.4 Vestry

Depending on the location of the central equipment rack and assuming it is in the vestry, there may be an advantage in having a local loudspeaker. This would enable the reproduction level to be monitored in the event of the system being manually controlled from the vestry.

5.5 Loudspeaker zones

Care should be taken to ensure that loudspeaker coverage is only provided when the particular area is occupied. Switching should be available to enable unused loudspeakers to be switched 'Off'. Failure to observe this important point means that otherwise, sound energy is being directed into an unoccupied space. This will result in the reverberant sound level being increased which in turn will have a detrimental effect on intelligibility throughout the church.

Consideration should be given to having the Nave, Side Aisles, Presbytery, Chancel, and Choir Stalls as separate zones. Depending on how the installation has been wired, switching can either be done centrally at the equipment rack or locally at each loudspeaker position. Clearly, the latter is less convenient.

6 Induction loop system

6.1 Coverage

Induction loop coverage should be available in all areas likely to be occupied by potential users who rely on a hearing aid.

If for practical reasons, loop coverage must be limited to a specific area, then there should be clear signage to indicate the extent of the coverage. A prominently positioned note should be included in the various Orders of Service.

Parties who may be compiling an Order of Service for a specific event or service, (e.g. weddings and funerals) should be asked to include the loop coverage details – again prominently positioned. Hearing aid users who may be visiting the church for the first time can therefore be made aware of the coverage zone and seat themselves accordingly.

6.2 Loop drive amplifier

The drive amplifier associated with the induction loop system should be installed in the central equipment rack. Its position in the rack and the route of the aerial cable should be such that there is no risk of interference being induced on other items of equipment and cabling within the rack.

6.3 Music / ambience input

In addition to the induction loop amplifier having a speech input, consideration should be given to including a music / ambience input. The microphone / microphones used for such an input should be positioned so as to pick up the sound of the choir / organ / ambience of the church. Automatic switching should be included so that when a speech microphone is 'On', the music / ambience microphone is automatically switched 'Off'. Conversely, switching a speech microphone 'Off' should reinstate the music / ambience microphone automatically.

The facility will result in speech being more intelligible for induction loop users along with the music / ambient sound being enhanced. Also, induction loop users will not need to switch their hearing aid between speech (i.e. the loop) and music (i.e. the aid's in-built microphone) during a service nor will they need to adjust their listening level between the speech and music elements of a service.

6.4 Signal strength

Matters relating to the magnetic field strength (ie signal strength) of an induction loop system for hearing aid use are defined in a British Standard. The signal strength can be affected adversely by the presence of metal elements such as structural steel in the floor, under-floor and surface heating pipes, skirting heating, radiators, floor gratings, de-mountable staging, balustrades and handrails.

Care must be taken to route the cable throughout the area of coverage so as to maximise signal strength. In some instances, practical limitations may prevent the optimum signal strength being achieved. However, although not meeting the requirements of the standard, a usable signal strength is still likely to result.

6.5 Loop test receiver

An induction loop test receiver should be available so that periodic in-house tests can be carried out on the induction loop system. This avoids the need to rely on hearing aid users to report problems with the loop. Also, in the event of a complaint that the loop is not working, the receiver can be used to verify the validity of the complaint.

6.6 Hearing aids

Some hearing aids (especially the 'in-ear' types) do not include facilities for induction loop reception. This results from the inability to fit the induction loop receiving coil inside the aid. Users must therefore listen to all sound via the hearing aid's in-built microphone(s).

In some instances, users may have both a digital aid along with a conventional non-digital (i.e. analogue) aid. This can cause the user *'aural confusion'* as there will be very noticeable differences to the sounds heard by each ear.

7 Live music systems

7.1 General

The performance of 'live music' using a wide range of instruments now occurs in many churches as part of worship. Depending on the church layout, its acoustics, the location of the musicians, their number and the instruments involved, there is generally a need for the musicians to be reinforced or in some instances, it is necessary to amplify them.

It is important to ensure that the choice and positioning of the associated equipment is such that good quality sound with intelligible vocals can be achieved – all of this without the risk of feedback.

The use of the same system for the reinforcement of speech and music might be tempting. However, it is rarely practical on account of the more onerous needs placed upon the system by the music element.

Usually, a much more comprehensive microphone mixer is required. In addition, it is necessary for the loudspeakers to have a wider frequency range and a much greater power handling capability than those required for speech.

Some performers may need to bring their own sound equipment - either as a stand-alone system or to interface it with the installed facilities. The practical and interface implications of these situations need to be taken into account.

7.2 Control position

It is possible that in some churches, the speech reinforcement control position and the live music control position may be in different locations. In any case, it is important for the live music control position to be located so the operator has an unobstructed view of the performance area.

Assuming that the equipment is to be permanently rigged, it is essential to ensure that it is suitably installed and rack-mounted where appropriate. Care must also be taken to ensure that when not in use, the equipment can be made adequately secure both in terms of prevention against tampering and theft.

7.3 Microphones & stands

Microphones having a cardioid polar response give greater flexibility, especially when they are stand-mounted and are being used simultaneously by two or more performers, i.e. duos and trios. However, their polar response increases the risk of feedback. The greater the number of cardioid microphones in use – the more likely the feedback. The situation is further exacerbated depending on the location of the loudspeakers in relation to the microphones and whether or not foldback loudspeakers are also being used.

Given the above potential feedback situations, consideration should be given to the use of microphones having a hyper-cardioid response and ensuring that they are positioned as near the performers as possible so that their gain can be minimised. This combination of the tighter polar response and reduced gain will enable a greater number of microphones to be used simultaneously whilst at the same time reducing the risk of feedback. Careful positioning of foldback loudspeakers forward of the performers should minimise the feedback risk further.

As noted earlier, consideration should be given to the use of floor stands with a circular base and having a clutch action as opposed to the more usual friction action. Circular-based stands present less of a potential trip hazard than stands with tripod bases. However, in situations where it is intended to use a boom arm on a stand, a tripod base may be necessary for reasons of stability.

7.4 Line level inputs

In addition to microphone inputs, it is advantageous to have a number of line inputs to the system for use with keyboards and other instruments which have a nominal line level output.

7.5 Pick-up coils

Some performers make use of pick-up coils on their stringed instruments so as to avoid the use of microphones. The coil enables the output of the instrument to be connected directly to an input of a sound system.

Depending on the format of the coil, there can be interaction between it and an induction loop system. This is not a deficiency in the induction loop installation. When pick-up coils are used within (or in close proximity) to the electro-magnetic field radiated by induction loop aerials, it is essential for the instrument to be fitted with a '*hum-bucking'* pickup coil.

7.6 Cabling / stage boxes

There is usually a need for a number of circuits between the performance area and the control position. Some of the circuits will be associated with microphones whilst others will be line level circuits relating to keyboards and foldback loudspeakers.

Consideration should be given to the use of a multi-circuit cable (or number of multi-circuit cables) rather than having individual circuits which are more difficult to accommodate and usually end up looking untidy.

Care should be taken to ensure that a good quality multi-circuit cable is used (preferably of the 'starquad' type) so as to guard against the risk of external interference on the circuits.

The stage box should be of robust construction. In addition to the number of XLR-3 sockets for the microphone circuits, it should also contain a number of connectors for foldback circuits. In order to avoid the risk of confusion between the different circuit types, it is suggested that XLR-3 plugs or jack sockets be used for the line level circuits and that they be labelled accordingly.

At the mixer position where the multi-core breaks out to the individual circuits, each of the circuit tails should be clearly labelled in relation to the stage box. Also, the multi-core cable should be secured at the mixer so that its weight is not being supported by virtue of the plugs connected to the mixer sockets.

7.7 Loudspeakers

The performance of the loudspeakers necessary for music reproduction will differ from that of the speech reinforcement loudspeakers. The music loudspeakers need to have a wider frequency response and be capable of greater reproduction levels. Given the size of such loudspeakers, it is likely that they will be more difficult to locate both in terms of the practical and aesthetic implications.

Also, care must be taken in their positioning so that coverage of the listeners is maximised whilst at the same time, the risk of feedback from the musicians' microphones is avoided.

7.8 Foldback loudspeakers

In cases where foldback loudspeakers are used, great care must be taken to ensure their location is such that there is no risk of feedback with the musicians' microphones.

Where possible, they should be positioned close to the musicians. This will enable lower reproduction levels to be used which in turn will reduce the risk of feedback and help to minimise the reverberant sound level within the church.

Equalisation should be used to reduce the level of low frequency sound fed to a foldback loudspeaker. This will help to further reduce the risk of feedback whilst having little or no impact on the reproduced sound for the musician.

Where the foldback loudspeaker has an integral power amplifier, care should be taken to ensure that appropriate measures are taken to electrically protect the mains supply to the enclosure and physically protect the cable by suitable means.

7.9 Mains power & protection

In situations where musical instruments (e.g. guitars and keyboards) require connection to mains power sockets, steps should be taken to ensure that the sockets are connected to the same phase of the mains supply as other elements of the sound system.

Great care should be taken to locate mains power sockets and cabling so that performers are not standing on any mains power-related elements.

Performers should ensure that where their instruments require a mains supply, the rating of the fuse in the plug is appropriate for the load with which it is associated and not left as a 'standard' 13 amp rated fuse.

Similarly, where illuminated music stands are used and adjustable light fittings are positioned on keyboards, the fuses in the plugs should be appropriately rated.

All permanently installed mains power outlets should be protected by correctly rated fuses or RCDs (residual circuit devices). Also, ELCBs (earth leakage circuit breakers) should be included to ensure that the musicians are suitably protected from the risk of electric shock.

Musicians should also ensure that they have included the necessary isolating safety devices in any of their instruments which require a mains power supply.

7.10 Performance area - cable protection

The extent of surface-mounted cabling in the musicians' performance area can often be significant, this being a combination of microphone cables, foldback circuits, loudspeaker cables and mains power.

Consideration should be given to using rubber mats, extruded cable protectors and plastic crossovers as appropriate. The cables should be grouped so that they can be run more tidily and routed so that people do not end up having to stand and / or to walk on them. In addition to being much safer, the end result is also neater and avoids potential trip hazards resulting from loose cabling.

8 Video facilities

8.1 General

Given the widespread use of video as part of worship, it is essential to ensure that the choice and positioning of equipment is such that the images meet the viewers' expectations.

Of particular importance is the ability to be able to read the displayed text - be this from worship projection software such as SongPro or other programmes prepared specifically for a service by the vicar, church members, visiting speaker etc.

8.2 Control position / central equipment

Depending on the extent of the video facilities required, it may be possible for the central equipment to be installed in the vestry. However, a location which affords the operator a view of the screen / screens is to be preferred.

Steps should be taken to locate the control position so that it is visible to as few members of the congregation as possible. Failure to do this means that during the service or event, the control area becomes a visual distraction to those who can see it.

The central equipment should include provision for a range of inputs, e.g. a DVD deck, laptop / desktop pc, video camera(s), visualiser etc.

Given the value of video equipment, suitable steps should be taken in relation to its security. Opportunist thieves will concentrate on removing video equipment from churches in preference to the audio equipment.

8.3 Projection screen

Given the intention to use the screen for the display of text, the screen size must take account of the most distant viewers.

The vertical angle for persons in the front row to the top of the image area should not exceed 35 degrees and preferably be 30 degrees or less.

The screen material should be selected to give the highest level of brightness in terms of the horizontal viewing angle.

The overall screen size should be such that the image area is surrounded by a suitably wide non-reflecting black border.

The overall screen size should be such that in the event of edge curl, such curl will not encroach on the image area of the screen.

In the case of motorised screens, the screen should incorporate bracing so that in the extended position, the screen material is stretched so as to avoid any unevenness to the projection surface.

Care should be taken to ensure that when a screen is in the extended position, steps are taken to prevent it swaying backwards and forwards as might result from draughts caused by the opening of doors, heater fan-coil units etc resulting in the image going in and out of focus.

8.4 Video projector

Consideration should be given to the projector location in terms of access and the possible health and safety implications which may be involved.

Given the projection distance, the projector must be rigidly mounted to avoid the risk of the image on the screen being blurred as could result from vibration.

Care should be taken to ensure the projector fan does not increase the background noise in the church to a level at which the noise is intrusive.

Given the cost of the projector, its security must be taken into account.

8.5 Plasma & LCD screens

Careful consideration must be given to the method of mounting the screens. This relates not only to the aesthetics but also to the weight involved.

Given that the main purpose of the screens is for the display of text, the screen size must take account of the most distant viewers, taking into account the text size, its colour and the font being used.

Care should be taken to establish the optimum mounting height (i.e. the vertical viewing angle) so the sightline is not obstructed for seated or standing viewers.

The screens should be positioned so that windows and light fittings are not reflected by the screen, thereby making it difficult to view the image.

Screens must be positioned so that they do not become a hazard to people as they walk by them.

The screens can be regarded as a high risk item in relation to theft. Care should be taken to ensure that they are secure.

The mains power and video cables should be run to the screens in a neat and tidy manner. This also relates to the rear of the screens where the cables are routed to the various connectors.

For health and safety reasons and for ease of operation, consideration should be given to having the mains power to the screens switched remotely from say the control position so that when not in use, the power can be totally isolated to all screen locations.

8.6 Interference

The presence of an induction loop system can cause interference on video equipment and the video output from computers. This is normally in the form of disturbance to the video image. Appropriate steps must therefore be taken in relation to cable routes, mains earthing etc in order to eliminate the problem. The inclusion of video isolating transformers may also be necessary.

9 Cabling considerations

9.1 Cable containment

Consideration should be given to the installation of conduit or trunking as appropriate. This will protect the various cables from damage and from any effects to the outer sheath which might result from the cables being in close proximity to sand, cement, lime, floor cleaning chemicals etc.

If containment is to be installed, it should be re-wireable thereby enabling changes to be made for whatever reason at any time in the future.

Where cables are not being contained, care should be taken to ensure that factors such as their location, method of fixing etc do not result in any form of damage to the cables.

9.2 Cable segregation

Cables carrying low voltage signals should be segregated to ensure that their close proximity to cables carrying higher voltages does not give rise to induced hum, noise or other forms of unwanted interference on low voltage signals.

Care must be taken to ensure that cabling associated with services such as thyristor controlled lighting, discharge lighting circuits, motor start gear, motive power, thermostats etc are sufficiently far away from cables carrying low level signals, e.g. microphone circuits. As a guide, a minimum distance of 600 mm should be the target and long parallel cable runs should be avoided.

9.3 Microphone circuits

Each microphone socket should be wired as a separate circuit back to the central equipment location.

Consideration should be given to the use of a 4-core ‘starquad’ screened cable so as to minimise the risk of external interference and hum on the microphone circuits. Single or multi-core microphone circuits can be used as appropriate.

A ‘starquad’ type cable should also be used for extension microphone cables.

9.4 Line level circuits

If line level circuits are to be installed, each line level socket should be wired as a separate circuit back to the central equipment location.

A good quality twin-twisted screened cable should be used. If there is a risk of interference being induced on the cables, then a 4-core ‘starquad’ cable such as that used for the microphone circuits should be used.

9.5 Loudspeaker circuits

Each loudspeaker should be wired as a separate circuit back to the central equipment location. This provides greatest flexibility and enables the system performance to be maximised in terms of loudspeaker zoning, equalisation, reproduction levels and where appropriate - delayed audio.

9.6 Radio-microphone receiving aerials

Care should be taken to ensure that the receiving aerials associated with UHF radio-microphone facilities are positioned so as to provide coverage of the areas in which radio-microphones are likely to be used.

It is imperative that a good quality low-loss cable of the correct impedance be used between the aerials and the receiver. This may result in the cable diameter being sizeable (typically 12 - 15 mm) to minimise signal loss over the distance involved. Care must also be taken to ensure that the minimum bending radii of the cable are not exceeded.

9.7 Induction loop aerial

9.7.1 General

The induction loop aerial cable should be run so that in so far as it is practicable, it surrounds the perimeter of all areas likely to be occupied by potential users who rely on a hearing aid.

Where the loop cable is to be installed under a floor with future access being difficult, consideration should be given to installing 1 no. or 2 no. additional loop cables so as to provide spares in the event of one being damaged. Where a loop cable is to be buried in a floor, steps should be taken to protect its outer sheath against the long term effects of sand, lime etc.

In situations where it is necessary to run the aerial under carpeted areas, a copper foil tape can be used instead of a cable. A purpose-manufactured adhesive tape is used to secure the copper foil in place. The tape is cloth-based and has a message running through it warning of the foil's presence beneath it.

Care should be taken to ensure that the induction loop aerial and feeder cables are not run in close proximity to microphone cables given the risk of induced interference. This is even more critical in relation to video circuits.

9.7.2 Feeder cable

To reduce unwanted signal radiation and minimise power loss, a twisted feeder cable should be run between the loop drive amplifier at the equipment rack and the feed point of the loop. Where more than one loop is required to cover the floor area, it may be advantageous to have a separate feeder cable for each loop.

9.7.3 Loop aerial – cable and tape

As a guide, the cable used for the loop aerial should be a tri-rated type having a single core with a typical cross sectional area of 2.5 mm^2.

If for whatever reason, it is not possible to use a 2.5 mm^2 tri-rated cable, instead, a copper tape which is typically 18 mm wide and 0.1 mm thick (i.e. 1.8 mm^2) can be installed, e.g. beneath carpets.

9.7.4 Protection

Care should be taken to prevent physical damage to the loop aerial cable by the use of conduit or trunking.

Note – Such conduit or trunking must be plastic. The use of metal-based materials must be avoided as they shield the signal radiated by the aerial cable.

9.7.5 Signal strength

As noted earlier, the presence of metal elements in close proximity to the aerial cable can affect the loop system's performance, e.g. structural steelwork in the floor, under-floor heating pipes, skirting heating / pipes, radiators, floor gratings, de-mountable staging, balustrades, handrails etc. Care must therefore be taken to route the cable throughout the area of coverage so the required signal strength can be achieved.

9.8 Video circuits

Where cables are to be installed for use with video monitors and / or projectors, each outlet should be wired as a separate circuit back to the central equipment location.

The installed cable should be capable of carrying digital as well as analogue video signals.

Care must be taken to ensure that the minimum bending radii specified by the cable manufacturer are observed.

Given the presence of the induction loop facilities, it is essential to route video circuits such that the signal radiated by the loop does not cause disturbance to the images being displayed by the video monitors or the input signal to video projectors. This also applies to cables associated with hired video and cctv equipment being used temporarily in the church.

9.9 Data circuits

Consideration should be given to the advantages of installing a data cabling infra-structure (such as Cat 5E) between the central equipment rack and a number of locations. This would provide a convenient and simple means of distributing data, audio and video signals around the building. Appropriate interface units for each type of signal would be required at each end of the circuit.

9.10 Mains power – dedicated supplies

A dedicated mains supply (assume a 13 amp switched socket outlet) should be installed at the central equipment location.

If provision is being made for the installation of video monitors (permanent or hired), consideration should be given to the inclusion of dedicated mains outlets at the monitor locations / data points. As noted earlier, it would be desirable for such outlets to be switched from the central equipment location.

10 Implementation

10.1 Fixings to the fabric

In any situation where it is necessary to secure cabling, containment or items of equipment to the structure, all fixings must be in mortar joints unless otherwise agreed. Regardless, all fixings should first be discussed with your inspecting architect and the methods of fixing the various elements to the fabric agreed.

10.2 Dimensions and fixings

The contractor should provide dimensional details of equipment, along with methods of fixings and weights. The dimension and fixing information should be shown on a drawing or be in the form of a schedule. Your inspecting architect should be asked to comment on the information before the contractor proceeds.

10.3 Weights

Where parts of the installation are built into walls or attached to the building by whatever means, details of all the dead and live loads for the items being installed should be submitted.

The weight details should be submitted in the form of a schedule, identifying the location of the item, a description, its weight and the number of items involved. Your inspecting architect should be asked to comment on the information before the contractor proceeds.

10.4 Steelwork

In cases where the contractor is providing steelwork, e.g. trunking support brackets and hangers, projection and video projector mountings, video monitor support frames etc, he must satisfy himself that such supports are adequate. In addition, he should provide details of all the dead and live loads for the elements which are being installed. Your inspecting architect should be asked to comment on the information before the contractor proceeds.

10.5 Labelling

The contractor should ensure that free and fixed connections and all controls of the installation are properly and permanently labelled in a clear and unambiguous way.

All cables should be labelled by suitable permanent means with the method of labelling being unambiguous. Methods such as the use of insulating tape or tie-on labels with written details should be avoided. A means such as numbered / lettered cable sleeves which are coloured differently to identify the various cable types or a proprietary heat-shrink based labelling method should be used.

A schedule should be supplied which shows the identity which has been given to the installed cabling. The information should be presented in such a way that the methods will be clearly obvious and easily understood.

11 Testing, commissioning & training

11.1 Testing

Ensure the contractor is responsible for rectifying any defects in workmanship, materials, maladjustments, performance or other irregularities which become apparent during his programme of tests.

11.2 Commissioning

Once the contractor has commissioned the system, he should provide the necessary test equipment and demonstrate to the interested parties that the performance parameters have been met. Where the satisfactory performance of the system elements is not based on measurements, he should demonstrate the operation of the facilities to the satisfaction of the interested parties.

11.3 User training

Once the demonstration of the system has been completed and assuming it has been acceptable, the contractor should instruct the users in the proper operation of the facilities which he has installed. In his submission, he should identify the duration he has allowed for the instruction period.

Prior to the user training, the contractor should submit a syllabus to the interested parties which identifies the issues which will be covered in the training session.

12 Warranty and maintenance

12.1 Warranty

Ensure that the contractor provides a full guarantee of the installation for at least one year. In the case of proprietary and purpose-manufactured elements, the guarantee should be not less than the period offered by the manufacturer.

During the warranty period, ensure that the contractor will be responsible for all costs including labour and parts (and replacement if needed) necessary to ensure that all of the elements are maintained in full working order throughout.

12.2 Maintenance contract

Maintenance contracts are expensive and provide no guarantee of system reliability. All too often, disturbing elements of an otherwise working system increases the risk of subsequent failure, the direct opposite to what maintenance is intended to achieve.

Having a visit or possibly two visits from a contractor annually to check over the elements of the system likely to develop faults as a result of ‘wear and tear’ is a sensible approach. For example, cabled microphones, extension microphone cables, lapel radio-microphones, hand-held stand-mounted radio-microphones and floor stands are more prone to damage than actual failure.

The cost is best covered on a time and materials basis rather than a ‘lump sum’ which in general is a significant cost and does not represent value for money.

13 Documentation & final information

13.1 Instruction manual

Ordinarily, a contractor will supply a single copy of the manufacturer's manual / data sheet associated with each item of equipment which has been supplied / installed. If you require additional copies, these can either be copied or in many cases downloaded from the manufacturers' websites.

13.2 Instruction card

The contractor should be asked to provide 3 copies of a basic *'Instruction Card'* for use by non-technical people which describes the operation of the facilities in a simple step-by-step format.

13.3 Record of settings

The contractor should be asked to include a chart on which the settings of all the system controls are noted as they were at the time of commissioning. In the event of any controls being disturbed in the future for whatever reason, it will be possible to get back to the commissioned settings.

13.4 Software backup

If any of the installed elements is software-based and has been programmed to meet the church's specific requirements, ensure that the contractor supplies typically two copies of the programme on CD or memory card as appropriate.

Each CD / memory card should be clearly labelled in terms of what it contains and be dated. Any time the programming is updated for whatever reason, ensure that replacement repeat CDs / memory cards are obtained and that previous copies are destroyed so as to minimise the risk of incorrect programmes being inadvertently used.

13.5 Additional information

There is additional information which can be very useful in the longer term. Clearly, the production of such information takes time and the contractor will therefore make a charge for it. In some instances, the parish may feel that the costs cannot be justified and will choose to do without such information.

If it is required, the following 3 elements of information and documentation should be submitted within 30 days of the installation being completed.

13.5.1 Documentation

The contractor should be asked to supply 2 copies of a manual which should include manufacturers' specifications, circuit diagrams, system schematics, along with cable type details, labelling etc and where relevant – maintenance instructions for each item of equipment.

Having all of the manuals in a single document makes reference to them easier and reduces the risk of individual manuals being lost / mis-placed etc.

13.5.2 Drawings

The contractor should be asked to supply 3 copies of ‘As Fitted’ drawings showing connector panel and equipment locations, mains power points and the inter-connections between the various system elements

13.5.3 Electronic format

In addition to hard copy ‘As fitted’ drawings and cable diagrams, these along with the working drawings and any other related drawings should be submitted in electronic format on CDs using an industry-standard CAD software package. The CAD drawing format should be agreed with interested parties. At least 2 no. copies of the CD should be submitted.

3 June 2013