



Technical and Functional System Requirements for AV equipment

Best Practice Document

Produced by UNINETT led working group
on AV
(No UFS119)

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May 2010

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Document No: GN3-NA3-T4-UFS119
Version / date: May 2010
Original language: Norwegian
Original title: "UFS 119: Technical and Functional System Requirements for AV Equipment"
Original version / date: Revision 1.71 of 20 May 2009
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UNINETT bears responsibility for the content of this document. The work has been carried out by a UNINETT led working group on audio-visual (AV) as part of a joint-venture project within the HE sector in Norway.

This translated version is based on the Norwegian counterpart approved by the Norwegian HE sector on 20 May 2009 after an open consultation period of four weeks.

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The translation of this report has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n°238875, relating to the project 'Multi-Gigabit European Research and Education Network and Associated Services (GN3)'.



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Executive Summary

This document is a shared supporting document for UFS 116 and 120. These documents specify functional descriptions for recommended Audio-Visual (AV) equipment solutions at universities and colleges. In UFS 119, there are technical and functional system requirements for the various components included in the functional descriptions.

INTRODUCTION



Directed by the GigaCampus program, UNINETT has established a workgroup for AV equipment. The workgroup has participants from universities and colleges throughout Norway, UNINETT and the consultancy firm, COWI.

Trade specifications (UFS) providing functional descriptions for recommended solutions for AV equipment at universities and colleges have been developed. The agreed upon solutions are based on the experiences of the members of the workgroup.

UFS 119 is a shared supporting document for the functional descriptions outlined in UFS 116 and 120. This document provides detailed technical and functional system requirements in order to ensure that system solutions and offered equipment maintains correct quality and functionality. The document is not meant to be used independently of the other UFS documents included in the documentation from the AV equipment workgroup.

In order to keep the recommended solutions up to date regarding technological developments, UFS 119 is intended to be updated more frequently than the functional descriptions of the other UFS documents. Check <https://ow.feide.no/gigacampus:av> to ensure that you have the latest version.

This document should be included in the basis for tender when ordering/contracting new AV systems. It is also a relevant basis for upgrading existing systems, and for budgeting during the planning period.

1 Document map

UFS 116: Functional description of AV equipment for classrooms and meeting rooms outlines recommended solutions for equipment for various types of rooms. In addition, the document also contains information that forms a useful foundation for planning and evaluating relevant solutions, and suggestions for describing user interfaces. The term class room includes all types of auditoriums, seminars, class rooms or communication rooms primarily used for lectures or communication. Meeting rooms include meeting rooms and rooms intended for study groups or other student-led activities, often flexibly furnished and adapted for various areas of usage.

In addition, two supporting documents have been developed:

UFS 119: Technical and functional system requirements for AV equipment outlines necessary requirements for ensuring the correct quality and uniform solutions. This document is assumed to provide the basis for all purchases, regardless of complexity or size. The document will be updated about twice a year.

UFS 120: Systems for operational support and transfer of audio and video concerns shared resources for several rooms utilized in connection with operational support and the external/internal transfer of audio and video (monitoring and remote control of AV systems, streaming of lectures, multi-party video conferencing, info systems, etc.)

TECHNICAL AND FUNCTIONAL SYSTEM REQUIREMENTS



The following chapters describe requirements for components and solutions as described in UFS 116 and 120.

All technical functional requirements and regulations are superior any detail solutions provided by drawings and quantity lists. The vendor of the AV equipment will be fully responsible for ensuring that the completed installation comply with the described functional requirements. If the bidder regards the technical specifications for any item as insufficiently exacting, he will offer equipment that will achieve the collective goals.

Functional requirements apply before specific technical requirements, and the overall system requirements apply before the requirements for single components.

All the offered equipment must be adapted thoroughly to the surroundings it is meant to function in.

Text in italics indicates comments to the system requirements that must be adapted for each individual installation.

2 Overall system requirements

This chapter describes some of the overall requirements and shared requirements for the various system components, including requirements for tagging and documentation. Remaining requirements are specified under the various chapters; sound systems, video systems and control systems (chapters 3-5). Requirements for solutions for remote education and video conferencing are collected in chapter 4, Video System.

2.1 Regulations

The installation is to be performed according to national regulations for electrical and telecommunications installations, as applicable.

2.2 CE Labelling

All equipment tendered is to be CE labelled according to relevant directives. Records stating that all relevant equipment is CE labelled and documentation for this must be available on request by the employer within three days.

2.3 Energy consumption

When selecting components, energy consumption for both standby and normal operation is to be emphasized. The AV supplier will especially ensure that video projectors, flat panels, audio amplifiers and active loudspeakers have the lowest possible energy consumption while in standby mode. Preferably, audio amplifiers and active loudspeakers will utilize Class D technology.

2.4 Selectivity

Regarding immunity against radiated radio energy, the normal requirements may prove to be inadequate for a number of special circumstances. This is because cell phones may get so close to certain equipment that even the 10 V/m limit is exceeded. It is necessary to require that cell phones may be utilized in all public areas, without causing functional disturbances.

The public cannot be expected to refrain from using personal, mobile, telecommunications equipment (cell phones, etc.) in areas where they are legally allowed to stay. All technical equipment that is permanently installed in these areas is therefore required to have sufficient immunity against radio signals of this type. It must be tested at a field intensity up to 100 V/m if the distance to a mobile radio transmitter can be less than 0,5 m.

2.5 Requirements for equipment in rooms with audio equipment

Technical equipment must not emit audible distortions, resonance or similar, even at high sound levels in the room.

2.6 Acoustic set noise from equipment

Maximum A-weighted noise levels from equipment used for AV systems (video projectors, fans, motors, etc.) must not exceed $L_{\max} = 30$ dBA at a position in the audience, more than 3 meters away from the interference source (air distance), at normal usage. Equipment only utilized for short periods of time (screen, curtains, etc.) must not exceed $L_{\max} = 45$ dBA.

If this requirement demands special mounting solutions etc., not taken care of by the AV supplier, this must be clearly stated in the tender.

2.7 Circuit installation and termination

Wires with differing signal types are to be kept in separate conduits whenever possible. Wires with the same signal types are to be gathered together. Wires for low-level audio must not share a conduit with other types of wires. See UFS 102, chapter 2.5 Separation requirements (https://ow.feide.no/media/gigacampus:ufs102_eng.pdf).

Shielding and transposition must follow the leads all the way to the point of connection (< 15 mm), and measures must be taken to prevent the shields from touching one another or other metal components. At the point of connection, sufficient wire ends are to be left to be able to reach the point of connection in an orderly manner, and to be able to redo the work at least twice.

Wiring of mobile furnishings is especially vulnerable for wear and tear. Chord anchorage must be utilized, as well as cable types that are capable of high mechanical loads. Cable sleeveings must be used where two or more cables are gathered.

All wiring is to be dimensioned and executed in a manner that, together with the relevant connected equipment, complies with EU's EMC Directive (see http://ec.europa.eu/enterprise/electr_equipment/emc/).

2.8 Grounding and EMC

Correct grounding is a premise for achieving good EMC conditions.

Grounding and shielding must comply with the guidelines for grounding according to the standards in EN 50174 Information technology – cabling installation and EN 50310 Application of equipotential bonding and earthing in buildings with information technology equipment.

In order to ensure proper grounding, it is vital that the contractors responsible for the wiring are well aware of the principles for grounding as set out in the references cited over. Handling/termination of shielded cables, wiring communication rooms, and rack grounding is especially important areas.

2.9 Implementation

Technical solutions, panel design, etc., must be approved by the owner before implementation. Solutions with a bearing on building appearance must be submitted to the architect. Equipment mounted in a way that is visible to the audience must be adapted to the surrounding furnishings in both design and colours, as far as this is practically possible. (Pay special attention to furniture, racks, loudspeakers and other wall-mounted equipment.)

All changes of equipment and solutions compared to the original tender must be communicated to the owner well before implementation. The owner may oppose the changes unless the equipment in question has been taken out of production or similar. If so, the replacement must at least be of equivalent quality, and the owner will make the decision if the quality is equivalent.

2.10 Reliability and availability

It is vital that solutions and components are chosen with a regard to achieving the greatest possible reliability and availability for AV systems, even if they are viewed as non-critical systems.

Central components and other components valued at over EUR 2.000 must be able to maintain normal operation (technical lifetime) for at least 5 years. The supplier must be able to support and supply spare parts during this time period. A special focus must be directed to power supplies for the various components. Remaining tendered equipment must, as far as possible, also comply with the above-mentioned requirements. If a single product is offered that cannot be expected to comply with the above-mentioned requirements, this must be clearly stated in the tender. Otherwise, it will be assumed that the requirements will be complied with.

The systems must be designed in a way that makes it uncomplicated to utilize basic functions (normally a laptop and a video projector) even if some of the central equipment is out of order.

The AV system is to return to normal operation after a power failure. The necessary initialization commands for the various components must be entered into the control system, if needed.

Software reliability (control systems) is related to the number of unwanted restarts per year.

Control systems must not have more than 2 unwanted restarts per year

See specific requirements under the individual system components.

2.11 Panels and rack enclosures

In general, panels and flush mounted boxes should be made of metal. All connectors must be installed so that none of the signal conducting parts (including grounding and shielding) have a conducting connection to panels or flush mounted boxes. All wires are directly connected to the connectors. All conductors (grounding and shielding included) are kept separate. The panels are not to be grounded. It must be ensured that the system only has one-sided grounding in order to avoid ground loops.

The functional description does not provide the exact number of outlets and connections for the various panels. This will be detailed by the bidder/contractor.

A lot of the equipment should be mounted in a 19" rack enclosures. All user operated buttons/switches must be accessible on the front panel. The units should be designed as 19" standard units, be equipped with 19" or fixed in 19" panels or shelves.

The rack enclosures should be supplied with the necessary fastening devices, conduit systems, distribution panels for outlets, etc. Blank panels for all unused 19" openings are to be included in the delivery.

Any side and back panels for the rack enclosure should be detachable for suitable access during service. Any front panels should be transparent, with space on the inside for connections in bays on the front of the rack enclosure, where relevant. Rack enclosures mounted visibly in rooms with public access, should have a black finish for all tracks, blank panels, fixing brackets, shelves, screws, etc.

Units with important settings that are accessible to, but should not be operated by, the user, should be covered by a transparent front cover, only removable with tools.

The rack enclosures are to be supplied adapted to the allocated space, but always sufficiently large for the tendered equipment, relevant source equipment not included, plus an additional 20 % extra space – a minimum of 4U. Where little height is allocated, it will likely be necessary to use two widths. If the allocated space is not sufficient, it is to be discussed with the owner during the detailing phase.

Rack enclosures that must be mounted in niches and similar must have wheels and must be able to be pulled out on the floor for servicing. Wiring of these rack enclosures must be implemented in a way that makes this possible.

Rack enclosures visibly mounted in rooms with public access should be highly aesthetic, especially the fronts and doors. A photo should be included of the type of rack offered for visible mounting in rooms with public access.

For central and playback equipment etc. that must be mounted in cabinets/shelves on the wall or in lecterns, tracks fastened to the side panels must be utilized. Apart from this, the requirements described above for fixing and implementing the mounting, are in effect.

The AV supplier is responsible for ensuring adequate cooling of rack-mounted equipment. Sufficient air circulation internally in the rack enclosure must be provided, in order to ensure that the operating conditions for all equipment complies with the temperature requirements in the data sheets from the manufacturer. The internal temperature in the rack enclosure must not exceed 30 C, measured during normal operation at a central position at the top of the rack enclosure, given an ambient temperature of 20 C. The measurements are to be carried out after leaving the equipment on for a minimum of 4 hours. The AV supplier should perform spot checks in connection with the commissioning of the system, and is responsible for implementing any improvements/adjustments in order to satisfy the above-mentioned requirements.

If fans or similar is regarded as necessary, they are to be included. Please note that the requirements for noise levels in rooms with public access still have to be complied with (see chapter 2.6 Acoustic set noise from equipment.) Placement, mounting and choice of fans should therefore be emphasized.

The AV supplier is responsible for indicating any problems with cooling or air circulation due to building conditions or other technical installations to the owner. The total power output for rack-mounted equipment should also be supplied on request, as a foundation for planning the ventilation/cooling system.

See also UFS 108 " Krav til ventilasjon og kjøling i IKT-rom" (Requirements for ventilation and cooling for rooms with IT equipment) (https://ow.feide.no/_media/gigacampus:ufs108_eng.pdf).

If lockable rack enclosures for rooms with public access are desired, the following additional requirements may be included:

All rack enclosures that are accessibly mounted in rooms with public access should be lockable, including the side and back panels. Grooves should be routed in the lock case of the front door for inserting a cylinder for a system key. The cylinder is not included in the AV delivery, but the routing is to be performed by the AV supplier. For the side/back doors a standard rack key is utilized which can be hung inside the rack enclosure.

Rack-mounted equipment for lecterns should be secured with a lockable cover of the rack rail fixing screws. The cover should be padlock-adapted, but the padlock is not included.

2.12 Lecterns

The following recommendations form the basis for the design of lecterns, but please note that the design must be adapted for each installation. It should be evaluated which rooms should be equipped with lecterns that can be raised/lowered. See UFS 116 chapter 4.1.

Lecterns should be designed with a view to a functional and clear operation of the AV equipment placed in the furnishings. Conduits and connections for mobile equipment should be designed in a way that makes easily accessible all connectors meant for user access, while cables and fixed connections are hidden as far as possible.

All equipment that the lecturer needs to reach is placed in the lectern. The width is adapted to the equipment to be installed in the lectern. Space for scripts/notes must also be allocated. The depth should be 800 mm, if there is available space on the presentation area. The minimum depth is 600 mm.

Manuscript holders should be 400 mm wide, and be placed on the lectern without being fixed.

The raising/lowering for the lectern should include both the tabletop and equipment shelving/cabinets. The height of the tabletop should minimum be adjustable between 700 and 1100 mm.

Rack-mounted equipment and PC's should be mounted under the tabletop. It is important to ensure that PC's and other equipment mounted in the furnishings have adequate cooling and that the equipment is easily accessible for servicing/inspection. The front cover should be easily slideable/removable for access.

Equipment placed on the lectern should as far as possible be placed permanently. Cables for connecting mobile equipment (laptops, etc.) should be permanently connected to the lectern with jacks accessible from the tabletop, but mounted in a way that makes the cables fall into place under the tabletop when the connections are not in use. Connections for other equipment across the tabletop are placed in a cable duct on the front cover.

The furniture should be supplied with the necessary lighting for manuscripts etc. It is preferable to utilize mini halogen/LED lighting mounted on a flexible gooseneck fixed permanently to the furniture. The lighting also covers unfixed manuscript holders.

All cables for connecting lecterns should be placed in a shared cable sleeving and plugged into outlets in the floor/wall. Chord anchorage must be utilized, as well as cable types that are capable of high mechanical loads.

It should be endeavoured to design the furniture to not be visually dominant for the audience. The AV supplier should develop outlines for the design and placement of the equipment in the furniture. The solutions should be adapted in cooperation with the architect/interior designer and the users.

2.13 Tabletop interconnect boxes

All cables between desk and floor outlets should be placed in a shared cable sleeving and connected to the floor box. Chord anchorage must be utilized, as well as cable types that are capable of high mechanical loads. The floor box should have one socket per tabletop box. If the conference table is to be moved, the tabletop boxes must be able to be disconnected from the floor box.

For rooms without floor boxes, the cables should be guided over the floor in an external cable duct. Tele-power poles are normally not used.

The boxes should be mechanically sound and have a high esthetical value.

Solutions should preferably satisfy the following requirements, but alternative solutions may be offered: Cables for connecting mobile equipment should be permanently connected to the table with jacks accessible from the tabletop, but mounted in a way that makes the cables fall into place in the tabletop box when the connections are not in use. For electrical outlets, fixed sockets are mounted in the tabletop box. The tabletop boxes should be mounted flush with the tabletop and have a fixed lid that can be slid down into the box. The lid and tabletop should form a flush surface when the tabletop box is not in use.

The bidder should include photos of the tendered equipment/solutions.

For tabletop boxes with only electrical outlets, fixed sockets are mounted in the panel/box under the tabletop. A loose lid with brushes for cable pass-through is accepted. For boxes with only electrical outlets, integrated boxes in the conference tables may be used.

The AV supplier is responsible for coordinating the design and adaptation of the conference tables in consultation with the supplier of the furnishings.

2.14 Floor boxes

Mounting frames with connectors in floor boxes must be carefully planned in order to ensure robust solutions with good functionality.

All connectors are to be logically grouped together with all connections for each equipment type placed together, and follow the same principle for each box and between the various boxes. (For instance, audio, video and computer networking are to be placed together, preferably with the same internal placement if there are several outlets for the same equipment type.)

The mounting frames should be placed deep enough into the box, and the outlet housing angled if necessary, to make it possible to put the lid on with all the equipment connected without connectors or housing being squeezed. (Often, because of narrow cable outputs in the lid, it will still be difficult to get the lid all the way down into the lid compartment.)

Standard connectors are to be utilized for all equipment if practically possible. Multi-connectors are only accepted where standard connectors cannot fit in the box, or where there are other reasons for putting various outputs in one connector, and are only to be utilized after approval from the owner.

Standard accessory plates can be utilized if this renders possible a solution satisfying the above-mentioned requirements, but often custom made mounting frames must be used.

2.15 Connecting free-standing furnishings in rooms without floor boxes

A cable duct or sleeving is utilized for extending cables between free-standing furniture and wall outlets where floor boxes or floor conduits are unavailable.

For conference tables or lecterns that should be able to be moved or disconnected, a shared cable sleeving is used, placed loosely on the floor. Connection panels are placed on the wall or in wall ducts.

For free-standing tables with a permanent place, a cable duct fastened to the floor with double-sided tape, or similar, is used. The duct must provide sufficient protection for the cables against kicking and trampling and should be of a design that reduces the risk of tripping over the duct.

2.16 Power supply

All the supplied equipment should be designed for 230 V power supply.

For equipment mounted in rack enclosures or lecterns, it is assumed that the AV supplier both supplies and mounts the electric power distribution panel. The distribution panel is connected to an electric outlet on the wall or in the floor box via a mobile cord or outlet. Floor boxes and connection panels on the wall for free-standing furniture are presumed usually installed with only one electric outlet per tabletop box/lectern.

Batteries are only accepted where cables are undesirable or pointless due to the function of the device. Rechargeable batteries should be of a type that can endure random charging.

2.17 Labeling

The AV supplier is responsible for labelling all connections and operating devices in a manner that ensures an interface that is easily understood and unambiguous.

The choice of labelling system must be adapted to other contracts.

The following labelling needs to be implemented:

- Labelling of devices stating the function of the device and its place in the system.
- Self-explanatory labelling of operational devices.
- Labelling of devices with signs stating the manufacturer, designation of type and compliance certificate (emblem) for equipment subject to special approval requirements.
- Primary labelling of cabinets and centrals.

- Information about the commissioning date and the name, address and phone number for repair and maintenance services.
- Labelling of all cables to/from distributors and centrals.
- Labelling of all terminal clamps/strips/blocks in distributors and centrals (with list no. /block no. and sequential numerical labelling for terminal strips/blocks).
- Labelling of the real circuit and rising main at both ends and on each side of the fire barrier.
- Labelling of all junction boxes and other junction points in the wiring.
- Labelling of electro technical installations according to national regulations.

Labelling of the system in a manner that provides unambiguous and durable information ensuring the correct operation and usage of the system is to be emphasized. The lifetime for the labelling equipment utilized should at least equal the lifetime for the individual device/component that is labelled.

If certain devices have no room for the described labelling, this is to be discussed with the owner with suggestions for which labelling should be prioritized.

2.18 Documentation

2.18.1 Documentation of tendered equipment

Technical documentation, technical data sheets for tendered equipment, apart from ordinary system material, make up an important part of the basis for evaluation and should be handed in together with the tender.

Technical data sheets should include:

- Data on the tendered equipment
- Area of application for the equipment
- Function
- Photo and an indication of the physical dimensions and colours
- Any environmental requirements where the equipment is installed.
- A functional diagram showing how the equipment should function together

Access is to be granted to system manuals and user manuals for all equipment included in the delivery.

In case of missing or erroneous information the cost of correction will be charged the contractor.

2.18.2 Documentation at equipment delivery

In connection with equipment delivery, the following documentation must be available:

- Fitting instructions with exploded view drawings.
- Connection table and wiring diagram.

There is a general requirement that the AV supplier of his own accord should evaluate and suggest alternative device types if developments after handing in the tender have led to the tendered device types being outmoded or replaced by new and improved products. This should happen within a reasonable amount of time before the installation starts.

2.18.3 Documentation at system handover (operation & maintenance manual)

All relevant information about the completed installation should be supplied on paper and any supplemental information should be in a digital format. (Drawings in DWG format.)

The operation & maintenance (O&M) manual should cover all components and systems in way that is easily understood.

The documentation on paper should be delivered in 3 copies in A4 binders, divided into paragraphs, together with a CD/DVD with an electronic version unless otherwise agreed upon.

The following is to be supplied:

- A complete set of updated plans corresponding with the completed installation. The drawings should include wiring and labelling of the installed components.

- Updated schematic drawings corresponding with the completed installation and with the necessary detail information included.
- Any detail drawings etc. developed by the AV supplier corresponding with the completed installation.
- Connection table/wiring diagram updated after implementation and labelling of terminal strips, terminal blocks and other junction points.
- List over components with part numbers.
- Product information with information about materials and composition of the products. Any hazardous substances utilized should be listed separately.
- Maintenance overview with dates as well as a basis for calculating the cost of maintaining the equipment.
- Oral instructions for users as well as for operational and maintenance personnel with information about operational, maintenance, auditing and cleaning routines.
- Separate user manuals for operating the AV system are to be developed, where the complexity of the equipment makes clear labelling insufficient. It is still our objective that the configuration of the system, the control system, user interface and labelling is implemented in a way that makes separate user manuals redundant.

The O&M manual should be delivered to the owner at the commissioning of the system.

If the contractor does not deliver the O&M manual specified within the time limit, the owner is entitled to have the documentation developed and charge the costs to the contractor. Similarly, the owner is entitled to keep back a certain amount of the final settlement if a satisfactory O&M manual is not handed over at the specified time. The owners cost in getting the missing documentation developed will be covered by the held back settlement.

The outline of the O&M manual is handed in to the owner one month before the commissioning of the system at the latest.

2.19 IP protocols

In the education sector, both Internet Protocol version 4 (IPv4) and Internet Protocol version 6 (IPv6) are in use. When the document refers to IP, this includes both IPv4 and IPv6. In the tender, certain reservations have to be made where the equipment does not support both protocols.

3 Sound system

3.1 Audio quality

Technical quality requirements are in general referring to IEC 268 if nothing else is specified. The requirements are mainly based on Nordtest Method NT ACOU 108 "In Situ Measurements of Permanently Installed Public Address Systems."

Acoustic remaining noise (buzzing, hum, etc.) from the sound system is not to exceed 25 dBA. Noise is measured at the normal rest position.

Please note that the specified technical quality requirements are not always sufficient for ensuring a satisfactory subjective audio quality. The shape of the room, the acoustic conditions and the remaining characteristics of the loudspeakers is also of vital importance for the sound quality experienced. All loudspeaker systems, including amplifiers, should be adapted to the shape of the room and its usage and be dimensioned with an emphasis on a high level of naturalness, constant sound pressure coverage and adequate output capacity.

The requirements below are recommendations to be used in most rooms intended for regular instruction, teamwork, meetings, etc., but should in some cases be adapted to the shape of the rooms and their use.

3.1.1 Vocal amplification

For vocal amplification systems the following main requirements exist:

- All microphone mixing should be automatic. The vocal amplification system should be equipped with frequency smoothing, dynamic limiter and signal delay.
- The system should be able to produce a constant, enduring sound pressure level at $L_{eq} = 90$ dBC (± 3 dB).
- The acoustic frequency response should be within ± 3 dB in 1/3 octave bands between 120 Hz and 10 kHz. Below 240 Hz and above 5 kHz a roll-off of up to -3 dB per Octave is also accepted.
- The system should, in the 2 kHz octave band, give a direct sound coverage with evenness within +3/-6 dB.
- The above requirements should be met for at least 90 % of the audience.
- Vocal clarity measured without people present should be a minimum of $STI = 0,7$ for the entire audience area, except for the two front rows. For these areas, down to $STI = 0,55$ is accepted for sound from the sound system alone (without direct sound). For auditoriums, down to $STI = 0,55$ is accepted also for the four front rows in the corners.
- Under these conditions there should not be any audible distortion. The electrical distortion should not exceed 1 % Total Harmonic Distortion (THD.)

3.1.2 Program audio

For program sound systems in classrooms, there are the following primary requirements:

- The system should be able to produce a constant, enduring sound pressure level at $L_{eq} = 100$ dBC (± 3 dB).
- The acoustic frequency response should be within ± 3 dB in 1/3 octave bands between 70 Hz and 12 kHz. Below 140 Hz and above 6 kHz, a roll-off of up to -3 dB per octave is also accepted.
- The above requirements should be met for at least 90 % of the audience.
- Under these conditions there should not be any audible distortion. The electrical distortion should not exceed 1 % Total Harmonic Distortion (THD.)

For combined sound systems with flush mounted loudspeakers in the ceiling, the above-mentioned requirements for vocal amplification apply. Additionally, requirements for program sound systems are to be met, but the requirement for the sound pressure level is reduced from 100 to 95 dBC.

3.1.3 Loudspeaker solutions for smaller rooms

For loudspeaker solutions in smaller rooms with flat panels/projectors, there are the following primary requirements:

- The system should be able to produce a constant, enduring sound pressure level at $L_{eq} = 90$ dBC (± 3 dB).
- The acoustic frequency response should be within ± 3 dB in 1/3 octave band between 100 Hz and 12 kHz. Below 200 Hz and above 5 kHz, a roll-off of up to -3 dB per octave is also accepted.
- The above requirements should be met for at least 90 % of the audience.
- Under these conditions there should not be any audible distortion. The electrical distortion should not exceed 1 % Total Harmonic Distortion (THD.)

3.2 Selection and verification of loudspeaker solutions

The selection of loudspeaker solutions (type, angles and quantity) depends on the tendered loudspeaker type, room size and reverberation time. Solutions for larger auditoriums should be verified by using suitable calculating programs (i.e. EASE®, Odeon®, CATT Acoustic®, BOSE Modeller®, CADP2® or similar). For the remaining rooms with vocal amplification, it is sufficient to draw the coverage radius (-6 dB) for the tendered loudspeaker type at head level for the octave bands 250 - 2000 Hz.

If adequate drawings and information about room acoustics (reverberation time) are unavailable when the tender is sent out, an adjustment of the solutions before commissioning must be expected.

The loudspeakers should be directional and as far as possible ensure a uniform direct sound level in the audience area, radiating as little as possible to other areas.

The documentation of the executed calculations of coverage etc. should be submitted to the owner before the system is implemented. If the tendered solution turns out not to meet the system requirements, it is the responsibility of the AV supplier to adjust the solution to make it meet the requirements.

3.3 Loudspeakers

In the quantity lists the term "central loudspeaker group" might be utilized. This means that a combination of loudspeaker units covering the function is to be offered. It is possible that the functional requirement is covered by a single cabinet.

3.3.1 Ceiling speakers

Ceiling speakers should be mounted flush with the ceiling.

Ceiling speakers should be 2-way speakers with a minimum of 6,5" woofers. For rooms with a varying distance between ceiling and audience, the choice of speaker types and impressed output is adapted to these conditions, to ensure a sound pressure level that is as constant as possible throughout the coverage area.

3.4 Headphones

For headphones the following requirements apply:

- Sensitivity: Min. 95 dB sound pressure level at 100 mW input power.
- Max. sound pressure level approx. 100 dB.
- THD < 0,2 %.

3.5 Induction loops - solutions for the hearing impaired

All induction loop systems in rooms with vocal amplification should be based on overlapping, phase-shifted individual loops. For technical quality requirements, refer to IEC 60118-4 Ed. 2.0 b:2006.

Induction loop systems should be dimensioned for:

- Field strength 100 mA/m long-term average, 400 mA/m peak value
- Frequency response 100 - 5.000 Hz (± 3 dB relative 1 kHz)
- Distortion < 3 % (200 - 2.000 Hz)

The requirements should be met for at least 90 % of the loop area for heights of between 1,1 and 1,3 m above floor height. A coverage plan should be submitted showing the areas that meet the requirements with an indication of where the level is respectively higher or lower. The plan should be framed and posted together with a standard induction loop symbol at the entrance of rooms equipped with this.

The induction loop system should reproduce the sum of the speech and program audio and should be adjusted in relation to the standard level when using vocal amplification. Program audio should be balanced in relation to speech to ensure that their mutual relation is natural. The induction loop should have the necessary controls for level, tone control and dynamics.

3.5.1 Portable induction loop units

Portable induction loop units should be able to be used in connection with stationary loops.

In a combined unit, a wireless microphone and an induction loop amplifier should be able to be carried to the room that has the actual loop permanently installed, terminated at an outlet in the wall. By connecting the unit to the loop outlet and 230V (only one plug), the system is ready for use.

The system should not require operation, and the microphone and loop amplifier should be permanently installed in the unit. The plug type for the induction loop should be a 4 pin XLR with a bayonet lock.

The amplifier's output should be adapted to the relevant room sizes.

A wireless microphone for fitting on clothing should also be supplied.

Externally on the unit there should be a pair of phono jacks, stereo summed to mono, for connecting external audio sources. The induction loop amplifier should have separate inputs for the wireless microphone and a separate audio source. Both inputs should have automatic gain control (AGC). Program audio for rooms with stationary induction loops should have outputs adapted to mobile loop amplifiers.

3.5.2 IR system

The systems should have modulation frequencies that will not interfere with IR remote controls.

The systems should be dimensioned for adequate coverage with a SNR > 60 dB within a zone, given an angle of radiation equal to $\pm 45^\circ$, provided there are no obstacles.

The IR system should reproduce the sum of the speech and program audio and should be adjusted in relation to the standard level when using vocal amplification. Program audio should be balanced in relation to speech to ensure that their mutual relation is natural.

Modulators for rooms without vocal amplification should have a microphone jack and a pair of phono jacks, stereo summed to mono, in order to connect program audio sources. The jacks should be adapted to the audio processor for rooms with speech reinforcement. IR emitters should be mounted high up on the wall or in the

ceiling, placed in way that provides an unobstructed view of as much of the seating area in the room as possible.

The receivers should be mobile units for borrowing and must have a neck loop for an inductive connection to hearing aids.

3.5.3 FM systems

FM systems for the hearing impaired are primarily utilized as mobile solutions in rooms without vocal amplification systems. In class rooms equipped with FM transmitters, these transmitters should be integrated in the rest of the sound system as a substitute for an induction loop system.

The same receiver should be able to be utilized for both permanently installed and portable FM systems, and all equipment should preferably be from the same manufacturer.

There are no specific requirements for which frequency bands the systems should utilize, but the AV supplier is responsible for making sure that the systems do not interfere with the wireless microphone systems.

Several systems should be able to be in use simultaneously in adjacent rooms without interference. Simple and robust solutions are emphasized for pairing the transmitter and the receiver, and for changing the channel/carrier frequency.

Requirements for sound quality:

- Frequency response 100 - 7.000 Hz (\pm 3 dB relative 1 kHz)
- Distortion < 1 %
- SNR > 60 dB

The AV supplier is responsible for ensuring that the transmitter's output and the chosen antenna solution for each room provides good coverage for the entire room. Stationary transmitters should not require operation when in normal use.

The receivers should be mobile units for borrowing and must have a neck loop for an inductive connection to hearing aids. The neck loop should be connected to the receiver by a mini jack plug for easy replacement of the loop by headphones, for instance.

The receiver should have a battery status indicator and it should be possible to see which receiving channel is connected. The receivers should be supplied with a rechargeable battery system for charging on a docking charger or another charging system (cable or similar) which makes changing the battery redundant.

The system should reproduce the sum of the speech and program audio and should be adjusted in relation to the standard level when using vocal amplification. Program audio should be balanced in relation to speech to ensure that their mutual relation is natural. The transmitters should have the necessary controls for level, tone control and dynamics.

The AV supplier is responsible for frequency planning. Further, the supplier should map any unforeseen frequency problems during the commissioning period and make the necessary adjustments to the supplied system to make it function to satisfaction.

Portable FM systems

Portable FM systems should constitute complete, personal systems that can be lent to students. The student should be able to bring the transmitter and the microphone to the lecturer in order for the lecturer to easily put on the equipment before the lecture commences. Apart from turning the transmitter and the receiver on, other adjustments should not be necessary to make the equipment ready for use.

The transmitter should be a light unit, able to be worn by using a belt clip. Transmitters should be supplied with a miniature lapel microphone. The transmitter should additionally have an input for external sound sources.

The transmitter should have a battery status indicator and it should be possible to see which receiving channel is connected.

The transmitters should be supplied with a rechargeable battery system for charging on a docking charger or another charging system (cable or similar) which makes changing the battery redundant. Transmitters should preferably use the same charger system as the receivers. Each system should have its own charging station.

3.5.4 Counter induction loop systems

The systems should be individual systems not connected to each other or to other systems. The loops should be mounted underneath the countertop. A durable standard induction loop symbol should be installed in connection with each loop.

General requirements for induction loops apply. The requirements should be met for a diameter of at least 0,5 m for heights from 1,5 to 1,8 m above floor height.

The power supply for the induction loop amplifier should be from 230V and the amplifier should have the necessary adjustment options for level, tone, dynamics and loop power.

The microphone should be of a directional type that is not affected by the induction loop, mounted on a 20-30 cm long black gooseneck. Any separate power supply should be included. Batteries are not acceptable.

3.6 Distance learning and video conferencing

A separate loudspeaker covering the lecturer should be included in class rooms equipped for distance learning. The sound level is to be controlled from the lecturer's control panel. This also applies for mobile solutions for distance learning.

The loudspeaker solution for the vocal sound system must be designed in a way that reduces the feedback from the microphones in the presentation area. In practice, this means adjusting the directionality (coverage area) and placement of the loudspeakers so that the speech is focused as much as possible towards the auditorium/audience.

3.7 Signal delay

In order to improve source localization, a signal delay (time delay) is to be utilized in classrooms with a vocal sound system.

The signal delay is to be adjusted individually for each room when installed. The goal is that the correct localization towards the lecturer is ensured as far back in the room as possible. In practice, this means that the delay has to be set as large as possible, probably around 10 ms, without causing audible echo or a reduction in the vocal clarity in the first row.

Time delays for fill speakers should be adjustable independent of the main loudspeakers. In larger rooms with ceiling speakers, it may also be necessary to have individual time delays for various speaker zones/circuits.

3.8 Digital signal processors

In rooms with vocal sound systems, mixing and sound processing is mainly carried out in an integrated, programmable signal processor (DSP). Some functions may be carried out completely or partially in separate units if the supplier considers this more suitable. Echo cancellation for distance learning can either be carried out using the video conferencing codec or using the DSP.

The sound system should have the necessary number of inputs to be able to operate the described functions, devices and connectivity. Where it is technically and functionally sensible, shunted inputs are accepted.

Additionally, there should be spare inputs for all relevant types in mixing units etc. – a minimum of 15 %, and never less than one of each type. Spare inputs should be available at commissioning.

The program sound level, speech level and the level should be individually adjustable from the control panel. The level should only be able to be adjusted ± 10 dB compared to the normal preset level.

Internally in the DSP it should also be possible to adjust the balance between the level in the main speakers and the fill speakers for each of the partial systems.

A corresponding solution can also be offered for other rooms where the supplier considers it suitable and affordable.

The units should have adequate processor and memory capacity to be able to solve the specific tasks, and sufficient in reserve to take care of any modifications during the building and commissioning stages. DSPs should have a minimum resolution of 24 bits and a sampling rate of 44,1 kHz.

3.9 Microphones

Generally, directional condenser/electret microphones are to be supplied with balanced, low ohmic output.

General frequency response 60 - 15.000 Hz (± 4 dB)

For all microphones it is relevant for, a clip and a windscreen should be included.

All microphones that are not supplied permanently mounted, should be supplied with a suitable cable.

Lectern microphones should be of a slender design with an integrated gooseneck and power button. Additionally, separate bases are to be supplied for the gooseneck microphones.

Ceiling mounted microphones should be miniature microphones. The microphones should be connected in the ceiling via jacks in order to simplify service and repairs without having to access the ceiling. The mounting system should allow angling towards the speaker.

All microphones should function unaffected by induction loops.

All microphones should function unaffected by cell phones, as long as the phone is located more than 0,5 m away from the microphone.

Signal inputs meant for microphones should have phantom feed. Batteries are not accepted for wired microphones.

3.10 Wireless microphone systems

Wireless microphone systems should be true diversity with two individual receiver channels.

The system should operate in the 800 MHz frequency range and comply with national regulations. The supplier can alternatively offer solutions based on other frequency ranges if he believes that these give a more robust solution with regards to noise and frequency planning.

The AV supplier is responsible for ensuring that the chosen antenna solution for each room provides good coverage for the entire area where wireless microphones may possibly be utilized. For larger auditoriums or for rooms where the receivers are not visibly placed in the room, external antennas should be utilized. Two antennas are mounted on the presentation area or the rear wall. If the room has more than one wireless receiver, an antenna splitter for external antennas should be used. If the antennas integrated in the receivers are used, the AV supplier should ensure that the placement in and design of the rack enclosure does not provide any unnecessary shielding.

Dynamic range > 70 dB.

Frequency response 80 - 15.000 Hz (± 3 dB) for the system as a whole.

As lapel microphones, miniature, skin coloured headband microphones should be supplied. The microphone should be very discreet; the band should be behind the neck and the microphone rest against the cheek. They should be easy to put on and comfortable to wear.

The transmitter should have a battery status indicator.

The transmitters should be supplied with a rechargeable battery system for charging on a docking charger or another charging system (cable or similar) which makes changing the battery redundant. Maximum charge time from empty to full capacity is 8 hours.

The receiver should have stepless squelch control.

The receivers should have a read-out for the RF level and the deviation and it should be possible to see which receiving channel is connected.

All system elements should be from the same manufacturer and otherwise mutually compatible.

The AV supplier is responsible for frequency planning. Further, the supplier should map any unforeseen frequency problems during the commissioning period and make the necessary adjustments to the supplied system to make it function to satisfaction.

3.11 General requirements for the audio quality of electronic audio components

The following requirements are regarded as the minimum requirements unless stricter or milder requirements are listed in the detailed statement:

- Frequency response 30 - 15.000 Hz (-3 dB)
- SNR > 90 dB
- THD < 0,1 %.

3.12 Standard levels and termination

In general, all audio signals passing through cables of total length more than 2-3 meters should be balanced. This can be solved internally in the equipment or by using external units (transformers, for instance) included in the unit price. The standard level for the system should be +4 dBu with minimum headroom +20 dBu. For consumer products (i.e. DVD player, video players etc.) signal levels at -10 dBV are acceptable.

3-pin XLR connectors with strain relief are used for connecting the microphones, while external program audio sources are connected by standard, unbalanced phono (RCA) connectors with the shielding isolated from the casing. All connection boxes should use metal as the main material. Connecting audio connectors should be in accordance with the usual European practice. See EBU.

3.13 Wiring

All the necessary wiring in order to ensure the entire function should be included in the delivery, with the exception of wiring which according to the interface description is implemented by another contractor.

3.13.1 Special cable requirements

General low level line including microphone cable:

- Twisted pair
- Individual pair shielding w/ground wire
- Internally isolated shielding
- Cross-section lead $\geq 0,22 \text{ mm}^2$
- Pair capacitance (1 kHz) $\leq 80 \text{ pF/m}$

Speaker cable:

- Conductor cross-section: $1,5 - 4,0 \text{ mm}^2$
- Multi-stranded wires (min. 20 wires/ mm^2)

Induction loop wire:

- The conductor cross-section is adapted to the loop length and the supplied amplifiers, but should be a minimum of $1,5 \text{ mm}^2$.
- Ribbon cables should be adapted to the floor construction but should have a minimum conductor cross-section of $1,5 \text{ mm}^2$ and a maximal conductor thickness of 0,2 mm.

Cold leads should be tightly twisted.

Antenna cables for microphone antennas/IR emitters:

- 50 or 75 Ω ($\pm 3 \Omega$) adapted to the tendered equipment
- Attenuation < 25 dB/100 mV/800 MHz
- Capacitance < 70 pF/m

If the tendered equipment requires other cable properties, the cable types should be adapted to this.

3.14 System specific requirements for testing and documentation

All audio amplification systems and induction loop systems, with the exception of simple program sound systems for use during presentations, should be measured. There are competency requirements and requirements for the technical resources used in measuring the implemented electro-acoustic system as well as for the calculation and design of the sound system. The owner can also require measurements of other sound systems if there is uncertainty about whether the systems fulfil the described system requirements.

The supplier should perform measurements of the audio amplification systems and submit a report (WinMLS®, SIM® or similar). Data for frequency response, level variations and voice clarity should be reported in accordance with the requirements in chapter 3.1 Sound quality.

A proposed measurement report should be submitted with the tender – if possible as an example from a previously completed delivery.

For vocal amplification systems in auditoriums, the measurements are to be taken with a reference speaker as source, placed in at least 2 natural speaking positions with a microphone distance of 20 cm. Measurements should be performed in at least 5 randomly chosen receiver positions, well distributed in the audience area, and should include positions right underneath and between the ceiling speakers.

All speaker systems should be tested by using slow pure tone sweeps with at least the stated audio level, in order to uncover vibrations and resonances.

For the induction loop system, the field intensity and frequency response should be measured in accordance with IEC 60118-4 Ed. 2.0 b:2006. Measurements for induction loops are documented on sector maps with the field lines indicated.

4 Video System

Chapters 4.1 - 4.3 assumes RGBHV as the primary signal format for image sources (e.g. VGA connection for PC). If you want to utilize digital transfer of video signals, these chapters have to be adapted to the chosen signal format.

4.1 Video switches and matrices

This specification does not state any exact inputs and outputs for the various components, beyond the tasks of selecting which sources should be connected and on which media these should be presented. Neither are unambiguous guidance given for which signal formats should be utilized in various connections. This is the responsibility of the supplier/contractor in order to offer a suitable total solution.

It is vital that adequate inputs are available at the various connection points. Video inputs are presumed to mainly be RGB. For certain equipment components, Y/C (S-Video) is also acceptable. Composite formats are not acceptable. For this description, RGB is primarily used as a collective term for high-resolution analogue RGB format, normally RGBHV. Based on the tendered image sources, the supplier should determine which exact signal formats should be utilized. There is opportunity to offer multi-function signal processors, with or without integrated format conversion, if the supplier considers this suitable in order to achieve good video quality and functionality.

The video system should have the necessary number of inputs to be able to meet the described functions and contingencies. Additionally, there should be spare inputs for all relevant types – a minimum of 15 %, and never less than one of each relevant type. Spare inputs should be available at commissioning.

A short time before implementation, the AV supplier should discuss the planned solution and its scope with the relevant user for each individual room, to ensure that the intended functionality is obtained.

Included in the offer, there should be a short description of the offered signal processing and signal distribution paradigms.

All switches, matrices etc. should be fully configurable from the control system, according to the functional requirements for the video system. The control system should select/control automatically based on the connected floor box, etc., and manual control by the user, correct source to the correct presentation medium (projector, monitor etc.)

The video system should allow full, individual control over what is shown on the monitor/interactive computer monitor in the lectern, on supporting monitors for distance learning, on video projectors and for outputs for distributing video signals to external parties, from the control system. Please note that it often is not practical that the above-mentioned functionality is fully available for regular users.

The video system should allow transparent routing of resolutions up to 1.600 x 1.200. All individual components in the system should minimum be able to handle RGB bandwidth up to 300 MHz.

Some video inputs will have accompanying audio inputs (stereo). Audio output from the video switch/matrix is routed to the associated program audio system and should follow the video shown on the video projector/flat panel monitor. The switch/matrix should have a mute function for audio and video outputs.

Video switches, matrices etc. are normally placed in the equipment rack, but if the supplier considers it practical, certain components may be placed in the lectern, if the described requirements regarding functionality and flexibility are ensured.

In simpler rooms without vocal sound systems, the video switch is presumed to handle audio associated with video inputs without using a dedicated audio processor or program audio switch. If the video projector/flat panel monitor has a sufficient number of inputs to cover all connections of permanently installed and mobile equipment, and satisfies the requirements for controlling/routing audio and video sources, a video switch can be omitted.

4.2 Video scalers

Video scalers should adapt the video format for each source to the native format for each input on the video conferencing codec/video projector/flat panel monitor, and should be automatically controlled by the control system. Scalers should be able to handle sources in both widescreen and 4:3 formats, and render all sources with the correct aspect ratio. Inputs should support high resolution video formats (UXGA, WUXGA and 1080p.)

The scaler should as a minimum have DVI, RGB and Y/C inputs. The inputs should support all standard video formats from PCs, see compatibility requirements in chapter 4.3. Outputs should support HDTV (720p and 1080p). It is up to the supplier if outputs for RGB or DVI are utilized. The scaler should manage correct signal transfer, and if necessary, generate EDID codes for DVI and HDMI signals adapted to the other components in the video system.

Scaling functionality can be integrated in the video switch.

4.3 Computer interfaces and signal formats

Universal computer interface for connecting PCs should be compatible with VGA, XGA, WXGA, SXGA, SXGA+, WSXGA+ and UXGA, and have an RGB bandwidth of minimum 300 MHz.

The signal format between a Blu-ray player and a video projector should be DVI/HDMI. All signal processors utilizing DVI/HDMI should support HDCP. Beyond this there are not specified any requirements for digital transfer of video signals (DVI/HDMI/DisplayPort) for the AV systems. In the offer, there should be a report considering how this can be incorporated for PC, and the costs in connection with this.

All video systems should have the necessary signal conditioning for loss-less transfer as well as processing sync signals ensuring compatibility with the video switch/matrix. It should be possible to utilize standard laptops running on battery. The AV supplier is responsible for including signal amplifiers or encoder-decoder solutions based on fibre or twisted pair transmission where necessary due to cable lengths and/or signal format. Skew compensation should be included if this is necessary due to the chosen cable type.

4.4 Video projectors

Unless otherwise specified, projectors should have WXGA resolution. There are no requirements for specific resolution, but the projectors should have a minimum resolution of 768 pixels vertically, and should support all relevant WXGA variants, like 1.280 x 768 and 1.280 x 800. They should additionally support other relevant resolutions, like VGA, XGA and SXGA. The projectors should at a minimum support HDTV at 720p. It should be possible to connect a laptop with the above-mentioned video formats, and choose between various sources without having to make changes in the setup menu for the projectors. Switching between sources with 4:3 formats and widescreen formats should be automatically managed with the correct aspect ratio. If necessary, a scaler should be included in order to satisfy the above-mentioned requirements.

Projectors specified with a 4:3 format should, unless otherwise specified, have XGA resolution (1.024 x 768.)

The projectors should have the necessary inputs for handling all relevant formats in the tendered system, including external control.

The light output for projectors in larger auditoriums and seminar rooms (80 seats and up) should be a minimum of 4.000 ANSI lumen, with the exception of projectors optimized for movies, which should have a light output of

minimum 5.000 ANSI lumen, unless otherwise specified. The light output in other rooms should be a minimum of 3.000 ANSI lumen.

For projectors that should be used together with interactive boards, the light output should be adjusted to the size of the interactive board and the reflection properties in order to avoid troublesome reflections. It may be necessary to reduce the light output beyond the requirements specified above. The aspect ratio (16:9/16:10) should also be adapted to the tendered interactive boards.

Evenness of illumination should be better than 85 %. The contrast ratio should be a minimum of 1000:1, with an exception for projectors optimized for showing movies, which should have a contrast ratio of a minimum of 2000:1. The light source (lamp) should have a minimum lifetime of 2.000 hours.

Image brightness at 50 % of the expected lamp lifetime for normal usage should also be stated. Full on/off contrast should also be stated according to the same criteria and after the first lamp replacement in order to uncover a change in image quality over time.

Lenses should be adapted to the specified positioning and image size for each individual room. Where necessary, the projector should have geometry control for adjusting the projection angle. Geometry control should in principle be implemented optically (lens shift), but for projectors in smaller rooms (with requirements for light output at 3.000 ANSI lumen), digital geometry control is also accepted (keystone).

It should be stated whether the projector has an air filter that requires cleaning/replacement, including recommended service intervals.

All permanently installed projectors should be supplied with mounting brackets adapted to the placement. The projectors should be controllable via RS232, and should support network connection for remote diagnostics/monitoring.

4.5 Desktop Monitors

Desktop monitors used as support for the lecturer in lecterns should have the same aspect ratio and minimum the same resolution as the projectors in the relevant room.

Panel size should at least be 17".

4.6 Larger flat panel monitors

Flat panel monitors are used as presentation monitors or supporting monitors in connection with distance learning/video conferencing. All monitors should be intended for professional use.

Larger monitors (size about 50") should have full HD resolution (1.920x1080 pixels). Smaller monitors (about 32") should have WXGA resolution (minimum 1.280 x 768 pixels).

The monitors should support all relevant WXGA variants like 1.280 x 768 and 1.280 x 800. They should additionally support other relevant resolutions, like VGA, XGA and SXGA. The monitors should support HDTV in 720p and 1080p. It should be possible to connect a laptop with the above-mentioned video formats, and choose between various sources without having to make changes in the setup menu for the monitors. Switching between sources with 4:3 formats and widescreen formats should be automatically managed with the correct aspect ratio. If necessary, a scaler should be included in order to satisfy the above-mentioned requirements. For supporting monitors for distance learning/video conferencing, only support for WXGA or 720p resolution, in accordance with the outputs of the video conferencing codec and the resolution of the projector, is required.

All connections should be easily accessible for wall-mounted monitors. The monitors should have scart and HDMI/DVI inputs. The monitors should have power savers. The monitors should be supplied with the necessary wall brackets/floor stands, as stated in the system description for the individual rooms.

The monitors should be controllable via RS232.

4.7 Interactive boards

Interactive boards are used for local and remote display of video and information applied by using an electronic pen.

The board should be based on front projection, with a size of about 95" in 16:9, unless otherwise specified. The board should be incorporated with a whiteboard with a height of about 1,2 m.

Pens should control a writing and drawing system with at least four different colours and the ability to use free-hand drawing (with pen).

The underlying computer image may originate from any computer program on the PC in the room.

The user should be able to duplicate the image shown on the board on any projection surface where such exist, and to save and print the image.

4.8 Interactive pen displays

Interactive pen displays should be LCD based. The size should at least be 17". The monitor should also function as a desktop monitor for a stationary PC, and should preferably have the same resolution as the video projector.

If widescreens models are available at the time of installation, any displays with 4:3-format should be offered to be changed for rooms that already have widescreen video projectors.

Besides this, the same functionality requirements apply as for smart boards.

4.9 Document cameras

Document cameras should be an integrated standard unit with a camera, lighting system and the necessary control buttons/levers. The unit should be able to display documents and objects in colour with different cropping.

The unit should be equipped with a CCD camera with a horizontal resolution of 750 lines minimum. It should also support widescreen output formats (WXGA/720p).

It should be possible to both manually and automatically set the focus, iris and white-balance. Motorized zoom (min. 10x) should be included. The unit should not have cooling fans.

The document camera should be connected to the control system in rooms with advanced control system and support control via RS232.

4.10 DVD players

DVD players should support both PAL and NTSC formats. Both DVDs and CD's should be playable. The player should support playback of MP3 files.

The video output should be RGB, or possibly Y/C (S-Video). Players with a recording function should have both RGB and Y/C (S-video) video inputs, and stereo RCA (phono) audio inputs. In rooms with control systems/video switches, the player should have an analogue audio output (stereo) connected to the video switch.

DVD players should be connected to control systems where applicable.

4.11 Blu-ray players

The player should support 1080p video format and Blu-ray profile 2.0. Both DVDs and CDs should be playable, and the player should also support playback of MP3 files. It should be especially emphasized that the playback starts quickly after inserting the disc. This is especially important for CDs.

Players used in rooms with support for multi-channel audio should have 7.1 analogue audio outputs connected to the audio processor (DSP) and an integrated decoder for all relevant multi-channel audio formats, including Dolby TrueHD, DTS-HD and LPCM. Alternatively, a separate surround processor may be offered.

The HDMI output is directly connected to the movie projector if present. In addition, analogue video and stereo audio outputs are connected to the video switch. The analogue video output should be RGB, or possibly Y/C (S-Video). Alternatively, the HDMI output is wired directly to the projector/flat panel monitor, as long as the described flexibility and a suitable user interface is ensured.

Blu-ray players should be connected to control systems where applicable.

4.12 Video camera interfaces

Connectors should include Y/C (S-video), HDMI and analogue audio (stereo RCA.) The HDMI input can be converted to RGB format in rooms with analogue video matrices/video switches.

Signals should be routed via the control system/video selector where applicable.

4.13 PC interfaces

Stationary PC's should have 2 USB ports accessible on the tabletop. This may be solved by using USB ports in the interactive pen display/desktop monitor in the lectern or on the conference table. If separate extension cables are needed, the USB ports should be installed in the table.

All interfaces for laptops or stationary PC's should include audio, video, power and network connectors. Audio connectors should be stereo mini-jack, and the primary video connection should be VGA, but the laptop interface should also include DVI. The DVI input can be converted to RGB format in rooms with analogue video matrices/video switches.

The systems should preferably have automatic video switches for VGA/DVI inputs, to ensure that the attached video input is automatically selected when laptop is chosen as source on the control panel. This may be solved by using a dedicated unit, or integrated functionality in the projector/flat panel monitor.

4.14 Distance learning and video conferencing

Video conferencing systems should be based on ITU's standards and guidelines.

Minimum specifications

Video section:

- Support for H.264/MPEG4 AVC. Should also support H.261 and H.263.
- HD support (min. 720p at 25/30 fps.)
- 2 VGA/DVI outputs.

Audio section:

- Full duplex
- Noise reduction and automatic level control.
- Synchronizing audio and video ("lip-syncing").
- Individual echo cancellation for every microphone input.
- Line echo cancellation min. 30ms.

Other:

- Support for SIP and H.323 video conferencing over IP.
- Support for H.239 and simultaneous transfer of video and image source (minimum 2 RTP streams).
- Support for QoS.
- Support for NAT/firewall traversal and H.460.18/19.
- Support for AES encryption.
- The codec should only use IP based transmission. ISDN is supported via an ISDN gateway or as an external service. *Must be adapted to the chosen solution.*

- The systems should be programmable to facilitate conference set-ups with pre-defined parties using only a few keystrokes.
- The systems should support document sharing (PC images, etc.)
- The systems should be supplied with a common operational support system that includes browser-based system diagnostics.
- The systems should support central video server integration for streaming and/or storing sessions. (A central video server is not included).

All components included in the distance learning systems should support the above-mentioned specifications.

The number of camera inputs should be adjusted based on the system description for each individual room. If necessary, a dedicated video switch should be supplied.

All components should be supplied with the latest available software version at the takeover date. Any costs with regards to maintenance and software/license upgrades should be stated in the tender.

Signal delay in relation to HD signal transfer has been a problem for several suppliers of video conferencing solutions. The bidder should seek a solution ensuring the smallest possible time delays, both for self-view and for end-to-end transmissions.

4.15 Cameras for distance learning

Video cameras with integrated pan-tilt-zoom (PTZ) stand, motor zoom and auto-focus should be used for rendering the lecturer and the class.

The camera w/bracket and housing should be a CCD colour camera with lens and minimum 7x zoom for light area 5 – 100.000 lux. The camera unit should have autofocus and HD resolution (min. 720p at 25/30 fps.)

The swivel should be silent and adapted to the camera's weight. The objective should be adapted to the relevant camera distance and the subject sizes. The camera should be controllable from the lecturer's/chairman's control panel via the control system.

The video output format should be adapted to the other tendered distance learning equipment, but it should be possible to retrieve uncompressed video signals from the camera without going through the codec (preferably HDMI/RGB format.)

4.16 MCU

The MCU should support connecting at least 12 parties, with support for distributing the capacity on up to 4 independent sessions. *Must be adapted to actual needs.*

The unit should support full transcoding, i.e. independent, automatic optimization of transfer quality for all parties in each session, and simultaneous HD quality for all parties (min. 720p at 25/30 fps.)

The unit should support simultaneous connection of remote parties via both ISDN and IP. This may be solved with the aid of a dedicated gateway. *It should be evaluated whether an ISDN connection should be supported via external services instead. In that case, the description should be adapted to the chosen solution.*

The bidder should explain the tendered unit's options and limitations.

4.17 Distance learning consoles

The following description must be adapted to the chosen solutions for lecturer support, and is relevant where two monitors are utilized, placed directly in front of the lecturer.

Please note that for smaller classrooms, the preferred solution is to mount cameras and monitors on the back wall.

With two 32" flat panel monitors, camera and an active loudspeaker for the lecturers contact with the remote party, the distance learning system should be put together into a unit. The console should be placed right before the lectern.

The monitors should be placed close together. The video camera should be placed over the right monitor, and an active speaker centered under the monitors. If the tendered monitors can be supplied with customized separate speakers, one of these may replace an active speaker. The monitors should have a narrow bezel to make the console as compact as possible.

The console is designed to make the unit inconspicuous for the audience in the classroom/auditorium. The back plates on the monitors should be covered and the cables hidden as far as possible to give the console a clean look seen from the back.

Stationary consoles should be mounted to the floor to avoid transferring vibrations from the writing surfaces to the camera.

Mobile consoles should be supplied with suitable wheels/casters.

The consoles should be included in the AV delivery, and the details of the design should be developed by the AV supplier in cooperation with interior designer/architect.

4.18 Mobile video conferencing units for conference rooms

Mobile video conferencing units should be able to be used in several conference rooms. The console should support all participants in the conference.

The unit should be fully integrated into one mobile unit without loose parts or cables, with suitable wheels/casters. It should easily be manageable by one person, and should pass through normal doorways, elevators, etc., without problems. It should be designed to be positioned at the short end of a conference table. The lower edge of the monitors should therefore be adapted to the height of the tabletop.

The unit should have two integrated 32" monitors, a camera, and an active speaker. See also the design specification in chapter 4.17.

The unit should include external projector/flat panel monitor and sound system connectivity. It should also include connectivity for external audio and image sources including PCs, document cameras, microphones, etc. This should be solved with the aid of a wall-mounted connector panel in all conference rooms prepared for video conferencing. Cables for connecting external equipment should have a shared cable sleeving. The AV supplier should ensure that all cables between the video conferencing unit and the connection panel are long enough to allow all relevant placements of the unit in all rooms where it is intended to be used.

4.19 Streaming solution

The streaming solution should support storage and editing of lectures to enable off-campus students to follow the lectures, in real-time or as recordings, from their own PC via a web-interface. The system should also support podcasts.

The system should support simultaneous recording of both video with audio and an image source (freeze frame). The interface for playback/display of the lectures should include both video source and image source (for instance PowerPoint presentations.) The students should be able to browse presentations, and video image/audio should be indexed and synchronized with the image source/presentation. The system should support multicast.

The system should be able to be used independently of the other distance learning solutions, but cameras for distance learning should be routable to the streaming system without going through the video conferencing codec. See also chapter 4.15 Cameras for distance learning.

Stored lectures should be able to be organized in a clear way, and indexed to make them searchable both for meta-data and content (text in presentations). Basic editing functions should also be included. The system should be integrated with learning systems via hyperlinks to websites, for instance, for playback of lectures.

The system should be supplied with a complete recording solution, any necessary servers for storage and streaming, and the necessary software. All functions vital for the daily operation and setup should be accessible via remote logon so that the equipment may be placed in a server room. All components should be supplied with the latest available software version at the takeover date. Any costs with regards to maintenance and software/license upgrades should be stated in the tender.

The system should be able to be pre-programmed to automatically start recording and streaming at a certain time. User friendliness should be highly emphasized when using the system daily.

Routing of signals for the recording solution and integration with the remaining parts of the AV system should be adapted to whether the streaming solution should be shared for several rooms, or only used in one room. See alternate solutions in UFS 120 chapter 8.

4.20 Projection screens

All motorized projection screens should be connected to the control system for the AV system in rooms that include this. In rooms without control systems, the screen should be automatically controlled via the projector.

The screen should be a matte white with gain = 1,0.

The screen should be adapted to the room and the function. Roll-up screens should in general cover the entire available height from the ceiling to the bottom of the board.

Roll-up screens with a width of more than 6 m should have bottom roller.

The bidder should state the speed data for all tendered motorized screen types together with a description of where the different types are intended to be used.

4.21 Whiteboards

All whiteboards should be supplied with a white glass-beaded surface and an aluminium frame with pen rack across the entire length of the board.

The boards should be magnetized and have hidden surface mounting.

It is possible that several boards mounted side-by-side needs to be used in order to achieve the described widths. The board surface should still be as smooth as possible without visible joints. Preferably, boards fully covered by whiteboard coating glued on after mounting the back plates should be utilized. Alternatively, the opposite frames would need to be removed and the joints grouted to ensure that the surface is smooth and whole.

4.22 Blackout curtains

Auditoriums and all other rooms with permanently installed video conferencing systems should have motorized blackout curtains controlled by the control system, unless otherwise specified. Integration with other shading in the control system is not presumed.

Motorized blackout curtains in rooms with AV systems are generally included in the AV delivery. Light-proof blackout roll-up curtains running in U-profiles on both sides of the opening should be tendered. *The above-mentioned may be adapted to the building's limitations. See UFS 116 chapter 6.6.*

The supplier should state the speed data for all tendered motorized curtain types together with a description of where the different types are intended to be used.

The AV supplier should take accurate measurements at the construction site and map any conflicts with window niches, handles, openable windows, etc., before the blackout solutions are ordered. Any needs for changed blackout solutions should be discussed with the owner.

4.23 Wiring

All the necessary wiring in order to ensure the entire function should be included in the delivery, with the exception of wiring which according to the interface description is implemented by another contractor.

4.23.1 Special cable requirements

High resolution coaxial cable should be used for transferring all VGA and video signals for the video system.

Minimum requirements:

- Impedance: $75 \Omega \pm 3 \Omega$
- Resistance: $< 18 \Omega/100m$
- Attenuation: $< 23 \text{ dB}/100m$ (100MHz)
- Capacitance: $< 60 \text{ pF}/m$
- Inductance: $< 45 \mu\text{H}/100m$
- Shared jacket

Coaxial lines for RGB:

- Impedance: $75 \Omega \pm 3 \Omega$
- Attenuation: $\leq 12 \text{ dB}/100m$ (300 MHz)
- Capacitance: $< 60 \text{ pF}/m$
- Shared jacket for elements in the same video signal

The above requirements are minimum requirements. If the tendered equipment requires other cable properties, the cable types must be adapted to this.

5 Control Systems

5.1 Integrated control systems

5.1.1 Advanced control systems

In auditoriums and rooms equipped for distance learning/video conferencing, module-based, PC programmable control systems with the necessary inputs and outputs for controlling of the AV systems and the equipment should be tendered. The systems should be controlled using a touch panel.

In general, the following functions and units should be controlled:

- General lighting
- 230V circuits for AV equipment
- Blackout curtains
- Projection screens
- Occupation indication
- Sound system
- Video system
- Systems for distance learning and video conferencing

The control equipment should consist of:

- Control panel
- Pulse switch at the entrance doors (*alternatively motion sensors*)
- Fire alarm system
- Remote control via network

Each room should have its own control central. For each control central, the necessary interfaces, relays, fuses, etc. should be supplied for interconnecting the control central, lighting circuits, motorized blackout curtains, motorized screens and other equipment that cannot be directly connected to the control central. The control centrals are presumed mounted in the AV racks unless otherwise specified, while other elements are mounted in sub-distribution boards, or hidden above the ceiling/in the hallway of the relevant rooms.

The number of inputs and outputs for the control systems is in principle given by the system description, but the bidder is responsible for defining the exact need.

The systems should have the necessary number of inputs and outputs to be able to operate the described functions, devices and connectivity. Additionally, there should be spare inputs and outputs for all relevant types – a minimum of 15 %, and never less than one of each type. Alternatively, the cost for later extensions of the system in order to cover the above-mentioned spare capacity in the tender should be stated, provided the control system is sufficiently scalable. Spare inputs should be available at commissioning.

The control system should use serial transfer of control signals and status indicators (RS-232, RS-485 or similar), alternatively, LAN (Ethernet.)

If some of the AV equipment is to be controlled via IR, a wired IR emitter directly mounted to the IR receiver on each device should be used, shielded in order to not disturb or be disturbed by others.

The AV system should be powered on from the control panel. Turning it off should reset the room to its initial state before powering down.

During fire alarms, the control central should mute the program audio and image sources, turn on all lights and open the blackout curtains.

The AV system should automatically switch to standby position if not operated within a preset time – starting at 3 hours.

The control systems should be supplied with a common operational support system which includes system diagnostics and complete remote control accessible from a PC on the network.

5.1.2 Simpler control systems

Control systems for simpler classrooms and meeting rooms should be adapted to the functionality and equipment of the rooms. The systems should be controlled using a keypad.

The rooms should have the same functionality as described for the advanced control systems in chapter 5.1.1, but with the following changes:

- The control central and control panel should preferably be integrated into one unit. It is presumed that the control central is mounted together with the control panel.
- The light controls should not be integrated into the AV system.
- Integration with the fire alarm system is not required.
- There are no requirements for spare inputs.
- In some rooms, there are no requirements for remote control/remote monitoring via the network. See the system description for each individual room.

5.2 Control panels and user interfaces

5.2.1 Touch panels

Control panels in rooms with advanced, integrated control systems should use touch panels. The panel should be mounted free-standing on the table. All panels should have colour displays. The size should be adapted to the complexity of the room. In simpler classrooms and meeting rooms, the panel should at minimum be 6", while in advanced auditoriums and other rooms with distance learning/videoconferencing, the panel should at minimum be 10".

The control panel should be programmed so that in any situation only a minimum of operation is required to achieve the desired total function.

An intuitive menu system should be constructed, where a few, easy operations from the lecturer are enough to effectuate all relevant usage types.

There should be suitable feedback to the lecturer about which functions are active.

All individual control functions in the systems should be accessible from the control panel. Advanced/specialized functionality should normally not be available for ordinary users.

The basic principle of the functions should be identical for all the systems in spite of the differences in complexity of the rooms.

It is the AV supplier's responsibility to suggest specific user interface designs. The designs should be based on guidelines from the users' organization and the details developed in cooperation with the user. A minimum of one round of adjustments of user interface designs should be included after the user has had a chance to gain experience in using the systems.

5.2.2 Keypads

Keypads should be flush mounted into the wall or lectern/conference table, see the system description for the individual rooms. The number of buttons and switches should be adapted to the complexity of the AV system. All buttons should be clearly marked and have indicator lights.

5.3 Distance learning and video conferencing

In rooms with permanent distance learning/video conferencing installations, and for mobile distance learning units that are only used in classrooms with advanced control systems, the system should be fully integrated into the control system.

The lecturer/chairman should be able to control the setup and composition of distance learning and videoconferencing sessions, that is, what is sent to each remote party. These functions should be integrated into the control system, together with control over what is shown locally in the room.

The system should be easy to connect, and should be programmed so that one keystroke on the operation controls automatically establishes a connection with one of at least 6 pre-programmed partner rooms. If the systems support multi-part conferences, either internally or via an external MCU, the pre-programming should also include simultaneous connection with several partner rooms.

Video cameras with pan-tilt-zoom and motorized zoom for rendering the lecturer should be manually controllable from the control panel. A minimum of 4 pre-set standard setups should also be programmed for each camera.

For mobile video conferencing consoles and mobile distance learning consoles that are also used in rooms without advanced control systems, it is presumed that the distance learning sessions and camera control is controlled by the remote control included with the video conferencing codec. The control system in each room should still be adapted to integration with mobile consoles.

5.4 Controlling the video switch/matrix when connecting lecterns to several floor boxes

In some advanced classrooms, it is specified that the control panel, monitor and other permanent equipment should be able to be connected to several floor boxes. The control system should be set up to register which floor box (position) the equipment is connected to, and configure the control and operation automatically based on this.

For classrooms with several floor boxes that only require the supporting lectern, microphones and control panels to be able to be connected to all floor boxes, the same functionality is required for the supporting lectern when the control panel is connected to the same box as the supporting lectern.

All video inputs in floor boxes, with associated audio inputs, that are not in use, should still be available from the control panel as sources with general names indicating their physical position and signal format (for instance "Output AV-1 / RGB-1"). The same naming principles apply for all video sources and inputs (with associated audio) in floor boxes.

If the lectern for instance is connected to the floor box AV-1, the video sources connected to the table should appear in the control panel with special names. With a stationary PC connected to RGB-1 in output AV-1, the input should in this case be called "Stationary PC" instead of "Output AV-1 / RGB-1."

When for instance, "Permanent PC" is chosen as video source in the control panel, the control system should automatically use a program setup which selects the correct input of the correct output panel. It may be presumed that the stationary PC is always connected to a certain input, for instance input 1 of each floor box, that all inputs are marked with both general and special names, and that the control panel has a number of pre-programmed setups for names of inputs equalling the number of floor boxes.

The above example is only meant to highlight the issue around identifying the connected equipment and the associated names on the control panel. It is the supplier's responsibility to plan a system that enables the user to relate to video sources in a clear manner, independent of which floor box is being used. Detection of which

floor box the lectern is connected to, may be done by short circuiting the extra connector set in the control panel multi-connector.

5.5 Controlling technical 230V circuits

230V supply of AV systems and all associated circuits will be implemented by the contracted electrician. It is, however, planned that the AV supplier should deliver and plan the connection elements (relays, etc.) for 230V for the rooms that are to have integrated AV control systems.

The control centrals are mounted in the AV rack. The 230V elements are suitably mounted with regards to conduits, preferably over the suspended ceiling in the respective rooms or in the adjoining corridor, alternatively in sub-distribution boards. The positioning of the 230V elements should be coordinated with the contracted electrician. The contracted electrician mounts and connects the 230V elements.

The scope should in principle be the same for all rooms with vocal audio systems and/or permanent installations for videoconferencing:

- Circuit for audio power amplifiers
- Projection screens (one relay output per motor)
- Blackout curtains (one relay output per direction)

In simpler rooms with control systems no controlled 230V circuits are required, with the exception of any motorized screens.

5.6 Controlling general lighting

Light control is not presumed integrated into the control panel for rooms with keypads.

For rooms with touch panels, all control of general lighting should be done via the control system. Integration with automated building systems is not required. Pulse switches mounted by each entrance door should activate the control system for normal lighting in the room. *The description has to be adjusted if motion sensors are used instead of pulse switches.*

This chapter should contain a briefing about the lighting solutions chosen for the various rooms, with a description of the fixture types, configuration and which circuits/fixture groups that should be able to be dimmed. Additionally, it should be stated which light control system should be utilized (normally Dali, DSI or 1-10V). It is presumed that the contracted electrician supplies all connection equipment and dimmers adapted to the chosen light control system, but that the AV supplier supplies controllers for each circuit/channel. Power supply for the Dali/DSI bus should be integrated into controllers supplied by the AV supplier.

The AV system should supply an individual control signal as well as on/off signal for each circuit/address.

Control integration is entirely the responsibility of the AV supplier, who will be responsible for ensuring that the supplied control equipment functions satisfactorily together with the supplied lighting equipment.

The programming should be implemented to enable the selection of pre-set scenarios. Additionally each dimmer group should be able to be steplessly overridden via an advanced menu in the control system.

Light sources with electronic connection equipment result in a certain emission of infrared light. It should be ascertained that the control system is not affected by this.

5.7 Occupation indication

Occupation indication should be controlled from the control panel.

Occupation indication fixtures are mounted outside over the entrance, and are presumed controlled using low-current signals directly from the control central.

5.8 Talk time functionality

It is requested that the control systems in classrooms have integrated talk time functionality.

The lecturer should have access to a real-time clock as well as stop watch functions on the control display.

The remote control functionality should support overriding the mentioned functions, as well as giving pre-set warnings on the speaker's monitor.

5.9 Other control requirements

All control systems should include the following functionality for sound and video systems:

- On/off button for audio and video equipment
- Level control for audio equipment
- Source selection for audio and video systems

Control systems based on touch screens should additionally include the following functionality:

- Function control for audio and video sources. They should minimum include start/stop, track change as well as rewind/fast forward. Additionally, the necessary functions for making changes in the equipment settings are included (menu choices.) The last point should normally only be available for advanced users, with the exception of menu choices for DVDs, etc.
- Changes of the settings for the document camera (normally not accessible by users.)
- Volume should be adjustable from the control panel, but should have a pre-set level when the system is reset or powered on. Vocal audio and program audio levels should be individually controllable. The vocal audio level should only be adjustable within a relatively small window.

In rooms with keypads, the function control for audio and video sources is presumed implemented with the associated remotes or directly on the front panel of the device. The keypad should be supplied with an integrated IR receiver where applicable.

5.10 Wiring

All the necessary wiring in order to ensure the entire function, should be included in the delivery, with the exception of wiring which according to the interface description is implemented by another contractor.

5.10.1 Special cable requirements

A shielded cable (PTS, PFSK or similar) should be utilized between the control central and the pulse switch by the door.

