Functional description AV equipment for classrooms and meeting rooms

Best Practice Document

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Executive Summary

This document is the first of three documents that gives recommendations for Audio-Visual (AV) equipment in the Norwegian HE-sector. UFS116 gives a functional description for recommended AV-equipment solutions in lecture halls, seminar rooms, class rooms, meeting rooms and group rooms.

Areas that are covered are: requirements for building construction and technical installations, sound, picture, control system, requirements for remote lecturing, video conferences, and burglar-proofing of the equipment. A system description is given for large lecture halls (over 80 seats), smaller lecture halls (less than 80 seats), seminar/class rooms, meeting rooms and rooms for video conferencing. Finally relevant integration and interfacing towards other contractors is covered.

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.

Best practice documents (UFS) providing functional descriptions for recommended designs for AV equipment at universities and colleges, have been developed. The agreed upon designs are based on the experiences of the members of the workgroup.

The document is meant as a tool when purchasing AV equipment, both in connection with new construction and when rehabilitating existing structures. The target audience is primarily technical personnel and advisors in charge of developing designs and technical requirements for purchasing. The document also provides recommendations for how to ensure that the chosen designs are firmly rooted in the actual needs of day-to-day users, i.e. students and lecturers.

1 Document map

UFS 116: Functional description of AV equipment for classrooms and meeting rooms outlines recommended designs for equipment for various types of rooms. In addition, the document also contains information that form a useful foundation for planning and evaluating relevant designs, 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 designs. This document is assumed to provide the basis for all purchases, regardless of complexity or size.

UFS 120: System for operational support and transmission of sound and video concerns shared resources for several rooms utilized in connection with operational support (monitoring and remote control of AV systems, streaming of lectures, multi-party video conferencing, infosystems, etc.)

2 Recommended process

When starting out defining the equipment and designs for each room, the following process is recommended:

1. **Define** the room's **function(s).** Consult the users and user representatives in order to uncover all needs and possible areas of utilization. It is important to *not* start with defining the equipment in the room, instead of the functions.
2. **Rank** the various **functions/areas of utilization** by importance for the relevant user groups. This will provide the foundation for any later financial prioritizing, or whether certain functions may be solved by using mobile/rented equipment.
3. **Choose/adjust designs** that satisfy the various functions based on the recommended designs provided by the various BPD-documents. If no suggested designs have been developed that satisfy all the functions, own competency within the organization or an external advisor must be utilized.
4. **Present the designs** for the users/user representatives to ensure that all needs have been intercepted.

5. Evaluate the needs for **training and user manuals.** It is vital to ensure that the supplier includes sufficient training of the technical support personnel and the users in order to ensure clear and unambiguous use of the systems, as well as a stable operational situation. It is important that the training is adapted to the existing knowledge of the individual. Additionally, the development of clear and unambiguous user manuals for all AV systems of a certain complexity should be included by the supplier.

Two central principles of design should be the basis when selecting designs:
Flexibility involves ensuring good adjustment possibilities and as little replacement of equipment as possible when upgrading/adapting equipment designs or rebuilding.
Scaleability means a configuration that is as similar as possible and uniform designs that does not depend on room size or complexity. This provides better possibilities for moving equipment, simpler descriptions of the equipment and a simplified operational situation.

It has been attempted to develop this documentation based on these principles. It is also a primary goal that the lecturer can recognize one classroom or meeting room from another, and one campus from another. The design of the designs and user interfaces should be as intuitive and self-explanatory as possible in order to reduce the need for operational support and assistance for the lecturer.

Note that these BPD-documents do not deal with conditions around purchasing process itself, like administrative and contractual regulations, the contracting process, tender evaluation, or support and maintenance agreements.

II BASIS

A template for framing the system descriptions with recommended designs for the various room types, is provided in part 0.

The following chapters give an important basis for planning and evaluating relevant designs. Chapter 3 especially, will be central during the early planning stage. Parts of the material will probably be familiar for many, and part II may be used as a reference work with the references provided in part 0 System description as a starting point.

3 Structural requirements and technical installations

When rebuilding or rehabilitating, there are often considerably limited possibilities for developing group and meeting rooms. In order to evaluate if certain rooms are appropriate for the intended functions, an overview has been developed with the recommended requirements for structural conditions and technical infrastructure. Before initiating large investments in AV equipment, it should be ensured that these requirements are satisfactorily attended to, or be able to accept the limitations inherent in the shape of the room.

It is vital to define the requirements for the shape of the room and the technical infrastructure as early as possible. This not only applies for new construction, but also when rehabilitating/rebuilding. The requirements will provide guidelines for both the architect and the technical contractors. The requirements for visibility, acoustics and conduits are vital to incorporate during the early stages of the project.

3.1 Floor plan and room design

3.1.1 Area, room shape and ceiling height

Auditoriums/rooms for seminars with more than about 50 seats, should have a ascending seating to ensure good visibility. For auditoriums larger than approx. 100 seats, it is preferable with a fan-shaped hall as this provides a shorter distance to the back rows, while letting everyone see well on the sides of the front rows.

For rooms with sloping galleries, the necessary ceiling height is normally decided by the requirements for free height at the back row, but for rooms with a level floor, the necessary ceiling height is often decided by the size and placement of the screen, see chapter 6.1.2. For auditoriums it is often a compromise between the optimal room acoustics (ceiling reflector panels over the stage) and height/placement of the display area (screens or projection areas). In general, it is recommended to prioritize good designs for boards and display areas, and to adjust the design of any ceiling reflector panels accordingly.

Based on Figure 1, it is possible to find the lowest recommended free height between the finished floor and the ceiling at the presentation area / position of the lecturer. Please note that it is assumed that there are no hanging light fixtures or other technical installations preventing unobstructed visibility between the projector and the display area. The two curves apply for rooms where it is presumed used respectively only sources in widescreen format (16:9), and both sources in widescreen format and standard format (4:3). It is presumed that the bottom edge of the projected display should be minimum 1,4 m over the finished floor.

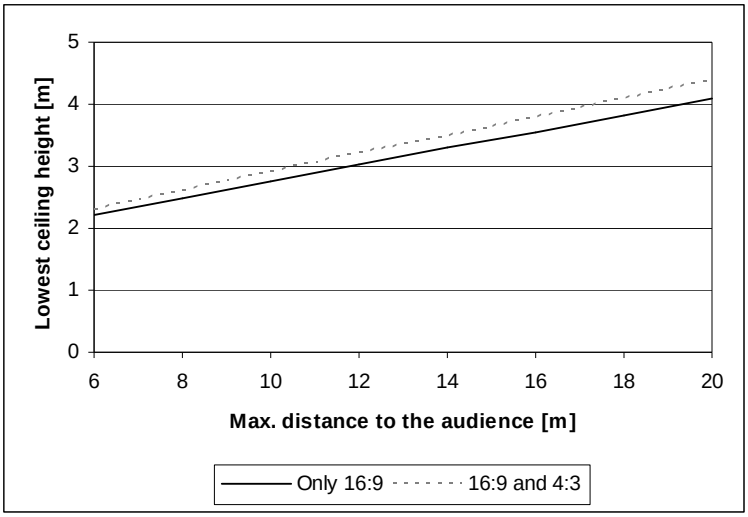

Figure 1. Lowest ceiling height (unobstructed height between the floor and the ceiling) as a function of the maximum distance to the audience.

At the minimum ceiling height it is presumed that the display area/screen is mounted flush with the ceiling. For mobile screens, it implies flush mounting in the suspended ceiling. See the recommended designs for display areas/screens in chapter 6.1.2.

The gross distance between the decks is minimum 0,3 meters larger, depending on the necessary drop of the ceiling in order to fit the ventilation ducts and other hidden technical installations. This means that rooms with more than approx. 50 seats, normally should span two floors.

For rooms where it is desired to place the display area over a blackboard, the requirements for ceiling height in Figure 1 should be increased by minimum 0,8 m, provided that screen boxes and any central speaker groups are mounted in the ceiling.

In meeting and group rooms, it is normally not necessary to have requirements for ceiling height in regards to visibility, except for large meeting rooms. If meeting rooms have flexible furnishings (including classroom/seminar configurations) the recommendations given in Figure 1 applies. For larger meeting rooms only furnished with a central conference table, and where the display area is placed by the short end of the table, the recommendations in Figure 1 may be reduced by approx. 0,2 m.

3.1.2 Visibility of blackboards and display areas in classrooms

If possible, avoid free-standing columns in classrooms. These will normally always reduce the visibility of the lecturer/presentation area.

If the room has different widths on the end walls, the widest wall should be chosen as the presentation area. (This does not apply for fan-shaped rooms.)

For large rooms with level floors, it will be a challenge to ensure good visibility for everyone. If the ceiling height allows, it may be sensible to raise the floor at the presentation area. Raising the back rows may also be considered. The requirements for universal design (access) should still be ensured.

Regardless, it is vital to ensure that it is possible to achieve good visibility for all seats in the room at the earliest possible stage in the project, and if necessary, re-evaluate the chosen floor plan.

3.1.3 Designing the presentation area

Recommended designs for blackboards and display areas are described in chapter 6.1.

The actual presentation area should be as clean as possible. This is important, both practically and esthetically.

Columns at the presentation area should be avoided. If this is not possible, a false wall should be erected in order to achieve a smooth surface. If there is a need for a sink for the lecturer, it should be placed at the end wall. Skirting ducts (horizontal cable ducts) should be avoided.

Nailing strips should be prepared for heavy wall-hung equipment, e.g. flat panel monitors, mounted on non-loadbearing walls. Alternatively, it should be verified that the equipment can be fixed at the desired locations by using the studs in the wall. With regard to future upgrades, a non-loadbearing wall with reinforced sheathing for the entire presentation area is preferable.

3.2 Lighting

General lighting is normally supplied by the contracted electrician. For rooms with AV equipment with advanced integrated control systems, the lighting should still be controlled via the control system. Co-operation between the AV supplier and the contracted electrician is very demanding when it comes to lighting control, and carefully considered planning and coordination during the installation phase is required in order to ensure a good end result. See recommendations in part 0 Integration and interfacing.

The publication "Luxtabell og planlegging av innendørs belysningsanlegg, 2. utgave, august 2007" (Lux-table and planning of indoor lighting systems, 2. edition, August 2007) from Lyskultur, provides instructions and advice for the planning of lighting systems and explains the most important terms used. The publication is a guide and a supplement to the European standard NS-EN 12464-1 - Light and lighting - Lighting of work places - Part 1: Indoor work places.

3.2.1 Auditoriums

To design good lighting solutions in auditoriums and advanced rooms for seminars is very demanding, especially rooms equipped for distance learning.

In larger auditoriums the following lighting types are normally required:

- Lights above the stage
- Light above the ascending seating
- Light over the blackboard
- Light along the walls
- Step lighting on the stairs
- Exit lights

All light circuits/groups should be dimmable/adjustable with the exception of the exit lights and the lights above the blackboard. Because the lighting is often planned and installed before the furnishings and AV systems have been planned in detail, the grouping of zones and programming of scenarios should be possible after the physical installation of fixtures and circuits have been completed. Blackboard lighting should be divided into zones in order to control any fixtures behind motorized screens individually.

Today lighting designs are often based on fixtures with T5 fluorescent lights and TC compact fluorescent light bulb. This gives a less neutral color rendering (color temperature) than traditional incandescent bulbs and halogen bulbs, but is often chosen due to energy requirements. Note that full color fluorescent lights may be used, but all fluorescent lights change their hue a little when the lights are dimmed.

Distance learning

If the auditorium is equipped for distance learning, additional lighting based on incandescent bulbs should be installed, possibly combined with halogen bulbs. This should include general lighting over the stage and over the ascending seating. Additionally, extra lights should be installed facing the stage in order to ensure good rendering of the lecturer when using a video camera.

The stage should have a combination of direct and indirect lighting, and a combination of vertical and horizontal light components in order to avoid disturbing shadows on the lecturer's face, and to ensure good rendering of the blackboard, etc. Be careful to avoid disturbing reflections from the whiteboard.

In many cases, a good alternative is to use stage lights for stage/theater use, possibly with so-called "barn-doors". This enables coverage of a defined area with a constant level of light, and may be used in auditoriums

where lights facing the lecturer/stage are desired, but where stray light towards the screen should be avoided. Note that these stage lights often have large power requirements.

See recommendations for surfaces and color choices for rooms equipped for distance learning in chapter 8.1.

Controlling lights using the AV system

In T5 fluorescent lights and TC compact fluorescent lights, the dimmer function is normally installed in each fixture, but for fixtures with incandescent bulbs and halogen bulbs there is often an external dimmer.

Today the lighting designs for rooms with advanced light controls are often based on the Dali control system. (DSI and analog 0-10V were used a lot in the past.) This is a digital system where the control signals are distributed in a bus-structure in parallel with the 230V fixture circuits, and with a high level of flexibility with regards to the grouping of the various fixtures and reprogramming the lighting scenarios. Outputs from the AV system control central is connected to the bus-structure via a separate interface (ballast controller), and the actual light control (grouping of fixtures, dimmer functions and scenarios) are programmed in the control central. It is recommended to establish a separate bus-structure for each room. This increases the cost of the ballast controllers a little, but substantially simplifies the programming of the control systems. Note that with Dali-controls, the 230V supply to the fixtures must be broken by a separate relay in order to avoid the fixtures using electricity even when they are turned off (on stand-by). It is recommended to avoid integration with EIB systems, etc., in rooms where the light is controlled using the AV system. Energy savings requirements can normally be ensured by using time-controlled shut-down when the room is not in use.

User interfaces for lighting control is discussed in chapters 7.1 and 7.3.

3.2.2 Seminar rooms/classrooms

The lighting designs are normally considerably simpler in seminar rooms and classrooms. It is still necessary to be able to adjust the light towards the stage/presentation area independent of the light above the students, especially in order to avoid stray lights towards the display area. Lights above the blackboard are also recommended in larger seminar rooms and classrooms. Regardless, enough lights towards the blackboard should be ensured for all classrooms.

If the room is equipped for distance learning, the same requirements apply for the lighting as for auditoriums.

Note that hanging fixtures should be avoided in the front half of classrooms with level ceiling height. These fixtures are often used because they enable a favorable combination of direct and indirect light with only one type of fixture, but will often conflict with line of sight between the video projector and the display area/screen. Please note that there are flush-mounted fixtures with a large amount of indirect light. Usually, the display area/screen should be placed as close to the ceiling as possible in classrooms with a level ceiling height, and the projector should also be placed high enough to keep it out of reach of people standing on the floor.

Light control in rooms with simple control systems

In standard seminar rooms/classrooms with button-based control panels the lighting is usually not controlled by the AV system. It is still important to have requirements for light control for these rooms. Solutions will largely be controlled by electrical engineering consultant/advisor and the contracted electrician, but the following functionality should be ensured:

- Switches/control panels should be placed close to the lecturer's position to ensure that the lecturer can easily adjust the lighting. It is usually necessary to install a pulse switch at each entrance or use movement sensors in order to activate normal lighting when entering the room.
- Scenarios or grouping of zones should be utilized to make it easier to adjust the general lighting for various room usage.
- All fixtures with the exception of blackboard lights, must have individual dimming. Because the lighting is often planned and installed before the furnishings and AV systems have been planned in detail, the grouping of zones and programming of scenarios should be possible after the physical installation of fixtures and circuits have been completed. In practice, this means that Dali with dimmer functions integrated into each fixtures should be used for all classrooms. Fixtures requiring external dimmers should be gathered in smaller groups (one whole/half a row per dimmer) which enable flexible programming.

- Any blackboard lights should be able to be turned off/on independent of other lighting, and should be divided into zones to ensure that any fixtures behind motorized screens may be controlled individually.
- The light towards the screen should be easily dimmed in order to reduce stray lighting when using a projector. It is recommended to control this light by using a separate switch which is easily accessible for the lecturer. Or the control system for the AV system can send a signal to the lighting control system when the projector is turned on. Usually, the control system for the AV system has outputs adapted for this, but the design and interface should be discussed with the electrical engineering consultant/advisor or contracted electrician.

3.2.3 Meeting and group rooms

For regular meeting and group rooms it is normally not necessary to divide the light into zones, with the exception of independent dimming of fixtures throwing stray light towards the screen. In smaller rooms the ability to adjust the general light in the room will be adequate.

Meeting rooms for video conferencing

The lighting designs have to be specially adapted in meeting rooms for video conferencing, . In order to have a well-functioning room, the lighting design has to be designed in a way that achieves an even light on all the participants, reduces facial shadows and ensures a natural rendering of colors when using a video camera. This means that the lighting has to be planned based on the positioning and design of the conference table in addition to the positioning of the presentation area and the video camera. See recommended furnishing designs in chapter 9.1.

The following principles are recommended for designing lighting designs for meeting rooms with video conferencing:

- The room should have a combination of general lighting over/behind the people in the room, light from the front towards the conference table and the faces of the participants, and light towards the walls.
- General lighting over/behind people should provide an even coverage for the entire room, and may with advantage be based on hanging fixtures with a combination of uplights and downlights.
- Lights from the front towards the conference table and the people should preferably be based on asymmetric ceiling-hung/flush-mounted fixtures (depending on ceiling height). Spotlights are not recommended as it is difficult to achieve an even light on all the participants without disturbing shadows.
- Lights on the walls can normally be of the same fixture type as for front lights on the conference table/people.
- Avoid direct lighting on the screens/display areas as far as possible.
- All three lighting types in the room should be individually adjusted. It is a prerequisite that the lighting is controlled by the AV system. See recommendations for user interfaces in chapter 7.3.

Regardless, it is recommended that light planners/advisors with special competencies in light-plans for rooms with video conferencing be used.

3.3 Other electrotechnical installations

Interfacing and integration with electrotechnical installations require special focus and good coordination. This includes conduits, 230V power supply, computer networks and lighting.

If the electrotechnical installations and the AV delivery are implemented by different suppliers, it is vital to define unambiguous interfacing between the contractors at an early stage. See recommendations in part 0 Integration and interfacing.

3.3.1 Electrical outlets and network connections

AV equipment

It is often necessary to have signal amplifiers/converters between the central equipment/image matrix and flat panel monitors, projectors or video conferencing cameras. This is especially relevant if digital video formats like HDMI and DVI are being used. It is therefore recommended to plan for double outlets for all flat panel monitors, projectors and video conferencing cameras.

Additionally should all projectors and flat panel monitors have at least one network connection for management and monitoring of lamps, etc. If TV distribution over the computer network (IPTV) is being planned, an additional network connection should be placed where the set-top box will be placed (usually in the equipment rack together with other central equipment.)

Even if distributing video signals over twisted pair between for instance the image matrix and a projector (usually UTP CAT5E or a cable made for transferring sound and video signals) is desired, it is not recommended to integrate this into the structured distributed network. This kind of wiring should instead be included by the AV supplier as part of the remaining signal wiring for the AV system, or be specified by the AV supplier to be installed by the supplier of the distributed network together with the remaining network wiring. The reason for this is both that cable types used for the general network (standard CAT6/CAT6A) are often less suitable for the transmission of high-resolution video signals (see for instance http://www.extron.com/download/files/whitepaper/tp_opt_wp.pdf), and that there should be a direct connection between for instance the projector and the central equipment point/image matrix. For transmitting high-resolution image signals, i.e. full HD quality (1080p), it should also be relevant to use fiber cable.

Other equipment components in the AV system may also use twisted pair or fiber cable transmission, but for point-to-point transmission locally in each room the wiring is included as a part of the AV supplier's circuitry.

A cabled network connection is recommended for permanent PC's and connection points for laptops to the AV system.

In summary, the following equipment units will normally need at least one network connection:

- Control central/control panels with integrated control central
- Video conferencing codec
- Any encoders/decoders for external transmission over the network
- Permanent PC
- Laptop
- Projector
- flat panel monitor
- Set-top box for IPTV

For video conferencing codices a 1 Gbit/s connection should be used. Other equipment units do not normally require high-speed network connections but it is recommended to establish a separate virtual network (VLAN) for AV equipment.

Student laptops

It is recommended to equip at least every second seat in the classrooms with electric outlets for laptops. The outlets should preferably be placed underneath the desktop for rooms with permanent galleries, but for classrooms with flexible furnishings, the chair rail along the walls and columns is normally the only realistic positioning. Alternatively, separate floor boxes with outlets may be established.

PC's (for students, etc.) is presumed connected to a wireless network. All classrooms should have wireless network coverage with adequate capacity. See Uninetts work with wireless networks at https://gigacampus.wiki.uninett.no/mobilitet.

3.3.2 Dimensioning and grouping of 230V circuits

230V circuits must be dimensioned and grouped in order to avoid noise in the sound and video systems, and take into consideration the starting current for the various equipment components.

The following recommendations should be the basis when planning 230V circuits:

- Sound amplifiers should have a separate 230V circuit taken directly from the electric distribution (16A C-characteristic).
- All motors (screens and curtains) should have a shared circuit taken directly from the electric distribution (16A C-characteristic), not used for other equipment.
- The remaining AV equipment in the rack and lectern should have a separate circuit taken directly from the electric distribution (16A B-characteristic). A separate circuit should also be allocated for projectors in

larger rooms, and a separate circuit for any high light output projectors. For smaller rooms, one circuit for all the AV equipment except for motorized screens, is sufficient.

The following equipment should have separate wiring from the relay block in addition:

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

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.

3.3.3 Conduits and floor boxes

Good and adequately dimensioned conduits are very important for achieving functional and visually undisturbing AV systems. This proves to be hard to ensure, even with new construction. Good solutions require integration with both building and electrotechnical trades, and early planning of the conduits during the planning stage. The increasing use of prefabricated concrete elements makes this challenge even greater.

The following principles are recommended when planning conduits:

1. Consider **future upgrades**. Establish conduits for all relevant upgrades/expansions during the first stage of the installation. In practice, this involves establishing spare capacity in the form of increased pipe diameter or the number of pipes where conduits are already planned, e.g. 50 % spare capacity. Additionally, for auditoriums it may be relevant to establish conduits from the stage to any sound or light mixers in the ascending seating. For transmitting sound and video to other rooms, today it is most relevant to use the structured distributed network. If in doubt about the need – establish the relevant conduits. It is much more expensive and more complicated to do this after the room has been completed.

2. Use **flexible conduits** where practically possible and esthetically acceptable, i.e. a cable run across the suspended ceiling or the chair rail. This facilitates equipment upgrades and future adjustments. For the remaining installations on/at the wall, hidden conduits terminated in a wall box or pipe stubs behind/under the equipment rack if the positioning of the equipment has been decided before the walls are closed up. For the remaining equipment, a miniature conduit from the ceiling or from the chair rail should be utilized.

3. Any **tele-power poles** in rooms used for presentations **must be carefully placed**. If tele-power poles are utilized, they must be positioned in a way that does not prevent a clear view of the presentation area from any of the seats in the room.

4. Use **floor boxes if possible** for free-standing mobile tables or for flexible connections of lecterns. Please note that it is still very demanding to ensure a good execution, especially in rooms with hollow core panels. A successful result requires precise planning and good coordination between the various trades.

   In a room with a lot of equipment, it is also a challenge to fit all the connections and to fit the lid with all the equipment connected. Mounting brackets must usually be specially fitted, but there are modular systems for AV jacks in some standard floor boxes. A floor box can almost never be deep enough! A good solution is to place the jacks horizontally in the walls of the floor box, as this gives a better possibility for putting the lid on when the box is full, and because the jacks are less exposed to dust, dirt and water entering the box. This design requires a lot of space around the actual box, and is therefore usually only relevant for boxes mounted in wooden joists. **Standard jacks** for all equipment are recommended if at all possible. Multiconnectors complicate future upgrades/replacements of equipment. If a freestanding lectern or conference table is permanently positioned and fastened to the floor, an alternative is to use direct cabling to the table via pipe stubs in the floor. This vastly simplifies the installation.

   Recommended placement of floor boxes for lecterns is on the front edge underneath the lectern.

   Conduit dimensioning must be planned based on the necessary equipment, but the following starting point for conduits to floor boxes may be utilized:

   - Advanced auditoriums/seminar rooms: Between each box and a central equipment point, lay 3 x 50 mm (alternatively 7 x 32 mm) of pipe. Boxes are connected internally with 2 x 50 mm (alternatively 5 x 32 mm) of pipe.

- Less advanced auditoriums/seminar rooms and advanced group and meeting rooms: Between each box and a central equipment point, lay 2 x 50 mm (alternatively 5 x 32 mm) of pipe. If the room has several boxes for flexible positioning of presentation equipment, the wells should internally connected with 3 x 32 mm (alternatively 1 x 32 plus 1 x 50 mm) of pipe.
- Simple class-, group and meeting rooms: Between each box and a central equipment point, lay 3 x 32 mm (alternatively 1 x 32 plus 1 x 50 mm) of pipe.

Generally speaking, large pipe diameters simplify the installation and enables using pre-terminated cables. 32 mm diameter pipe should only be used if 50 mm pipe is impossible. Note that the implementation must be coordinated between the fire technician and the acoustic advisor to ensure fire sealing requirements and sound insulation. Any water in the pipes should be dried before the cables are wired.

5. For free-standing lecterns, rostrums or conference tables where floor boxes or pipe stubs are not possible, it is recommended to use cables across the floor from the outlet on the side wall, either using a cable channel glued to the floor or a loose cable sleeving. Using a loose cable sleeving requires minimal traffic over the cables. A cable channel glued to the floor is preferable if the table has a permanent position.

3.4 Other building conditions and technical installations

The following chapter gives a short briefing on other requirements for designing classrooms and meeting rooms, and which trades are usually responsible for ensuring these conditions.

3.4.1 Fire safety

Fire safety requirements are usually ensured by the fire technician (RIBr).

For new buildings the fire technical planning should be implemented according to:

- "Teknisk forskrift til plan- og bygningsloven" (Technical regulations for the planning and building code) (TEK) [1].
- "Veiledning til teknisk forskrift" (Instructions for the technical regulations) (REN) [2].
- "SINTEF Byggforsk detaljblad 321.027 - Brannteknisk detaljprosjektering. Dokumentasjon og kontroll." (SINTEF Byggforsk data sheet 321.027 - Fire technical detailed plan. Documentation and control.)

Existing buildings need to satisfy the requirements in "FOBTOT - Forskrift om brannforebyggende tiltak og tilsyn av 26. juni 2002 nr. 847" (FOBTOT - Regulations on fire preventing measures and inspection of June 26th 2002 no. 847) [3]. These are the regulations the fire department enforce.

Be especially aware of fire sealing around conduits and pipe stubs in floors/floor boxes. It should be ensured that pipe stubs are properly positioned before fire sealing is implemented.

3.4.2 Acoustics

Acoustic requirements are usually ensured by the acoustic advisor (RIAk).

The relevant requirements for sound insulation, reverb and noise from technical installations are given in "Norsk Standard NS8175" (Norwegian Standard NS8175). For Statsbygg projects, these requirements are often somewhat stricter. In Statsbygg's planning instructions "PA 5551 Romakustikk og elektroakustiske anlegg" (PA5551 Room acoustics and electroacoustic systems) examples are shown for how to ensure good conditions for communicating speech in auditoriums [4]. See the SINTEF Byggforsk series, especially data sheet 527.304 "Lydregulering i rom med tilhørere" (Sound regulation for rooms with audiences) og 727.304 "Forbedring av lydforhold i undervisningslokaler" (Improving sound conditions for educational facilities).

Sound systems for vocal amplification must be adjusted to the room acoustic conditions in the room. Note that the vocal audio system should be a supplement to, not a replacement for good room acoustic conditions. Some cases will, on the other hand, consist of a compromise between the optimal design of the display areas/screen and an acoustic reflector over the stage in the auditorium. See chapter 5.1 Loudspeaker designs and chapter 6.1.2 Display areas.

For rooms intended for distance learning, video conferencing or video recording, there are special requirements for the acoustic conditions. It is especially important to achieve low levels of background noise, short reverb time and avoiding strong wall reflections. See chapter 9.4 Sound systems for meeting rooms with video conferencing.

3.4.3 Ventilation

Ventilation and air quality requirements are usually ensured by the HVAC advisor (RIV).

In the instructions from the Norwegian Labour Inspection Authority on climate and air quality at the workplace, there are guidelines for necessary air volume per person and ventilation of materials per m2 [5]. For projects by Statsbygg it is usually referred to table 30.1 in Statsbygg's building program for indoor climate requirements.

Note that air intakes/exhausts should not be positioned near the presentation area, as it may increase the background noise when using microphones. Ventilation exhausts should also be kept at a distance from the projector in order to avoid problems with dust and particles. Any incoming air by the projector may be beneficial, but it should be free of condensation and dust.

3.4.4 Daylight

Daylight requirements are usually ensured by the architect (ARK).

Both the Working Environment Act and the Planning and Building Code have daylight requirements. Relevant references:

- "Veiledning til forskrift om arbeidsplasser og arbeidslokaler" (Instructions for workplace and premise regulations) [6].
- "Teknisk forskrift til plan- og bygningsloven" (Technical regulations for the planning and building code) (TEK) [7].

In "Veiledning til teknisk forskrift" (Instructions for the technical regulations) (REN) [8] pre-accepted designs are provided in order to satisfy the requirements. These designs require conditions in order to be utilized that are often not fulfilled, and should therefore be used with caution.

Often the daylight requirements conflict with the need for blackout/shielding of display areas and the use of video cameras. See chapter 8.3.2.

3.5 Universal design

Requirements for universal design are relevant for all trades. For an outline of regulations and documentation, see http://www.be.no/universell/. "Statens byggtekniske etat" (National Office of Building Technology and Administration) (BE) has also developed guidelines for the universal design of buildings and outside areas [9].

In connection with AV systems, requirements are often triggered for designs adapted for the hearing impaired. See chapter 5.5.

Floor plans and furnishing of classrooms depend on the size and area of application, and the need must be clarified during the user process. Regardless, the physical design should support good communication between lecturer and students. This means that dominating furnishings and visually noisy elements should be avoided. The design of the furniture and the presentation area should be as orderly and clear as possible. This is especially important for distance learning, see chapter 8.1.

4 Positioning presentation equipment

4.1 Lecterns and rostrums

The design and positioning of lecterns and rostrums should allow for various forms of instructions and should be easily adapted to different lecturers. It is recommended to plan the design and choice of material for lecterns and rostrums before calling for tenders for the AV delivery.

In **smaller rooms** like classrooms and seminar rooms, it is usually sufficient with one lectern with a non-permanent manuscript holder (rostrum addition.) The positioning should be adapted to the room layout, but the table is recommended positioned to the side of the center line in the room, away from traffic zones. Permanent positioning and cabling is not recommended unless the users want to be able to move or remove the table whenever necessary.

Specifying the lifting/lowering function for lecterns is recommended, but the need must be evaluated on an individual basis.

Cabling should be conveyed to the wall if the table is closely against the side wall. For free-standing tables, the recommended design for conduits is described in chapter 3.3.2.

In **auditoriums** there is usually a need for a mobile lectern with a non-permanent manuscript holder and a rostrum. All lecterns in auditoriums should have a lifting/lowering function. It is recommended to connect by using floor boxes. For small and medium sized auditoriums (up to approx. 150 people) it is usually sufficient to have 2 floor boxes, larger auditoriums should have 3. It is usually adequate that the lectern is only connected to one of the boxes, while the remaining boxes only support the connection of a rostrum, extra microphones and a control panel.

If there is a need for increased flexibility, the boxes may be designed to ensure that both the lectern and the rostrum may be connected to all the boxes. Note that this design is more complex and requires scaling of among other things, image matrices and control systems. With a view to costs, the need for full flexibility for floor boxes should therefore be carefully evaluated.

The control system should automatically change its settings depending on the boxes being utilized.

Take care that lecterns are not positioned in a way that puts the lectern or the lecturer in the way of the projected image. This is especially important in rooms with level floors, and means in practice that the display area and the lectern should be positioned on separate sides of the presentation area for rooms of this type. In auditoriums with a ascending seating it will also normally be smart to position the lectern and the rostrum to the side of the center of the presentation area.

In rooms with lecterns, the rostrum is only equipped with a gooseneck microphone and a copy holder The design should be as compact as possible. In certain rooms it may be relevant to replace the lectern with a large rostrum due to space consideration. In that case, the solution would need to be customized.

The recommended distance between the lectern/rostrum and the presentation area is 1,2 m. Recommended design requirements for lecterns and rostrums are described in UFS 119 chapter 2.12.

Examples of the positioning of lecterns/rostrums and floor boxes for the various classrooms are shown in figures 2 and 3.

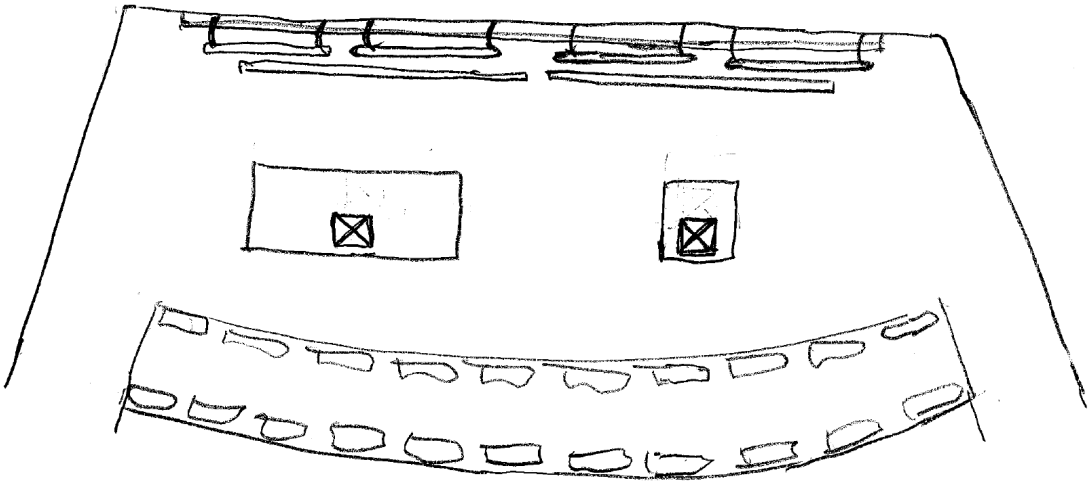

Figure 2. Examples of the positioning of lecterns/rostrums and floor boxes, large auditorium.

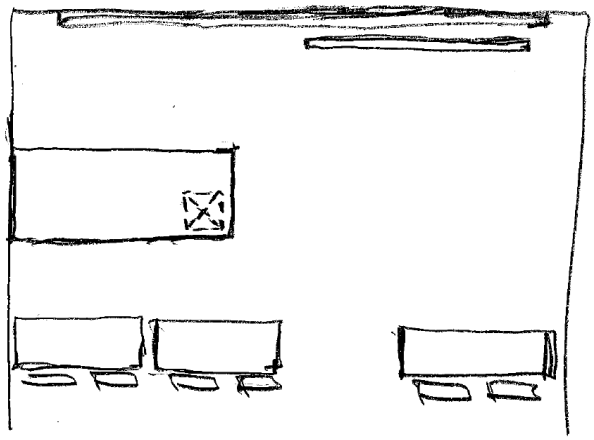

Figure 3. Examples of the positioning of lecterns and floor boxes, seminar rooms.

4.2 Positioning of central equipment

All the equipment that the lecturer or the chairman does not need to reach, is usually placed in the equipment rack. This includes equipment like audio processor, amplifiers, image matrices and control centrals. Permanent PC's may also be placed in the equipment rack if needs like access to DVD/Blu-ray players and USB connections are ensured, by using external units and extensions for instance. If possible, the rack is placed in a technical room close to the presentation area. Alternatively, a position that interferes as little as possible is chosen at the front of the classroom/meeting room. Also, take into consideration the wiring to the ceiling, floor boxes and the presentation area. If the described requirements for functionality and flexibility are ensured, it may be considered to place some of the central equipment (i.e. video switch) in the lectern.

Note that the equipment needs to be available for maintenance and repairs from both the front and the back of the rack. Racks mounted in niches or with the back panel against the wall must have wheels and be able to be pulled forward on the floor for maintenance. Cooling internally in the rack should be ensured by the AV supplier. See requirements in UFS 119 chapter 2.11. Note that both air circulation around the rack and heat dissipation should still be considered when deciding on the positioning of the rack and with regards to planning the ventilation/cooling system.

Cooling systems and sprinkler heads should not be placed directly over areas where the rack will be placed in case of leakage/condensation.

For simpler classrooms/seminar rooms without vocal audio systems and for simple/standard meeting rooms, it is usually not necessary to have a separate equipment rack. Button-based control panels frequently have the control central integrated into the panel, and smaller video switches, etc. may often be placed in the lectern or in wall-mounted cupboards/shelves. See the recommended requirements for designing for racks and lecterns in UFS 119 chapter 2.11 and 2.12.

Establishing control rooms for auditoriums is not recommended as it is our experience that these are seldom used. Assistance during presentations and operational support may either be solved locally in the room or by using remote control and remote monitoring of the AV systems over the network. See UFS120 part II Operational support.

5 Sound system

This chapter provides recommended designs for loudspeakers and microphones for various room types. Additionally, the functionality of central equipment (audio processor/mixer/program audio switch) and recommended designs for the hearing impaired are described.

System descriptions with regards to purchasing equipment should be developed for each individual room based on the recommendations below. This may be a difficult task, and an alternative is to specify that the bidder/supplier designs the sound systems based on the guidelines in this chapter.

In general, it is referred to Statsbygg planning instructions "PA 5551 Romakustikk og elektroakustiske anlegg" (PA5551 Room acoustics and electroacoustic systems) [4]. This documents provides recommendations for both room design in order to achieve good room acoustics, and principles for designing speaker systems adapted to rooms of various shapes and sizes.

Note that there are requirements for the verification of the tendered speaker designs and control measurements of the installed sound systems. See requirements in UFS 119 chapter 3.2 and 3.14.

See chapter 3.4.2 Acoustics.

5.1 Loudspeaker designs

5.1.1 Large auditoriums (more than approx. 80 seats)

Large auditoriums are usually equipped with a separate audio amplification system for vocal and program audio.

Vocal audio

If the ceiling height allows, the vocal audio should be rendered by a central loudspeaker group above the stage. (This may be solved by a single loudspeaker.) Additionally, it may be necessary to use supporting loudspeakers flush-mounted in the back part of the ceiling. Any supporting loudspeakers should render both vocal and program audio.

In rooms with low ceiling height (typically when the auditorium only spans one floor), it is recommended to render vocal audio through flush-mounted speakers in the ceiling. The positioning and the number of speakers should be adapted to the shape of the room and the distance to the audience.

Program audio

For program audio it is preferable to use a pair of stereo speakers mounted on the presentation area. The speakers are mounted either flush with the transition to sloped ceiling or with an adjustable bracket next to the projection areas.

For rooms with a low ceiling and a long distance to the back row, it may in some cases be relevant to use speakers mounted flush with the ceiling for program audio as well, i.e. a shared system for vocal and program audio.

It may also be a good design to use a combined vocal and program sound system for larger auditoriums as well, with a speaker/group of speakers mounted on each side of the stage. A prerequisite is that the speakers can be mounted far enough away from the presentation area to reduce the acoustic feedback, and that the tendered speakers are of high quality and that their directionality is carefully adapted to the audience area.

See chapter 8.2 for adaptations of speaker designs in classrooms equipped for distance learning.

5.1.2 Small auditoriums (up to approx. 80 seats)

Smaller auditoriums usually have no need for vocal audio systems, but this requires that the room acoustics are optimized for vocal communication from the stage, see chapter 3.4.2 Acoustics.

Program audio systems are designed as for large auditoriums.

If vocal amplification is necessary, it can usually be integrated into the program sound system. Alternatively, use the same solutions as for large auditoriums.

5.1.3 Classrooms and seminar rooms

In classrooms and seminar rooms it is usually sufficient to use a simple speaker design for program audio. It is recommended to use two active speakers, mounted on each side of the screen.

If the rooms are to be utilized for critical listening (music rooms, etc.), special sound quality requirements exist and it will often be practical to use hi-fi speakers or active studio monitors. Please note that studio monitors usually are intended for near field listening and the selection of the type of speakers and the positioning must be adapted to the shape, size and usage of the room.

5.1.4 Meeting rooms and group rooms

All meeting rooms and group rooms with permanently installed video display systems (flat panel monitors or projectors and screens) should also be equipped with a simple speaker design for program audio. It is recommended to use two active speakers, mounted on each side of the screen.

For rooms with special requirements for audio quality, see chapter 5.1.3 above.

See chapter 8.2 for adapting speaker designs in meeting rooms with video conferencing.

5.1.5 Movie support

In auditoriums with movie support, the sound system should be upgraded in order to render multi-channel sound. This functionality should be integrated with the speaker design for vocal and stereo program audio. The following designs are relevant:

- Program audio speakers mounted on the front wall are also utilized for the left/right channel in a multi-channel system. These may also be supplemented with two additional bass speakers. Bass speakers are preferably mounted flush with the ceiling, if possible
- In rooms with a central speaker group, this group is also utilized as the center channel when showing movies. This involves adapting the speaker group to the program audio speakers. Alternatively, install a separate center speaker.
- Surround channels are rendered either by using flush-mounted ceiling speakers on the sides or in the back part of the ascending seating, or by using separate cabinet speakers mounted high up on/in the side walls (and possibly the back wall) of the ascending seating. Ceiling speakers give a less visible installation, and may also be used as support speakers for vocal audio, while wall-mounted cabinet speakers provide a better rendering of the surround channels.

5.2 Microphone system designs

It is recommended to base the vocal audio amplification in classrooms on wireless headband microphones. This provides good audio quality and freedom of movement for the lecturer. Additionally, the wired gooseneck microphones are mounted in rostrums and rostrum extensions. In auditoriums and classrooms equipped for distance learning it is also recommended to use at least one wireless, handheld microphone.

In order to provide a more flexible usage, it is recommended to install extra jacks for wired microphones in the auditorium.

Recommended solutions for the various room types are provided in part 0 **Error! Not a valid bookmark self-reference.**.

5.3 Central audio equipment

In rooms with vocal audio systems, it is recommended to base the sound system on an integrated digital signal processor DSP). This processor should ensure all the necessary processing, mixing, routing and volume control for both vocal and program audio systems. Relevant processing includes the following functionality:

- Compressor/limiter for microphone inputs
- Echo cancelling for distance learning (may also be solved in the video conferencing codec)
- Frequency equalization
- Frequency divider for any bass speakers
- Individual time delays for the various speaker circuits/groups to ensure correct localization of vocal audio towards the stage.

Functionality requirements are described in UFS 119 chapter 3.8, and it will be up to the tenderer/supplier to adapt the tendered solution to the described functionality.

For multi-channel sound in connection with screening movies, it is recommended to use a separate surround processor with digital audio input, like you will find in a good home theater solution. See chapter 11.2 Appendix E. Movie support

In rooms that are intended to have only a program sound system, there is usually no need for a DSP. In simple installations it is often possible to use the audio out on the projector. The sound will then accompany the chosen video source and the volume is adjusted by using the volume control for the projector. A video switch may also be used where the sound for each source is routed together with the video signal, or a dedicated program audio switch. It will be up to the tenderer/supplier to specify a solution that satisfies the technical and functional system requirements provided in UFS 119.

5.4 Distance learning and video conferencing

Adapting sound systems in classrooms equipped for distance learning and meeting rooms equipped for video conferencing is described in chapter 8.2.

5.5 Solutions for the hearing impaired

All rooms with vocal audio amplification should have solutions for the hearing impaired. In addition, all public service points should be equipped with induction loops. Beyond that, it is normal to install mobile solutions in a variety of other rooms.

The requirement is provided by "Teknisk forskrift til plan- og bygningsloven" (Technical regulations for the Planning and Building Code) (TEK) [10]. See chapter 3.5 Universal design and UFS 119 Technical and functional system requirements chapter 3.5.1.

5.5.1 Permanent induction loop systems

Usually, induction loops are installed, but because of disturbances between the various loops it is often difficult to use induction loops simultaneously in two or more rooms just above, or next to each other. So-called phase loops ensure reduced disturbances and a smoother rendering throughout the coverage area, and it is recommended to use this for all rooms with vocal amplification and induction loops.

All induction loops should be mounted in the floor or in the ascending seating. Ceiling installations are not recommended. If it is not possible to cast conduits or install loop cables under light gallery construction, ribbon cable/flat cable should be used and installed under the flooring.

5.5.2 IR system

In some cases, for instance due to disturbances or confidentiality requirements, an induction loop is not suitable. IR systems may be utilized in these situations. IR systems use infrared light to transmit. The audio signal may either be presented with separate headphones or by using a mini-loop connected to the user's hearing aid worn on the body. The receiver should be worn visibly to ensure clear view between the receiver and the transmitter.

Be aware that IR systems will increase the risk of stigmatizing due to it being more obvious who is using the equipment. Additionally, the systems require establishing a rental system for personal equipment. Induction loops are therefore preferable where possible to install.

5.5.3 FM systems

FM systems are often used as personal systems for hearing impaired students. A personal FM system usually consists of a pocket transmitter with a lapel microphone for the lecturer and a receiver for wearing that is connected to headphones or mini-loops, like an IR receiver. A key difference, compared to IR systems, is that free visibility is not required between the transmitter and the receiver and the student may therefore wear the receiver concealed. The transmitting equipment is also relatively similar to a wireless lapel microphone with a pocket transmitter, as used in large auditoriums, and it will therefore be simple for the lecturer to use the system.

The primary drawback when using an FM system is that the system uses radio waves in the same way wireless microphones do, and may therefore interfere with other FM systems and radio equipment. It should still be resolvable in most cases. Please note that FM systems may not be used where there are confidentiality requirements.

If FM systems nevertheless are being purchased, and some rooms with vocal audio amplification can't be equipped with induction loops, permanent FM transmitters should be installed instead of IR systems for these rooms. The permanent transmitters should be compatible with the receivers included with the personal FM systems, so the students may use the same receiver for all rooms.

5.5.4 Mobile induction loop systems

For rooms that are not equipped with vocal audio systems, passive induction loops may be installed and terminated via a wall jack. These loops are used together with a mobile induction loop unit. This is a suitcase containing a wireless microphone and an induction loop amplifier, and should be able to be transported to the room with the actual loop permanently installed. By connecting the unit to the loop jack and 230V, the system should be ready to use.

Note that the size of the induction loop amplifier must be adapted to the size of the room and it may therefore be difficult to ensure correct usage and sufficient flexibility. It is recommended to primarily use personal FM systems if there is a need for mobile solutions for the hearing impaired.

6 Video system

Auditoriums and seminar rooms should have flexible, modern presentation tools that can be adapted to lecturers with various wants and education methods. This provides guidelines for choosing video designs. In meeting rooms and group rooms it will usually be sufficient to use simple presentation designs.

In this chapter we present the recommended designs for blackboards and display areas (screens), presentation equipment and curtains. The functionality for the central equipment (video switches and converters) is also described.

System descriptions with regards to purchasing equipment should be developed for each individual room based on the recommendations below.

6.1 Blackboards and display areas

For classrooms it can often be challenging to achieve a good design of the presentation area which ensures both good working conditions for the lecturer and good visibility for everyone in the room. See chapter 3.1 Floor plan and room design.

In addition to using a floor plan together with a furnishing plan, a cross-section of the room and a sketch of the presentation area will be a very useful basis for planning the design of the presentation area.

For meeting rooms, the primary challenge is to position both the blackboard (whiteboard) and a flat panel monitor/screen in a way that ensures the visibility for everyone in the room without having to place the board and the flat panel monitor/screen on different walls.

6.1.1 Blackboards

Board widths should be defined during the user process, and the needs/wants for the classrooms often vary between the different disciplines. Please note that the increased use of computer-based presentations, interactive boards, and document cameras reduce the need for large blackboards. It may often be easier to achieve a good design of the presentation area if a smaller blackboard suffices, preferably positioned to the side of the display area.

Liftable blackboards are not recommended, unless specifically desired by the users, and if the need is evaluated as real. Track-mounted blackboards that can be pushed horizontally may on the other hand be relevant in some cases where combining sufficient blackboard space with a favorable positioning of the display area/screen proves difficult.

For classrooms with a permanently positioned lectern, the blackboard should be positioned near the lectern.

In meeting and group rooms, the positioning, size and number of boards should be adapted to the application of the room. It is recommended to place both the blackboard and the flat panel monitor/screen by one of the side walls if the shape of the room and the conference table design allows for this, to ensure that everyone in the rooms can focus on one presentation area. A roll-up screen may be installed, completely or partially covering the board. In some meeting and group rooms it may be a good alternative to place the blackboard and the screen/flat panel monitor on opposing side walls due to a lack of available space. It is also possible to place a narrow blackboard next to the flat panel monitor/screen, in addition to a wider blackboard on the opposing side wall or on one of the long walls.

It is recommended to use whiteboards in all rooms. This removes the need for a sink by the presentation area. But be aware of the risk of reflections from the whiteboard, especially during distance learning.

The recommended board height is approx. 1,2 m, with the bottom edge positioned 0,9 m over the floor. If desired, the boards may be equipped with an AV list for hanging paper.

6.1.2 Display areas

Display areas are used as a collective term for manual and motorized screens that are rolled up, framed or consist of wall surfaces used for displaying the image from a projector. For auditoriums, it is recommended to use two display areas side by side if the width of the presentation area allows for this.

Permanent display areas (skim-coated, painted wall or framed screen) should be used unless there is a need for freeing the space behind the display areas when these are not in use as boards, etc. The display areas should be positioned above or next to the board. If video is projected directly on the wall, this creates strict requirements for the wall surface.

Mobile display areas (motorized or manual screens) should be used when permanent display areas are unsuitable. It is recommended to only use motorized screens in classrooms. Also, be aware of any potential conflicts between the board lighting and mobile screens placed in front of the board. For rooms where the ceiling height is limited, it will often be necessary to mount the screen box flush with the ceiling to ensure that the effective display area is installed as high up as possible. Please note that because of possible conflicts with the other technical installations, it may be difficult to fit a flush-mounted screen box, and the cost of adjusting the ceiling may be relatively high. External screen boxes should, due to esthetics, be installed close to the ceiling, unless the presentation area is very tall. The length of the screen should be sufficient to ensure that the bottom of the projected image has the desired height, se recommendations below. See technical and functional system requirements in UFS 119 chapter 4.19.

Whether the display areas should be placed above or next to the board, is decided by the room's layout. Placing it above the board is only relevant for auditoriums with galleries and both adequate height on the presentation area and a gallery layout that ensures that the ones in the front row may look up at the display area without having to bend their necks too far back. This means that the front row of the gallery should be placed higher than the stage and be at least 4 meters from the presentation area.

In smaller rooms with permanent lecterns, it will usually make more sense to position the lectern and blackboard against the outer wall while the display area is placed on the opposite side of the presentation area.
In classrooms with level floors, the bottom edge of the display area should be a minimum of 1,4 meters above the floor. The absolute minimum height is 1,2 m. In rooms with galleries and/or a raised stage, an evaluation of the visibility conditions should be performed based on a cross-section of the room. It is important that everyone is able to see the entire display area!

Meeting and group rooms should be equipped with either a manual/motorized screen or a flat panel monitor. In rooms with a maximal audience distance of approx. 5 m, i.e. approx. 25 m^2, it is recommended to use a 50” flat panel monitor. A screen should be used in larger meeting rooms. (As of today, flat panel monitors larger than 50” are disproportionately expensive.) It is recommended that simple meeting rooms are equipped with manual screens, but motorized screens are recommended for standard meeting rooms with control systems.

Recommended size of display areas is shown in figure 4-5. Please note that a widescreen projector (16:9) should be the minimum standard for all rooms. The recommended size depends on whether compatibility with traditional video format (4:3) is desired. (In most cases this is no longer relevant.) The recommendations are

based on the sources being set to XGA/WXGA resolution. If the sources utilized are set to a higher resolution, web pages, PDF documents, spreadsheets, etc., will usually have fonts that are too small to be legible in the back row. This is important to take into account when setting up image sources and training the users. (In Windows, Ctrl + scroll is a very useful function for easily zooming in or out on a webpage or in a document.) Display areas that are slightly larger than shown in figure 4-5 may be used if suitable, but smaller display areas are not recommended.

Note that the recommendations implies that the primary application is regular teaching with PowerPoint presentations, etc. If the room will be used for special purposes, like showing map data, CAD drawings, etc., or other applications requiring high resolution and a high level of detail, the size of the display areas should be increased. To start with, the recommended sizes in figure 4-5 may be increased with approx. 40 %.

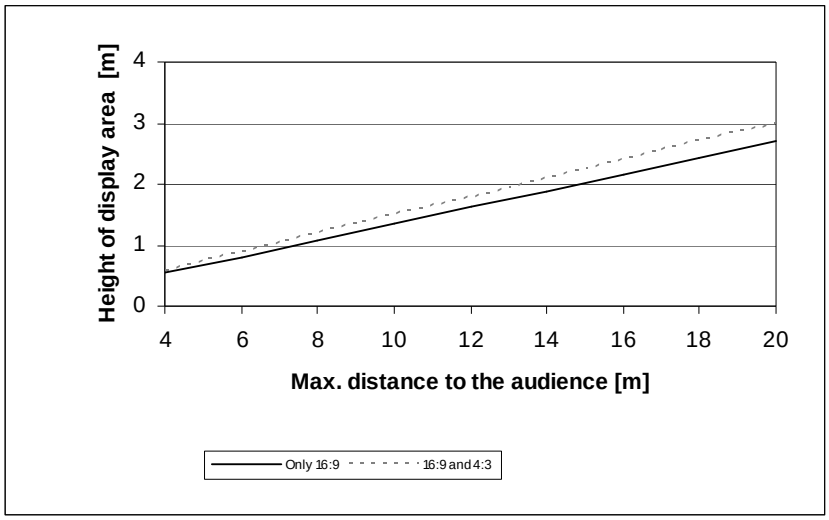

Figure 4. Recommended height of display area as a function of distance to the audience.

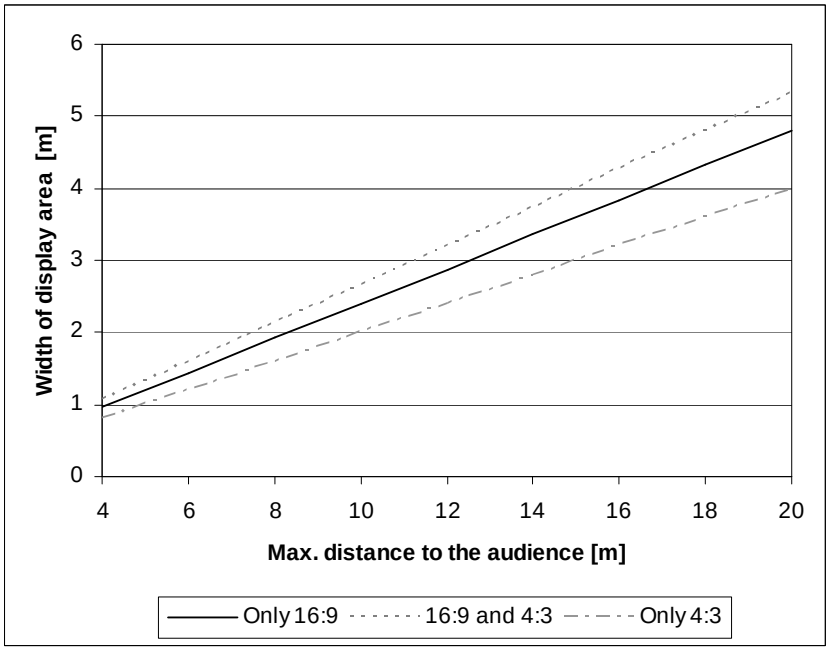

Figure 5. Recommended width of display area as a function of distance to the audience.

In auditoriums, **support for screening movies** is often desired. This is difficult to combine with two projectors that are side by side. A third centered projector especially adapted for screening movies is recommended in that case. If two screens side by side is used, a third motorized screen should be installed in front of/behind these. The minimum horizontal size when showing movies is 40 % larger than the recommended width given in Figure 5 (only 16:9), but usually the available height of the display area is the limiting factor. The optimal horizontal size when showing movies (provided that the format is 16:9, with optional format 2,35:1), is approx. 80 % larger than the recommended width given by Figure 5 (only 16:9).

The following installation heights is recommended for display areas:

- **Large auditoriums with display areas installed above the blackboard**: The bottom edge of the display areas are installed just above the top edge of the blackboards. An optimal solution is to expand the wall above the blackboards with approx. 0,4 m, and make a niche above the blackboards for installing lights and any background curtains for distance learning.
- **Auditoriums and seminar rooms with galleries and screens installed in front of the boards**: The lower edge of the display area must be installed a minimum of 1,2 m above the floor, but in many cases 1,4 m will be the optimum height. The optimum height must be evaluated based on the distance to and the height of the first row in the gallery, and a visibility analysis for all the seats in the gallery.
- **Seminar rooms and classrooms with level floors:** The lower edge of the display area should be installed a minimum of 1,4 m above the floor. If the ceiling height allows, it may be suitable in some cases to raise the lower edge of the display area up to 1,6 m, but this should be evaluated based on the distance to the front row.
- **Meeting rooms**: If the display area/screen is positioned by one of the ends of the table, it is recommended to install the lower edge of the display area approx. 1,2 m above the floor. Depending on the furnishings, this height may be lowered in some cases if all the participants are still ensured a clear view.
- **Meeting rooms for video conferencing:** The rooms should be designed so that everyone in the room is facing the camera/screens. In order to achieve a natural communication style with a distant party, the screens should be placed at approximately the same height as a seated person. The recommended height for the lower edge of the screen is therefore approx. 0,95 m above the floor.

With the exception of solutions where the display area is placed above the blackboard, the display area should in general be placed as low as possible, while ensuring that everyone in the room is able to see the entire projected image/screen.

The distance to the first row is decided by the size, installation height and the horizontal positioning of the display area. In classrooms the first row is often placed too close to the presentation area in order to fit the desired number of seats. This is especially a problem in seminar rooms/classrooms with level floors. The following rules of thumb should be used:

- **The recommended maximum vertical viewing angle is 20 degrees**, measured at the relative center of the display area. For instance will a 1,6 m high screen, installed with the lower edge 1,4 m above the floor give a 1 m difference between the center of the screen and eye level (1,2 m). The minimum audience distance will then be approx. 2,9 m. If necessary, the maximum viewing angle may be increased to 25 degrees, which for the above example equals a minimum audience distance of 2,4 m.
- **The recommended maximum horizontal viewing angle is 45 degrees**, measured at the relative center of the display area. This means that the distance between the presentation area and the outermost seats in the front rows equals the difference in distance between the wall and the center of the screen, and the wall and the outer edge of the audience area/gallery. If necessary, the maximum viewing angle may be increased to 55 degrees.

Typical solutions for designing the presentation area for various room types is shown on figure 6-10.

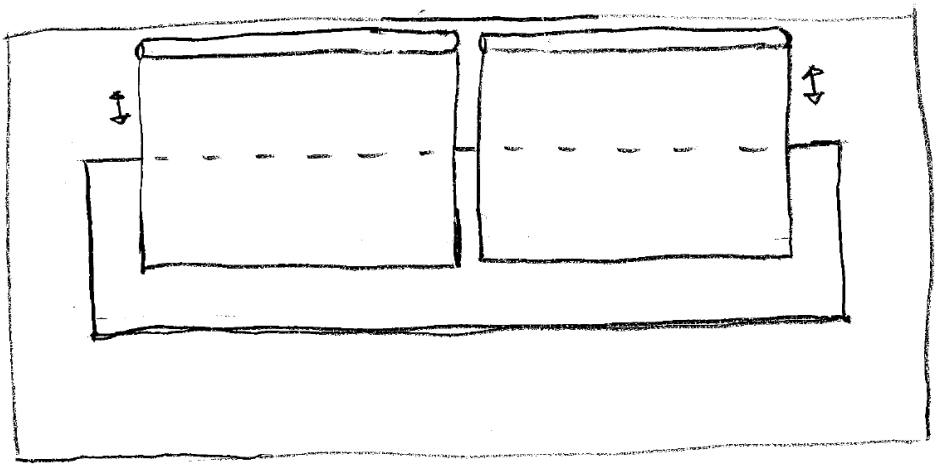

Figure 6. Example of layout of presentation area. Large auditorium, screen installed in front of blackboard.

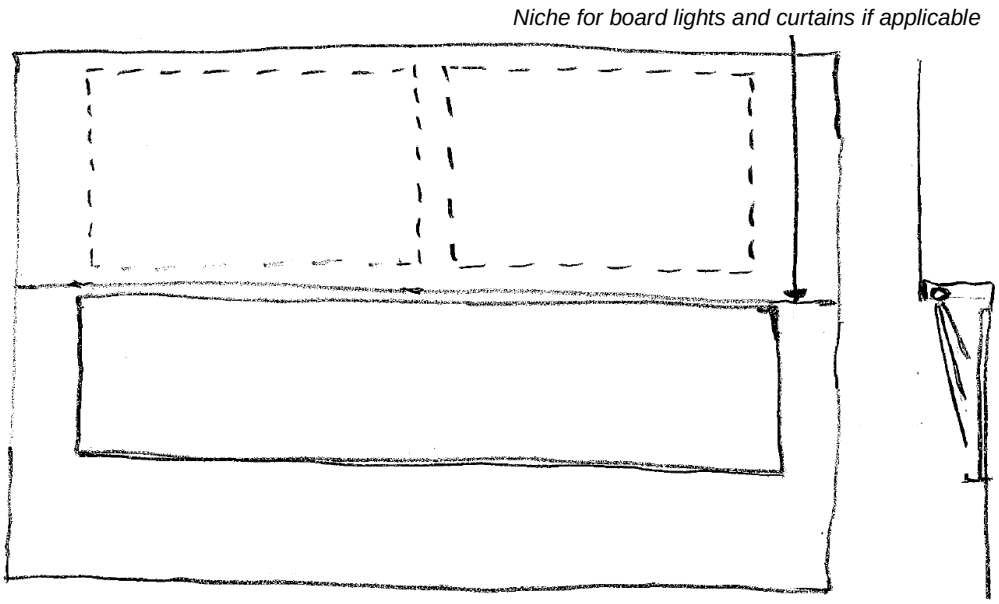

Figure 7. Example of layout of presentation area. Large auditorium with permanent display areas installed above the blackboard and niche for board lights and curtains if applicable.

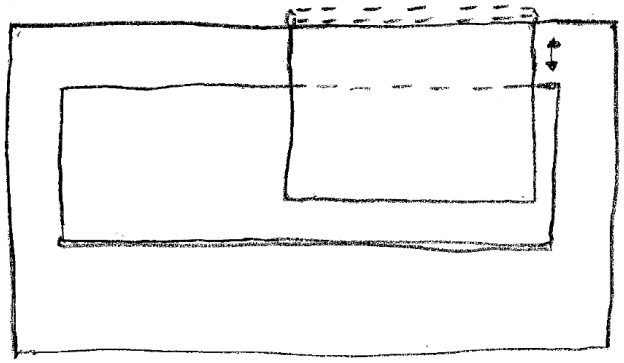

Figure 8. Example of layout of presentation area. Seminar rooms with low ceiling height and flush mounted screen in front of blackboard.

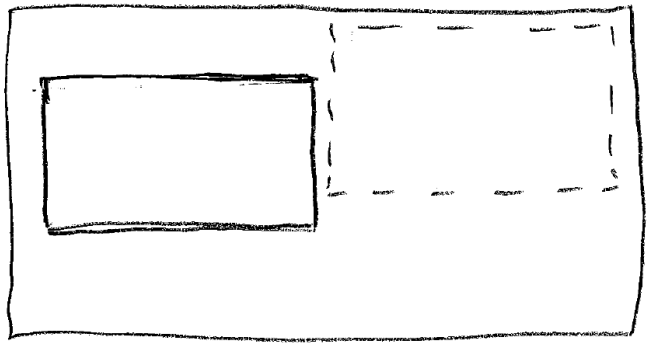

Figure 9. Example of layout of presentation area. Seminar room with narrow board and permanent display area.

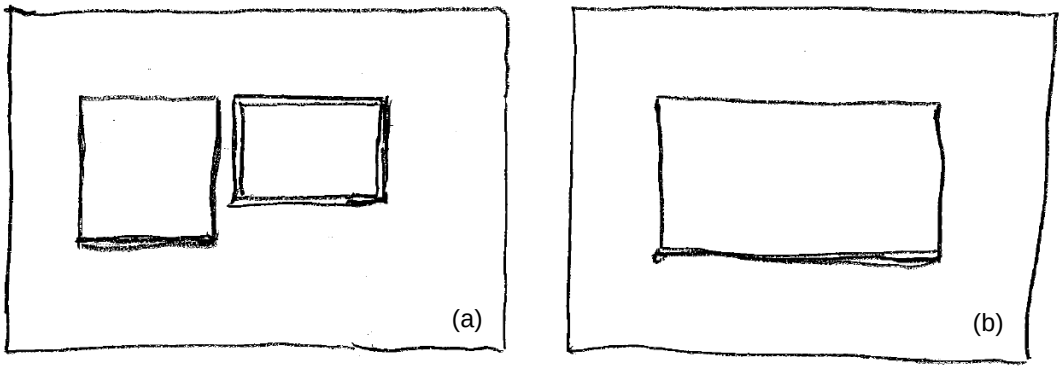

Figure 10. Example of layout of presentation area. Meeting rooms with a flat panel monitor and narrow board on front wall (a) and wide board on back wall (b).

6.2 Presentation equipment

In addition to traditional blackboards and flipboards, the presentation equipment includes a stationary PC/laptop, interactive boards, playback equipment for audio and video (DVD player, video camera, etc.) and a document camera. Traditional overhead projectors are not recommended, since a document camera covers this function with a far higher image quality, simpler installation and a more flexible usage area.

The recommended equipment for the various room types is described in part 0 System description. Most of the presentation equipment is assumed to be well-known, but the interactive board design and the document camera are described below.

6.2.1 Interactive board design

Interactive board designs are often installed to supplement traditional black boards in classrooms and meeting rooms. These boards are very well suited in connection with distance learning.

In smaller rooms (with a maximum viewing distance up to 10 meters) usually a wall-mounted interactive board is used. This is a touch sensitive screen which is used in connection with a video projector or a flat panel monitor. Using a PC with adapted software you can control computer applications and write with a digital pen directly on the board, as well as save and distribute notes and presentations. A wall-mounted interactive board is usually used instead of a screen.

Rear-projection is used for interactive boards where this is technically possible and economically acceptable, but front-projection is usually recommended. A flat panel monitor with an overlay is not recommended because the distance between the actual screen and the overlay gives the wrong location for the digital pen when looking at an angle.

For large classrooms and meeting rooms for video conferencing, or for rooms where auditorium equipment is desired, an interactive computer monitor will be a better alternative. This is an interactive pen display designed to be installed on a table with an interactive board functionality which replaces the monitor for the stationary PC in the lectern. The on-screen image is also shown via the projector. This design ensures good visibility for everyone in the classroom and enables the lecturer to make notes on the board while facing the students. For meeting rooms with video conferencing, an interactive monitor with provides the option of transferring notes and sketches to the remote party in real time while facing the camera and the monitor.

Because interactive boards require special software, a stationary PC is recommended for all rooms with interactive boards. As an alternative, there are products with cables (USB) with integrated memory sticks which automatically start the necessary software when connected to a PC.

6.2.2 Document cameras

Document cameras are often installed in auditoriums/large classrooms and advanced meeting rooms. They may be used for showing documents, making notes directly on images/documents during presentations, or for showing objects (mostly relevant for auditoriums or some types of labs). The image is shown via a projector or a flat panel monitor.

Document cameras replace traditional overhead projectors.

6.3 Video projectors

It is recommended that all projectors, flat panel monitors and interactive boards in seminar rooms/classrooms, meeting rooms and group rooms are in widescreen format[1]. It is also a prerequisite that all video sources are adapted to widescreen format. This ensures compatibility with most newer monitors and laptops. In addition, using widescreen format reduces the necessary image height as illustrated in figure 4, something which may be an important factor for rooms consisting of a single story.

[1] Widescreen format usually means 16:9, but some projectors, flat panel monitors and interactive boards also use the format 16:10. Projectors adapted to interactive boards must be supplied with the same image format as the interactive board, but apart from that, equipment units with respectively 16:9 and 16:10 formats are evaluated for use in the same installation.

In auditoriums, especially rooms spanning over two stories and which have two projectors side by side, it may be relevant to use the 4:3 format. Choice of format must be done based on the layout of the room, the application area and an evaluation of whether it is important to use the same image format for all rooms. A 4:3 format may be better suited for traditional presentations (PowerPoint or similar), but the consumer market development still makes it probable that the widescreen format will take over in time. Because the 4:3 format requires a narrower horizontal size, this design may also provide a better possibility for using a board next to two projected images.

The light output of the projectors must be adjusted to the size of the room, but the requirements in UFS 119 are based on using video projectors with full light in all rooms. The lighting designs should still be adapted to avoid stay lighting towards the display areas, see recommendations in chapter 3.2.

If there are specific requirements regarding image quality and correct color rendering, for instance in connection with medical equipment (displaying x-rays, etc.) petroleum technology, mechanics/simulations, architecture/design or biology, the projector requirements needs to be specially evaluated: This goes for both light emission, resolution, color rendering and required inputs. These applications also require special focus on good lighting designs. Note that for usage with medical equipment it may be suitable to utilize projectors that support DICOM (see http://dicom.nema.org/.)

6.4 Central equipment

In all large AV systems, one or more video switches/matrices are used for routing the various video sources to the projectors, monitors, video conferencing codecs, etc. Usually, a video switch for each signal format is necessary. For smaller installations it is often possible to use the video switch in the projector or the flat panel monitor, thereby eliminating the need for a video switch. In rooms without vocal audio systems, it is often suitable to use a video switch that routes the sound together with each video source, i.e. with an integrated program audio switch. It will be up to the tenderer/supplier to specify a solution that satisfies the technical and functional system requirements provided in UFS 119.

Even if digital formats (DVI, HDMI and DisplayPort) more and more often are supported by PC's and other video sources, and by flat panel monitors/projectors, it is still recommended to use VGA (RGBHV) as the primary signal format for the video systems, but connecting a laptop and a video camera should also include DVI/HMDI for in order to increase the compatibility with new equipment. HDMI/DVI inputs are should still be able to be converted to RGB format in rooms with analog image matrices/switches.

The reasons are large price differences, compatibility requirements with video sources with only analog video outputs, maximum cable length and uncertainty about which digital video format will be the dominating one for PC's (DVI or DisplayPort). Even if digital video formats may provide a higher quality video, there will normally not be any discernible difference in the video quality for PC based presentations, etc. in classrooms and meeting rooms, as long as the video system is of good quality and the video outputs are set with a resolution adapted to the projector/flat panel monitor. In the long run, digital video formats are still expected to take over. If there are special requirements regarding video quality it is recommended to use digital video format, usually DVI or possibly HDMI. See UFS 119 Technical and functional system requirements, chapter 4.3.

To ensure flexible presentation designs for the auditoriums, the video switch should allow full, individual control from the control system over what is shown on the monitor/interactive computer monitor in the lectern, on video projectors and for outputs for distributing video signals to external parties. All inputs should be able to be routed to all outputs. or a selection of them, for all combinations and for all signal formats. (This functionality is included in UFS 119 Technical and functional system requirements, chapter 4.1.) Note that this usually does not imply that the user should have access to this flexibility, but that full flexibility should be accessible when programming the control system and for any advanced functions on the control panel.

The maximum transfer distance for digital video signals is limited, and it will therefore quite often be necessary to use signal amplification or converters in order to transfer the signals via twisted pair or fiber cable. It will be up to the bidder/supplier to include these converting solutions where required. See comments regarding selecting cable types in chapter 3.3.1 Electrical outlets and network connections.

In advanced rooms equipped for distance learning, it is recommended to install a scaling unit which automatically adjusts the video format for each source to a video conferencing codec. This increases the video

quality, and lowers the entry level for connecting for instance a laptop since the lecturer does not need to change the resolution on the PC. The scaling unit may also be dimensioned to include video projectors.

In other rooms without stationary PC's, where the users private laptops will be the primary presentation source, it is recommended to install a scaling unit as well. This is especially relevant in meeting rooms/group rooms and simple classrooms. In our experience, it is often difficult for the users to adjust the video output on their laptops to make the resolution match the optimal video format for flat panel monitors or projectors. Even if both the PC and the flat panel monitor/projector has WXGA as the specified format, there are small variations in the actual resolution within this format. A scaling unit will both improve the video quality and reduce the number of errors and support tickets regarding connecting a laptop.

6.5 Distance learning

How to adapt video systems for classrooms equipped for distance learning is described in chapter 8.3.

6.6 Blackout curtains

It is usually recommended to install motorized blackout curtains controlled via the AV system in all auditoriums with light entry, and in all other classrooms utilized for distance learning. Note that the need for blackout curtains for classrooms not equipped for distance learning must be evaluated based on the orientation (compass point) and the layout of the windows. Meeting rooms for video conferencing should also have blackout curtains, but manual curtains may be used here. The curtain system should minimum cover windows with daylight entry, but preferably also include any windows facing hallways, etc. Motorized curtain systems should be controlled via the AV control system.

Curtains should normally be light-proof blackout roll-up curtains in U-profiles on both sides of the opening. Be aware that this design requires an internal window sill, so the windows should not be installed flush with the inner wall. As an alternative, light-proof curtains using tracks may be installed, but this will usually allow some light in under and on the sides of the curtains. Be aware that openable windows should be avoided where blackout designs are required, due to open windows and handles conflicting with or destroying the blackout curtains.

In other rooms with video projectors of flat panel monitors, it should be ensured that the curtains or shading devices (external blinds, for instance) gives sufficient control over the light entry into the room. For buildings with weather-controlled shading devices, these need to be able to be overridden manually in each room in order to ensure this requirement.

For pricing purposes, the blackout requirements for each of the individual rooms must be stated in the request for offers, either in the description or as a drawing.

7 Control systems

All rooms, with the exception of simple meeting rooms, are recommended to be equipped with control systems. In advanced rooms, the control system should control all functions in the room, including audio and video systems, lighting and curtains. For simpler rooms, only the AV system is presumed controlled by the control system. The lighting is recommended to be controlled through a separate control system in order to simplify and reduce the cost of the control system for the AV equipment. See chapter 3.2 Lighting.

Recommended designs for the various room types are provided in part 0 **Error! Not a valid bookmark self-reference.**. See detailed functionality requirements in UFS 119.

Integration with fire alarm systems are described in chapter 18.7.

7.1 User interface

The main principle should be to establish user interfaces that are as simple and intuitive as possible, where the layout and positioning of the control panel is adapted to the functionality of the various rooms.

In advanced rooms it is recommended that the control panel be placed on an interactive pen display, while in simpler rooms a panel with buttons may be used. Button panels are usually sufficient when only the source

selection, volume and simple lighting needs to be controlled, while interactive pen displays are recommended when controlling playback equipment (DVD players, etc.) and in rooms equipped for distance learning. interactive pen displays also provides the option to have advanced functionality/settings hidden from regular users.

Designing good user interfaces is demanding, especially for advanced rooms. The various universities and colleges have established different standards, and it is not realistic to suggest a standard layout that everyone will want to use. Instead, it has been selected to present a few main principles for how the user interfaces should be designed:

1. Focus on **clarity**. The functions that are most central should be available from the main screen.
2. There should be a high degree of **recognizability** between rooms with different functionality and equipment, and between various rooms within the same educational facility.
3. What happens when the lecturer presses a button should be **predictable**. This means that care should be taken to not include many functions for one button, for instance source selection, adjusting the lighting, curtains and controlling the screen, without making it clear to the lecturer which response he/she may expect. Function controlled responses will simultaneously simplify the user interface and reduce the number of buttons and submenus.
4. **Reduce** the number of **submenus**. It is important that users can't get lost in the menu structure. Tabs should also be avoided. Navigation buttons in the menu structure and possible help functions should be available in the same place for all submenus.

See also chapter 7.3 Lighting control. Additionally, it is recommended to use the reference database for examples of user interfaces in use for this sector, see part 0 **Error! Not a valid bookmark self-reference.**.

7.2 Support for assisted presentation/operation/monitoring

It is recommended that all control systems in classrooms, standard meeting rooms and meeting rooms for video conferencing are supplied with a system for assisted presentation/operation/monitoring via the network. This simplifies the operation, because among other factors, the lifetime of the lamps and possible problems with the AV system may be monitored and because it provides the option of helping the lecturer with setting up the systems. Installing an IP camera in each room may also be appropriate to ensure that the support personnel can see what is happening in the room.

The system should be able to be operated by one person, but have the option of using assisted presentation when required. This is especially relevant in connection with distance learning, but requires support personnel with the capacity and relevant competency within the organization. See a more detailed description in UFS 120 System for operational support and transmission of sound and video.

The above-mentioned functionality may replace traditional production rooms in the back part of the auditorium.

7.3 Lighting control

Principles for lighting designs for various room types are described in chapter 3.2.

All light circuits/groups should be able to be individually controlled via the AV system in auditoriums, but it is usually not desirable that the lecturer has access to advanced settings. Instead, it is recommended to establish a few pre-programmed scenarios adjusted adapted to the various educational situations/functions relevant for the auditorium.

At every entrance install a pulse switch which activates the control system for normal lighting in the room. Alternatively, movement detectors that register whenever someone enters the room may be used.

In meeting rooms for video conferencing, it should be possible to adjust each type of lighting (front lights towards persons and conference tables, general lighting above/behind persons and lighting towards the walls) individually. Pre-programmed scenarios for various applications of the room should also be in place.

See recommendations for lighting control for rooms where the lighting is not controlled via the AV system in chapter 3.2.2.

7.4 Controlled 230V circuits

It is necessary to control a few 230V circuits via the AV system. In auditoriums and advanced seminar rooms/classrooms, it is recommended to plan the electrical installation with the following controlled circuits:

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

Note that due to the time required for starting up, storing settings, etc., cutting the power for certain units is not recommended. It should therefore be up to the AV supplier to decide where to use controlled circuits.

In simpler seminar rooms/classrooms, no controlled 230V circuits are required, with the exception of any motorized screens.

See chapter 3.3.2 Dimensioning and grouping of 230V circuits and user interface suggestions in chapter 18.1.

7.5 Flexible room layouts

The functionality of the control systems for seminar rooms with flexible room layouts is described in chapter 11.2 Appendix F.

8 Distance learning

It is usually required to equip some auditoriums and possibly some seminar rooms, for distance learning.

Please note that we have elected to differentiate between the terms distance learning and video conferencing in the UFS documents, even though both functions are constructed around a video conferencing codec.

Distance learning is used for systems primarily intended for educational purposes. In this instance the primary goal is to transmit lectures for students not presently on campus, or possibly to other rooms on campus. Students in other locations should be able to pose questions to the lecturer, but there is usually no need to provide direct communication between local students and remote students.

The distance learning functions should be incorporated into the other audio, video and control systems, but in order to provide an overview of the necessary functionality, we have chosen to collect the equipment and adjustments for distance learning in this chapter.

8.1 Surfaces and color choices

In rooms equipped for distance learning special care should be taken when choosing surfaces and colors for the sections of the room covered by video cameras. Tidy and clean surfaces that do not attract attention should be the goal, and the color choice should be adapted to avoid strong contrasts with whatever is in the foreground (usually the lecturer and a board). Grey and blue hues are well suited.

If stationary display areas are placed above the board covering the entire width of the front wall, it is recommended to use motorized background curtains that may be pulled in front of the board, covering it entirely or partially.

8.2 Sound system

In order to ensure the communication with distant parties, it is required to upgrade the sound system. It is also necessary to adapt the acoustic conditions in the room in order to reduce the risk of echoes (like for speaker phones/conference phones), and to ensure good vocal understanding for the distant party.

The following functionality must be ensured:

- A loudspeaker design for vocal audio must be designed in a way that reduces the feedback from the microphones on the stage. In practice, this means adjusting the directionality (coverage area) and placement of the loudspeakers so that the vocal audio as much as possible, is focused towards the auditorium/audience.

- Additionally, an extra speaker must be installed so the lecturer can interact with the remote party. It should only render vocal audio from the remote party. In rooms where a separate console for distance learning is used in front of the first row in the gallery (see chapter 8.3.1), the active speaker should be integrated with the console. As an alternative, a speaker may be flush-mounted in the ceiling above the stage. This is the most relevant design for smaller rooms.
- The lecturer should use the same microphone design as for the remaining vocal audio system. It is recommended to primarily use wireless headband microphones in connection with distance learning.
- Questions from the audience are communicated using a wireless handheld microphone or by the lecturer repeating the question. It is not recommended to have microphones hanging above the gallery as this in our experience will lead to problems with background noise from the students.
- Echo cancellation may either be solved by using DSP or built-in functionality in the video conferencing codec. It will be up to the tenderer/supplier to adjust the tendered design in a way that satisfies the technical and functional system requirements provided in UFS 119.

With regards to acoustic adjustments, it is important to avoid strong reflections from the vocal audio speakers towards the stage/lecturer's position. It is also important to avoid so-called flutter echo or other strong reflections from the lecturer back towards the stage. Generally, the reverb time should be slightly shorter than for rooms that are used solely for local teaching. See chapter 3.4.2 Acoustics.

8.3 Video system

The video designs must be upgraded and adapted to ensure that both students present in the room and students following the lectures from other places experience good communication with the lecturer and presentations that function well.

In order to ensure this, there are two particular aspects that need to be attended to:

1. The room should be equipped with flexible, electronic presentation designs suitable for external transmission.
2. Solutions for ensuring the lecturer's contact with the remote parties (supporting monitors) should be designed to help the lecturer focus on the auditorium while simultaneously watching the monitor with the remote students.

Technical and functional system requirements for the video conferencing codec, camera, etc., are described in UFS 119 chapter 4.14-4.18.

8.3.1 Supporting monitors for the lecturer

Usually, two supporting monitors are required for the lecturer to keep in contact with the remote parties. One monitor shows the outgoing picture while the other one shows the remote party (incoming picture). If desired, a single monitor may be used with a picture-in-picture (PIP) design, or a picture-and-picture design (PAP). PAP is especially well suited for widescreen format (16:9).

In small auditoriums and seminar rooms it is recommended to place the support monitors on the back wall. The monitors should be positioned as low as possible but high enough to provide the lecturer with a clear view of the monitors. The size should be based on the distance to the stage. For distances up to 10 meters it is recommended to use two flat panel monitors of approx. 50”. For distances between 10 and 12 meters, the size should be increased to approx. 60”.

In larger rooms, either place a distance learning console in front of the front row in the gallery with two flat panel monitors of approx. 32”, or install an extra projector with a motorized screen or a permanent display area on the back wall. The later alternative makes it easier for the lecturer to focus on the audience while simultaneously keeping an eye on the remote students, but is often difficult to integrate into the room in a practical manner. The outgoing video may either be shown as a PIP/PAP design on the back wall or on a monitor in the lectern.

8.3.2 Video camera

A video camera must be installed with a motorized pan-tilt-zoom (PTZ) stand and motorized zoom for rendering the lecturer. This camera is positioned centrally above/between the support monitors and must have manual remote control from the control system.

A camera is also installed in the middle of the front wall for rendering the audience. This camera is preferably positioned directly above the board, but in a way that does not conflict with any motorized screens. It is not recommended to use the automatic panning function. See recommendations for user interfaces in chapter 8.4.

It is often desirable to be able to film the lecturer for other purposes as well, for instance in connection with lecture broadcasts etc. In order to achieve sufficient flexibility, it is therefore advisable to allow being able to get an uncompressed video signal from the camera without going through the video conferencing codec. This may be done by splitting the signal from the camera to the codec and then transmit the signal directly to the image matrix in addition to the codec. See more details in UFS 120 chapter 8 and 9, as well as the technical and functional system requirements in UFS 119 chapter 4.15.

8.4 Control systems

As described in chapter 6.4, the video system should be designed to give the lecturer complete, individual control over what is sent to the monitor in the lectern, the projectors and the video conferencing codec.

The video conferencing codec should support simultaneous transmission of video from one of the video cameras and one presentation source (for instance a PC or a document camera).

The lecturer should be able to control the setup and composition of the distance learning sessions, i.e. what is sent to the remote party. These functions are recommended integrated into the control system, together with control over what is shown locally in the room.

It is therefore difficult to create a user interface which both provides flexibility for the lecturer regarding what is shown in the display areas in the auditorium, allows a functional composition/alternation between sources for remote students and which lets the lecturer focus on what he/she is presenting.

The following principles for expanding the user interface for the control system is recommended:

1. Let the lecturer focus on what is presented to the local students as much as possible. Transmissions to remote students should as far as possible follow the local setup. At the same time it is important that remote students are provided with an adequate educational situation.
2. Local students rarely need to see the outgoing camera image or video of the remote party. The exception is when remote students pose questions to the lecturer. Local students should not have to take distance learning into consideration, and the system should be designed to make the local students feel that the lecturer is focusing on them.
3. One projector should therefore be defined as the main projector. The image displayed on this projector is always transmitted to the remote party. The image displayed on a second projector will usually be an extra presentation source that is only displayed locally. This projector is also used for displaying the remote party when applicable.
4. In addition, the remote party will receive an extra video transmission showing the lecturer and the board, or the students during questions from the audience. The camera showing the lecturer should be adjusted to minimize the need for adjustments of zoom and direction during the lectures. It is recommended to pre-program the most frequently used camera positions to ensure that these can easily be selected from the control panel.
5. The system should be programmed so that contact may be established with the most frequently used partner rooms with only one keystroke on the control panel.

8.4.1 Assisted presentation

If there is operational personnel within the organization with the capacity and the competence to assist during the setting up and carrying out of the distance learning sessions, it may lower the threshold for the lecturer, and improve the quality of the lectures.

The recommended designs for assisted presentation is described in UFS 120, but the important thing is that the support personnel takes care of both the setup and the composition of the distance learning session, to enable the lecturer to primarily concentrate on the local students, and control what is displayed on the local video system. See also chapter 7.2 Support for assisted presentation/operation/monitoring.

In video conferencing meeting rooms, the need for assisted presentation is usually less than for classrooms with distance learning, but it may still be suitable to include the same functionality.

8.5 Portable solutions

If distance learning support is needed for several auditoriums/seminar rooms, but rooms are rarely used for distance learning simultaneously, it may be sensible to install a portable distance learning console that may be moved between rooms.

The console should contain a camera showing the lecturer, a video conferencing codec, supporting monitors and an active speaker for communication between the lecturer and the remote party. Two flat panel monitors are installed side by side. A camera is installed over the right monitor and the speaker is installed centered beneath the monitors. The active speaker may be replaced by one speaker adapted to the flat panel monitors. The console is placed in front of the front row and is connected to the AV system in each individual room. The permanent AV system in each room must be scaled and composed in the same way as for rooms with stationary distance learning equipment. It is recommended to fully integrate the controls for the distance learning console with the control system in the room, but using the integrated remote control in the video conferencing codec for setting up the distance learning sessions and controlling the camera may be considered. The camera displaying the audience should be permanently installed in each room.

A portable solution is especially a good alternative to a permanent installation in each room for large auditoriums, and the total investment costs will be greatly reduced.

8.6 Support for multiple remote parties

Support for multi-party conferences is either solved by using the built-in functionality of the video conferencing codec, or by using a dedicated unit (MCU). If distance learning and video conferencing systems are installed in multiple rooms, it is recommended to install a shared MCU. See recommended solutions in UFS 120 chapter 5.

9 Video conferencing

It will often be advisable to equip one or more meeting rooms for video conferencing. The rooms are preferably customized for this purpose, but may, if necessary, also be adapted for use as regular meeting rooms. Please note that this solution will be at the expense of the video conferencing functionality.

We have elected to differentiate between the terms distance learning and video conferencing in the UFS documents, even though both functions are constructed around a video conferencing codec.

Video conferencing is used for meeting and group rooms where the purpose is to establish a meeting situation between a remote and a local party. If so, it is usually equally important for everyone in the room to be able to communicate with the remote party, and the local and remote parties are usually equivalent.

The video conferencing functions should be incorporated into the other audio, video and control systems, but in order to provide an overview of the necessary functionality, we have chosen to collect the equipment and adjustments for video conferencing in this chapter.

9.1 Conference table design

One of the primary goals when designing conference tables for video conferencing meeting rooms is to ensure that all the participants are covered by one video camera, and that the distance to the camera is as similar as possible for all the participants. This ensures the best possible focus without having to adjust the camera during a conference.

It involves the following:

1. Limit the number of seats in the room. Under ideal circumstances, a video conference does not have more than 6-7 people in each location. The maximum number of people for an acceptable functionality is approx. 10 people.
2. The conference table should be v-shaped with a rounded center or like a curve, see examples in figure 11.
3. If it is desired to also use the room as a regular meeting room, a table design with curved sides may be selected, and then only use one of the sides of the table during video conferences. Alternatively, consider a modular conference table design. Note that this requires an additional flat panel monitor/screen and projector at the short end of the table in order to achieve good functionality when used as a regular meeting room without having to change the design of the conference table. See examples in figure 12.

It is important to ensure that the conference table has a matte, unreflecting surface.

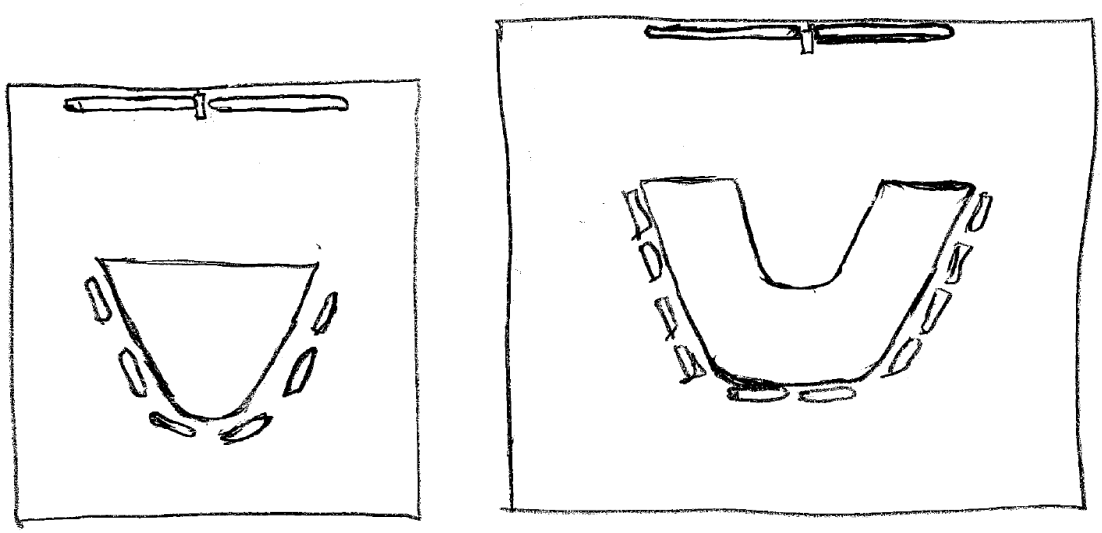

Figure 11. Examples of designs of conference tables for video conferencing, small room (a) and larger room (b).

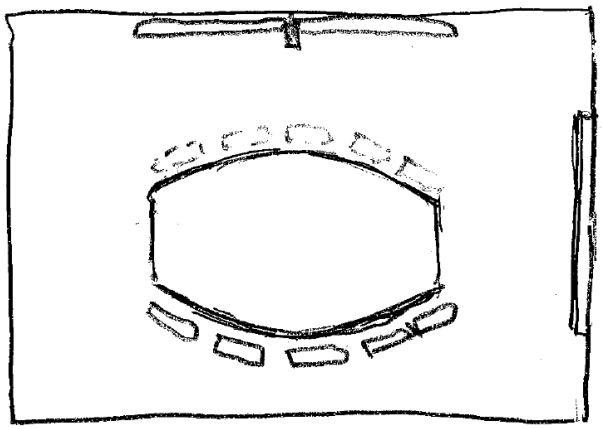

Figure 12. Example of meeting room layout for video conferencing, furnishings adapted for combined usage as both video conferencing and regular meeting room.

9.2 Surfaces and colour choices

In video conferencing meeting rooms, it is important to aim for clean, neat and discreet wall surfaces, and the color choices should be adapted for the video camera. Grey and blue hues are well suited. It is recommended to select colors containing a minimum of 15% black.

All windows receiving daylight need to be equipped with blackout curtains. Smaller rooms may have manual blackout curtains, but motorized blackout curtains are preferable. The color choices for the blackout curtains should follow the recommendations for the wall surfaces.

If the room is equipped with whiteboards on walls covered by the camera, manual background curtains should be installed to cover the board during video conferences. It is preferable that the background curtains are designed as blackout curtains.

9.3 Video system

The video systems must be designed to achieve flexible electronic presentation solutions, suitable for both local viewing and for transmitting to a remote party, and enable communication that is as natural as possible with the remote party.

Recommended designs for video sources and connecting to portable equipment is provided in part III System description in chapter 16.

It is not recommended to use traditional blackboards during video conferences. A whiteboard may be mounted on one of the side walls if the room is to be used for regular meetings as well.

Technical and functional system requirements for the video conferencing codec, camera, etc., are described in UFS 119 chapter 4.14-4.18.

9.3.1 Monitor designs/presentation areas

In video conferencing meeting rooms it is recommended to install two 50" flat panel monitors centered in front of the conference table. This is sufficient for rooms with a maximum distance to the audience of approx. 5 meters. In larger rooms the size of the monitor must be increased or the monitors replaced by projectors and permanent display areas. The lower edge of the monitors should be mounted approx. 0,95 m above the floor.

9.3.2 Video camera

In video conferencing meeting rooms, only one video camera is commonly in use. This camera should be placed above the monitor on the right. Provided the camera image of the remote party is only displayed on the monitor on the right, this installation ensures the best possible eye contact. It is difficult to ensure a good rendering of everyone in the room, especially in large rooms, but this should be solved by the layout of the room, the design of the conference table and lighting. As a starting point, the conference table may be placed to make the distance between the lens of the camera and the front edge of the table approx. 0,6 times the width of the camera's coverage area.

For large rooms, it may be necessary to have an additional video camera to cover all the participants, depending on the room's layout, the number of people in the room and the table design. The two cameras will normally cover one half of the conference table each. This is not an optimal solution, since all the participants cannot be seen at the same time by the remote party, and because the design requires a larger degree of control/direction by the chairman.

Solutions also exist based on the simultaneous use of several cameras, where each camera covers two of the participants, for instance, and is rendered on dedicated monitors at the remote location (so-called "telepresence"), but these solutions are not regarded as realistic for universities/colleges at present.

To ensure good rendering of both the lecturer and the student, or of all the participants, it is imperative that the lighting solution is customized. See recommended solutions in chapter 3.2. It is also important to equip the room with curtains for blocking out the light. See chapter 6.6. Because daylight and artificial light have different color temperatures, problems will often arise with automatic adjustment of the color balance if daylight enters the room.

9.4 Sound system

The room should have the option to render program audio from a local source, in addition to vocal audio from the remote party. It is recommended to install an active speaker on each side of the monitors to render both local program audio and vocal audio from the remote party, or to use two speakers adapted to the flat panel monitors.

The challenge regarding when it comes to microphone systems is to be able to pick up direct sound from all the participants with as little influence from reflections in the room as possible without having a separate

microphone for each person. Additionally, as little of the rendered vocal audio from the remote party as possible should be picked up by the microphones.

The recommended microphone solution is two ceiling-mounted, directional miniature microphones. In large rooms it may be necessary to increase the number of microphones. The drawback with using ceiling-mounted microphones is that they require control over the acoustics in the room, and may need to be placed so low that they are covered by the video camera in order to adequately pick up the direct sound.

As an alternative, table-mounted microphones may be utilized, but these are more vulnerable for noise from bumps against or movement of the conference tables and may also be covered by documents, etc.

With regards to adjusting the room acoustics, it is important to avoid strong reflections from the walls, and to have sufficiently short reverb.

The maximum recommended reverb is 0,6 s. Scattered space-cloth should be mounted on the back and side walls to reduce strong reflections. It is also recommended to increase the requirements for the maximum noise levels from technical systems to L_{max} = 30 dBA.

9.5 Control systems

It is recommended that all video conferencing meeting rooms are equipped with advanced control systems with touchscreen-based integrated lighting control.

As for classrooms equipped for distance learning, the challenge is to achieve a user interface that ensures a simple setup of video conferencing sessions and which provides sufficient flexibility regarding the selection of sources and signal routing, while enabling the chairman to focus on the actual meeting as much as possible.

The following principles for customizing the interface of the control system for video conferencing is recommended:

1. The right-hand monitor is reserved for the video camera display. This monitor will usually display video of the remote party/parties, or the outgoing video when required. When setting up conferences, it is important to be able to see the outgoing video, but during the actual conference this will normally not be necessary.
2. The other monitor displays either a local data source (laptop, interactive monitor, document camera, etc.) or the incoming data source, possibly with a picture-in-picture design where the outgoing video is displayed in one of the corners.
3. The camera controls should be available during setup, but are usually not in use during the actual conference. The camera is normally reset to a pre-programmed mode when setting up a new conference. (Note that stored positions will be lost if anyone physically moves the camera.)
4. The system should be programmed so that contact may be established with the most frequently used partner rooms with only one keystroke on the control panel.

See general advice for designing the user interface in chapter 7.1.

9.5.1 Assisted presentation

In video conferencing meeting rooms, the need for assisted presentation is usually less than for classrooms with distance learning, but it is still recommended to include the same functionality. See more details in chapter 7.2 Support for assisted presentation/operation/monitoring.

9.6 Portable solutions

If video conferencing solutions are required for multiple meeting rooms, but furnishing a separate room for this purpose is out of the question, a mobile video conferencing unit may be a good solution. This unit is principally designed as a portable distance learning console, as described in chapter 8.5. The unit should be designed to be placed by the short end of the conference table, and it is recommended that it is equipped with two PZM-microphones to be positioned on the table.

The unit must be able to be connected to external projectors/flat panel monitors and sound systems. It must also be able to be connected to external audio and video sources. This should be solved by using a connection panel mounted on the wall of all conference rooms prepared for video conferencing.

See also the recommended technical and functional system requirements in UFS 119 chapters 4.17 and 4.18.

9.7 Support for multiple remote parties

See recommendations in chapter 8.6

10 Theft-proofing

The need for theft-proofing the AV equipment must be evaluated on an individual basis, based on risk assessments/previous experience regarding the frequency of thefts, boundary protection and access control for rooms, operational structure and ownership structure and the optional integration with other electronic theft-proofing systems in the building.

There is often a trade-off between investment needs connected to theft-proofing, costs of replacing lost equipment and service access. Regardless, the physical protection must be implemented in a way that will not be a substantial obstacle during maintenance of the equipment.

Many still find that breakdowns and error messages/frustration among the users is the bigger problem regarding theft of AV equipment.

The following methods for theft-proofing may be relevant:

- Physical protection by using a projector box, lockable cabinets or wire.
- Acid marking.
- Alarms as a part of the systems for monitoring equipment status (i.e. projectors)
- Alarm connected to equipment, labeling on doors.

There is also general building security, like boundary protection, room-based access control, ITV system (surveillance camera), connecting locking systems with motion sensors, etc.

SYSTEM DESCRIPTION III

This description outlines the AV systems. The purpose is to give an overview over the functionality and the design of the solutions. This section should also be used as a basis during the user process to evaluate to what degree advanced functionality is necessary for the various room types.

This part of the document is designed as a template for creating system descriptions in connection with purchases and planning solutions. To ease the development of an unambiguous bid description, the word "must" has been used, even if the descriptions only provide recommended solutions that need to be adapted to the needs and wants of the users for each individual project. The text in italics provides comments or items that need to be adapted to each individual installation, and which therefore must be described based on the selected solution.

The system description should describe **what** the room should be used for, **how** it should be designed, and **what presentation equipment** should be used in the room. The description should provide a general overview over the functionality and design of the solutions for the users. Additionally, it should, together with drawings and technical and functional system requirements, provide the bidders/suppliers with an overview over what should be supplied, and how the solutons should be designed and integrated.

Part II provides a basis for designing the solutions and selecting the functionality. It is recommended to have an overview over the contents in part II before starting to plan each room. It is also referred to various chapters in part II under the descriptions for the various partial systems for each room type.

For each room type, a basic installation is described along with any relevant additional functionality. **Basic installation** describes the recommended minimum equipment for the various room types. **Appendix** describes the relevant additional functionality adapted for various applications. The need for this functionality should be clarified in the initial user process.

11 Large auditoriums (more than approx. 80 seats)

11.1 Basic installation

The auditorium must be equipped like a modern electronic classroom with integrated sound, video and control system.

Lectern and rostrum

A mobile lectern should be established on stage where the AV supplier must place all the equipment that the lecturer normally would need to reach:

- Control panels using touchscreens
- Interactive computer monitor (should also be used as monitor for the PC and video display)
- Stationary PC (in the lectern)
- Keyboard and mouse (possibly wireless).
- Space and connectors for laptops
- Document cameras
- Blu-ray player with support for DVD's and CD's
- Connections for video cameras and external audio sources (MP3 player)
- Non-permanent extension to the rostrum (manuscript holder) with wired gooseneck microphone

Non-permanent units placed underneath the tabletop should as far as possible be integrated into the lectern. Control panels and other equipment on top of the table should not be permanently fixed to make any changes uncomplicated.

A rostrum must be supplied for the auditorium. Equipment equivalent to the above is not placed on the rostrum, but the wired gooseneck microphone and connectors for the laptop must be included.

The rostrum should be mobile and be able to be connected to *two/three* different floor outlets *(adapted to the number of floor boxes)*, but the lectern should only be able to be connected to one of the floor boxes. Lecterns and rostrums must be able to be used simultaneously. *The need for full flexibility regarding floor boxes should be evaluated, see chapter 4.1*.

Recommended placement for central equipment is provided in chapter 4.2. The system description must be adapted to the chosen solution.

Sound system

The room must have speaker systems for both vocal and program audio. *Recommended speaker solutions provided in chapter 5.1.1. The system description must be adapted to the chosen solution.* The sound system should be designed around an integrated digital signal processor (DSP). This processor should ensure all the necessary processing, mixing, routing and volume control for both vocal and program audio systems.

The auditorium should be equipped with *two/three* wireless microphone channels *(must be adapted to actual need*). *Two/three* wireless headband microphones must be supplied and a wireless handheld microphone (*must be adapted to actual need*).
In addition to gooseneck microphones in the rostrum/rostrum extension, it must be possible to use at least four wired microphones. The four additional microphone inputs must be connected in parallel in all the floor boxes and in the outlet panel in the gallery.

The auditorium must have provisions for the hearing impaired, either in the form of an induction loop or an IR system. See chapter 5.5 for recommended solutions.

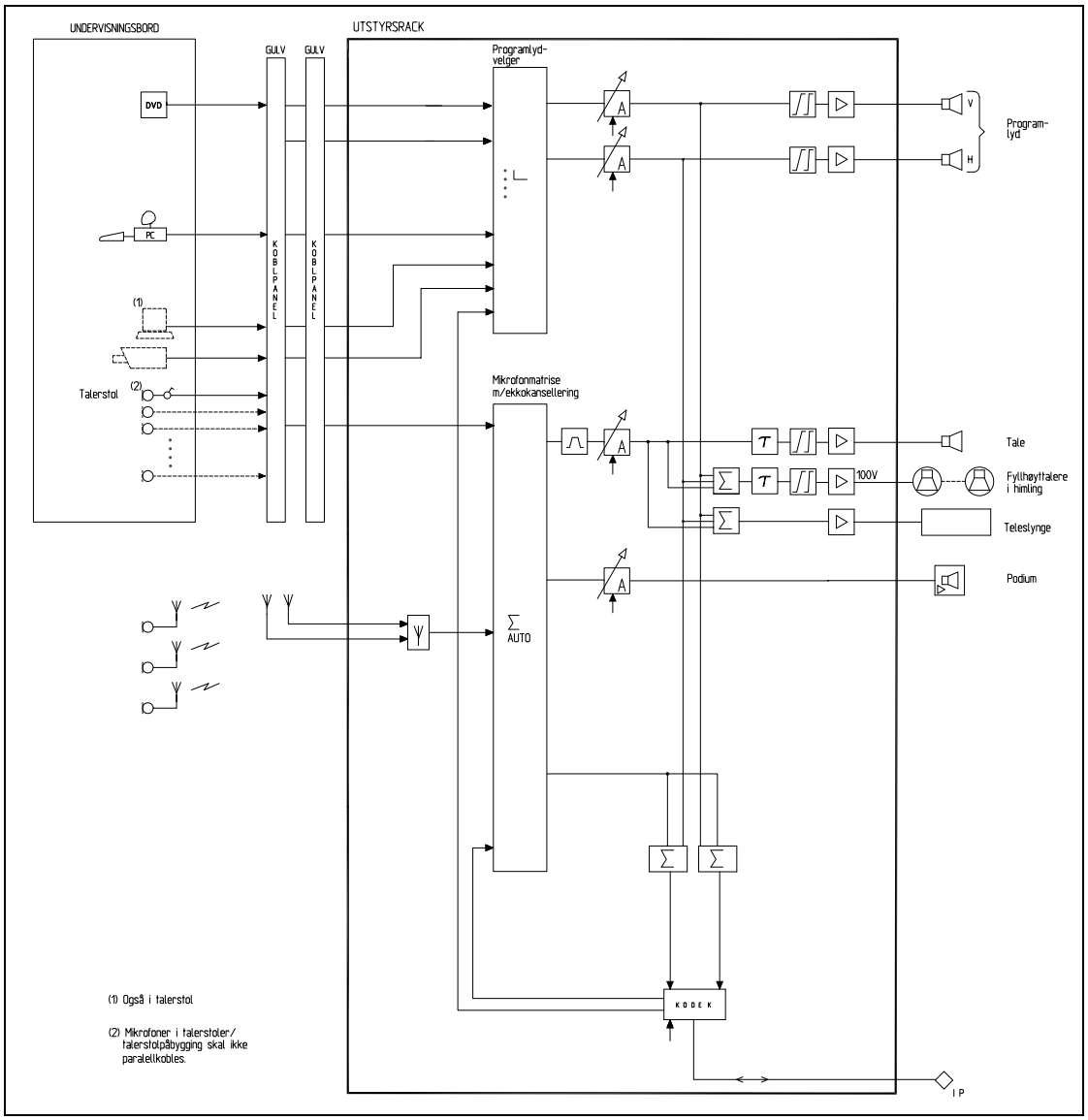

Figure 13. Examples of system schematics. Sound system for large auditorium with support for distance learning

Video system

Recommended designs for blackboards and display areas are provided in chapter 6.1.The system description must be adapted to the chosen solution.

The auditorium must have two projectors displaying one half each of the presentation area. The projectors must be installed on ceiling-mounted brackets.

All sources and presentation, distribution and registration units in the video system should be connected to inputs and outputs in a video switch/matrix.

Recommended designs for blackout curtains are provided in chapter 6.6. The system description must be adapted to the chosen solution.

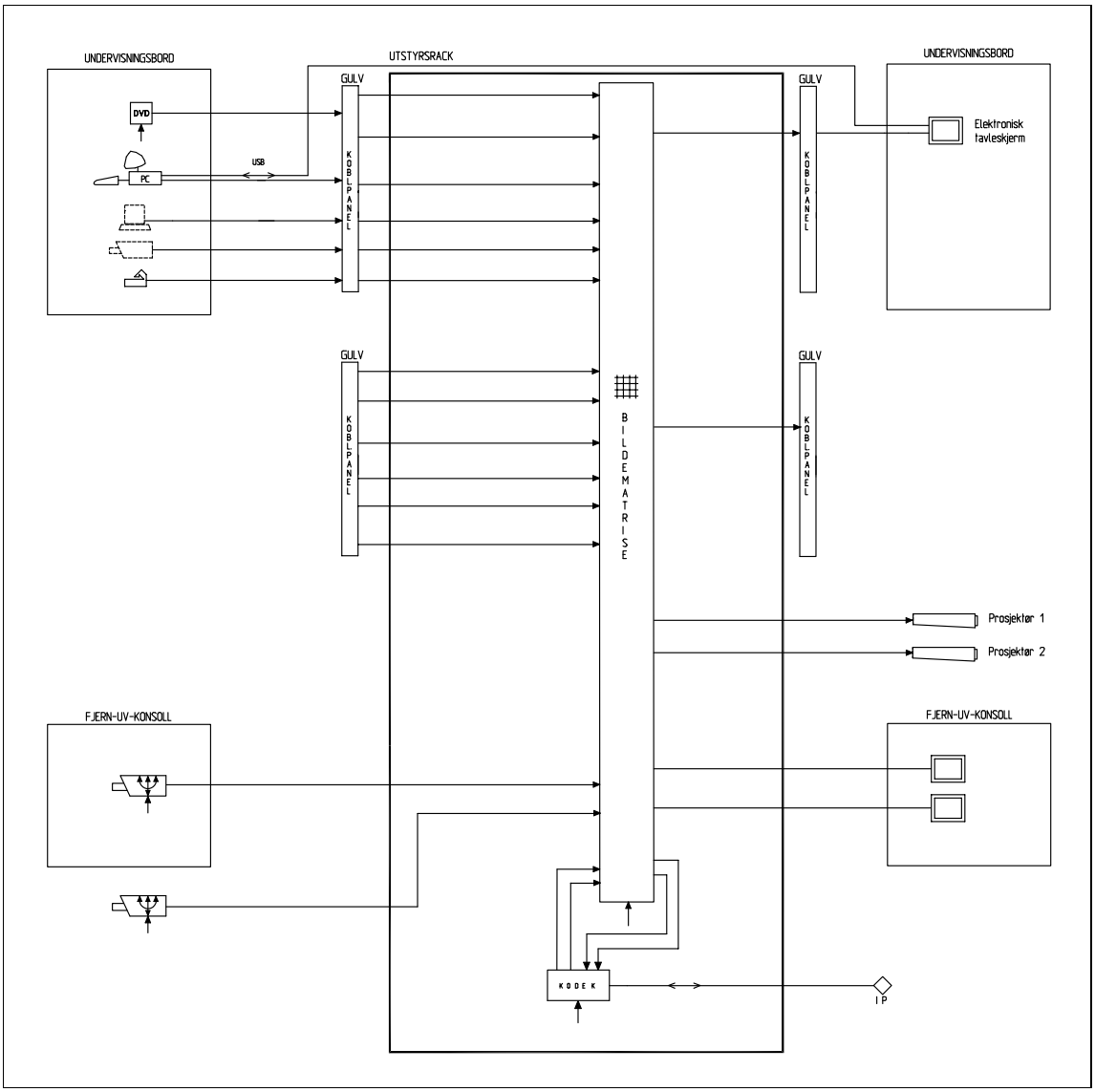

Figure 14. Example of system schematics. Video system for large auditorium with support for distance learning

Control systems

The control system must control all functions in the room, including sound and video systems, lighting, busy lamps and curtains.

The system should be able to be operated by one person, but have the option of using assisted presentation when required. A system for assisted presentation/operation/monitoring of the AV equipment over IP must be included.

The control panel must be able to be removed and connected independently if the lectern is not needed. In addition to the floor boxes, it should be possible to connect it to the bottom riser in the gallery.

At every entrance a pulse switch must be installed which activates the control system for normal lighting in the room. Busy lamps must be installed outside above the entrances.

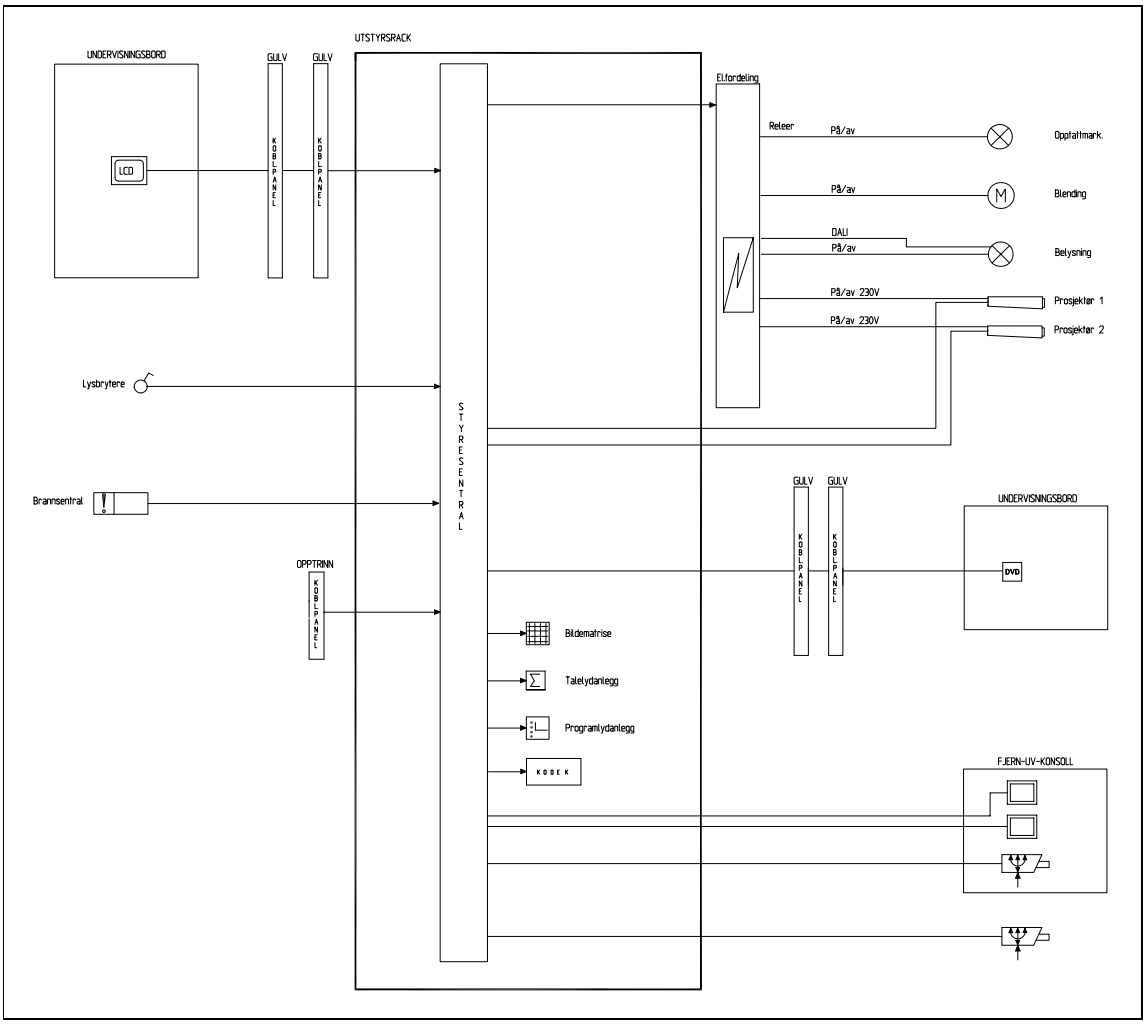

Figure 15. Examples of system schematics. Control system for large auditorium with support for distance learning

11.2 Appendix

The following expansions of the AV system in the auditorium may be relevant:

Appendix A. Automatic scaler

In order to increase the user-friendliness and improve the video quality when connecting a laptop, the following additional functionality may be relevant:

An automatic scaler should be supplied for connecting a laptop.

Appendix B. Distance learning

The auditorium must be completely equipped as an electronic classroom for distance learning and video conferencing. The room must be able to communicate with other electronic classrooms in the building, and with other colleges/universities. The primary communication protocol must be IP.

The functions should be incorporated in the other sound, video and control systems. The items below are directly connected to distance learning and must be included:

- *Lecturer support. This must include displaying incoming and outgoing video and a loudspeaker only covering the stage for received audio from the remote party.Recommended solutions are provided in chapters 8.2 and 8.3.1.*
- Video camera with pan-tilt-zoom (PTZ) and motorized zoom for rendering the lecturer, integrated in the distance learning console, with manual remote control from the control system.
- Video camera like the one above for rendering the audience centrally positioned in the front wall. The automatic follow function must not be used. *See chapter 8.3.2 for the recommended positioning*.
- Loudspeaker designs adapted for microphones and to the acoustic conditions in the room.
- Video conferencing codec
- Integrated lecturer control incorporated in the control system.

In addition, and automatic scaler for video sources must be supplied.

Questions from the audience must be communicated using a wireless handheld microphone or by the lecturer repeating the question.

The following extras are recommended if permanent display areas are installed above the blackboard:

Back cloth should be installed for use during distance learning. The curtains must be able to cover the entire blackboard and must be controlled from the control system for the AV equipment.

Appendix C. Internal distribution (streaming) of lectures

If it is necessary to be able to follow the lectures from other rooms on-campus, the distance learning solutions may be expanded to cover this functionality.

See a more detailed description in UFS 120 System for operational support and transmission of sound and video.

Appendix D. Support for assisted presentation

All control systems in advanced classrooms must be supplied with a system for assisted presentation/operation/monitoring over IP. See a closer description in UFS 120 System for operational support and transmission of sound and video part II Operational support. As a supplement to this, the following additional functionality may be relevant:

An IP camera must be supplied for observing the room during assisted presentation.

Appendix E. Support for cultural events

If the auditorium is to be used for cultural events like small concerts, plays, etc., the following additional installations are recommended:

A connection point should be established for the audio mixing unit at the back of the gallery. An outlet panel must be installed on stage for wired microphones and stage monitors, a total of 24/8 lines, wired to the connection point in the gallery. *The number of inputs and outputs must be adapted to the actual need. The outlet panel should be placed on the side wall on stage.* Stereo output from the audio mixer is connected to the DSP for rendering over the program audio system.

The mixing unit is not included, but the control panel must also be able to be used as a simple audio mixer if using the extra microphone outputs in the floor boxes are utilized. This is solved via a separate menu on the control panel. An additional connection point for the control panel must be established by the mixing unit.

A light bar must also be installed from the ceiling at the front of the stage. Lighting equipment is not included, but wiring for lighting control (DMX) must be established between the mixer and the central equipment point/dimmer rack.

Equipment and cables capable of generating electro magnetic noise, for instance dimmer switches and dimmed light circuits, must be kept separate from the audio installation in order to avoid noise in the sound system.Lighting equipment should therefore not be installed together with the equipment rack for the AV system. Dimmer switches also generate acoustic noise and should preferably be placed in a separate technical room.

Appendix F. Movie support

If the auditorium is to be used for screening movies, the following additional installations are recommended:

A third, centered projector should be installed and optimized for showing movies. *See chapter 6.1.2 for adapting display areas for screening movies.*

Additionally, the sound system needs to be upgraded to support multi-channel audio. *Recommended speaker solutions provided in chapter 5.1.3. The system description must be adapted to the chosen solution.*

12 Small auditoriums (up to approx. 80 seats)

12.1 Basic installation

Small auditoriums may be equipped the same as large auditoriums, but with the following changes:

- *It has to be evaluated if a rostrum is needed in addition to the lectern.*
- *Smaller auditoriums usually have no need for vocal audio systems, but this requires that the room acoustics are optimized for vocal communication from the stage. If vocal amplification is necessary, it can usually be integrated into the program audio system.See chapter 5.1 for recommended loudspeaker solutions.Microphones and induction loop/IR systems are not included for rooms without vocal amplification.*
- *Because of the available width of the front wall, one projector only may be relevant. Two projectors are still recommended where the layout of the room allows for this.*

12.2 Appendix

- *If the room is equipped for distance learning, the solutions for lecturer support should be adapted to the layout of the room and the number of projectors. See recommended solutions in chapters 8.2 and 8.3.1*
- *Appendix E and F are usually not relevant.*

13 Seminar rooms and classrooms

Seminar rooms and classrooms may vary greatly regarding equipment level. Basic installation describes the basic presentation solution, but relevant appendices include functionality equaling a small auditorium. For these rooms, it is of vital importance that the application and needs are clarified early on in the user process.

13.1 Basic installation

The room must be equipped with presentation solutions for both audio and video controlled by an integrated control system.

Lectern

A lectern must be established in the presentation area where the AV supplier must place all the equipment that the lecturer normally would need to reach:

- Keypad-based control panel (flush-mounted in/on the tabletop)
- Stationary PC (in the lectern)
- Keyboard and mouse (possibly wireless).
- Monitor for PC and video display
- Space and connectors for laptops
- Connections for video cameras and external audio sources (MP3 player)

Control panel and connectors for mobile equipment may be combined into one unit.

Non-permanent units placed underneath the tabletop should as far as possible be integrated into the lectern.

Recommended solutions for positioning and conduits for lecterns is provided in chapter 4.1. The system description must be adapted to the chosen solution.

Recommended positioning of central equipment is provided in chapter 4.2. The system description must be adapted to the chosen solution.

Sound system

The room must have a loudspeaker solution for rendering program audio. *See chapter 5.1 for recommended solutions*.

Video system

Recommended designs for blackboards and display areas are provided in chapter 6.1.The system description must be adapted to the chosen solution.

The room must have a projector. The projector must be installed on ceiling-mounted brackets.

Control systems

The control system should control all the functions of the AV system. The lighting is not presumed controlled by the AV system.

Busy lamps must be installed outside above the entrances.

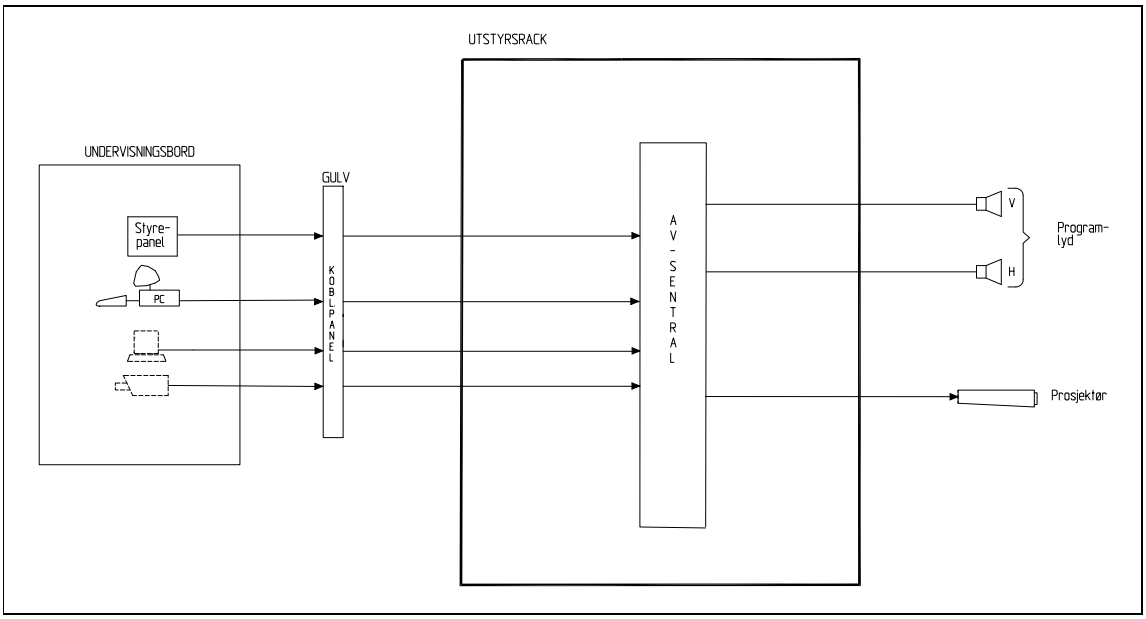

Figure 16. Principle drawing of the AV system in a simple seminar room with the central equipment in a rack and connections through a floor box.

13.2 Appendix

The following extras/upgrades may be relevant for seminar rooms and classrooms:

Appendix A. Automatic scaler

In order to increase the user-friendliness and improve the video quality when connecting a laptop, the following additional functionality may be relevant:

An automatic scaler should be supplied for connecting a laptop.

Appendix B. Interactive board/monitor

These rooms are preferably equipped with interactive boards. Recommended solutions are provided in chapter 6.2.1.

Appendix C. Document cameras

Document cameras may be relevant to achieve more flexible presentation solutions.They may be used for showing objects, handwritten/photocopied notes, or for writing directly on the paper or semi-finished notes during lectures.

Appendix D. Support for assisted presentation/operation/monitoring

In order to simplify the operation/maintenance and provide better user support, it may be sensible to include the same functionality as for auditoriums:

A system for assisted presentation/operation/monitoring of the AV equipment over IP must be included.

As a supplement to this, the following additional functionality may be relevant:

An IP camera must be supplied for observing the room during assisted presentation.

Appendix E. Touchscreen-based control panels

In order to simplify the user interface, the control panel may be upgraded from a keypad to a touchscreen. This is especially relevant for rooms with advanced functionality. See also chapter 7.1 User interface.

If a touchscreen is used, it is recommended to also integrate lighting controls in the AV control system.

Appendix F. Distance learning

It may be relevant to also use classrooms and seminar rooms for distance learning. In that case, the functionality will be as for auditoriums. See chapter 11.2 Appendix B. In rooms for distance learning, it is recommended to use a touchscreen-based control system with functionality equivalent to that of auditoriums. See chapter 11.2.

Solutions for lecturer support is adapted to the layout of the room and the number of projectors. See recommended solutions in chapters 8.2 and 8.3.1

Appendix G. Flexible room layouts

In some cases it is desirable to use seminar rooms in a flexible layout where two or more rooms may be used together or separately.

These solutions must be customized, but should be based on the following principles:

- *Operating the AV systems when the rooms are used separately should not depend on what is happening in the other rooms included in the flexible room constellation. The lecturer should see the AV system in each room as an adequate, independent presentation solution.*
- *When the rooms are used together, the AV systems should work as a common system where the partial functions of the individual rooms are integrated in a unified manner. Flexibility regarding the connection of the lectern/rostrum to various floor boxes and routing of video sources to different projectors, etc. should be ensured in the same manner as for large auditoriums. See also the description of central equipment for video systems in chapter 6.4.*
- *The functionality for sound, video and control systems should automatically change based on which rooms are used together. This may be solved by integrating sensors in the folding walls, for instance.*

In practice it means that the sound and video systems for each room must be integrated with a central equipment point where all audio and video signals may be routed to all outputs. Each control panel should also be connected to a common control central. AV systems for these rooms should be planned as one large system with advanced functionality.

14 Simple meeting rooms and group rooms

Simple meeting rooms should be equipped with a basic presentation solution for audio and video.

Connections for laptops is installed in the chair rail or in/on the wall.

The room must have a whiteboard. *Flipboards and AV lists for paper may be included.*

Rooms smaller than approx. 25 m^2 are equipped with a 50” flat panel monitor, while rooms larger than approx. 25 m^2 have ceiling-mounted projectors with manual screens.

Recommended solutions for the positioning of screens/monitors and boards are provided in chapter 6.1. The system description must be adapted to the chosen solution.

In rooms equipped with flat panel monitors, the program audio is rendered via the loudspeakers integrated in/included with the monitor. In rooms equipped with projector, the active speakers are installed on each side of the screen.

15 Standard meeting rooms and group rooms

During the planning of standard meeting rooms and group rooms, future upgrades should be taken into account. Include connections for mobile equipment and requirements for the dimensioning of the image matrix and the control system for presentation equipment likely to be installed at a later time.

15.1 Basic installation

Standard meeting rooms must be equipped with presentation solutions for both audio and video controlled by an integrated control system.

All connections for presentation equipment must be integrated in the lectern. A flush-mounted interconnect box with connections for laptop, video camera and an external audio source (MP3 player). An interconnect box must also be installed with a minimum of 6 electrical outlets for laptops. *Must be adapted to actual needs.*

All functions are presumed controlled by keypad-based control panel. It is recommended to install the panel flush-mounted in the lectern, but it may also be flush-mounted in a wall or chair rail if using the room without the conference table is desired. The system description must be adapted to the chosen solution.

Recommended placement of central equipment is provided in chapter 4.2. The system description must be adapted to the chosen solution.

Video system

The room must have a whiteboard. *Flipboards and AV lists for paper may be included.*

Rooms smaller than approx. 25 m^2 are equipped with a 50” flat panel monitor, while rooms larger than approx. 25 m^2 have ceiling-mounted projectors with motorized screens. An automatic scaler must also be supplied for connecting a laptop.

Recommended solutions for the positioning of screens/monitors and boards are provided in chapter 6.1. The system description must be adapted to the chosen solution.

Sound system

The room must have a loudspeaker solution for program audio based on active loudspeakers mounted on the wall of the presentation area.

Control systems

The control system should control all the functions of the AV system. The lighting is not presumed controlled by the AV system.

Busy lamps must be installed outside above each entrance.

15.2 Appendix

The following extras/upgrades may be relevant for standard meeting rooms:

Appendix A. Interactive board/monitor

These rooms are preferably equipped with interactive boards. Recommended solutions are provided in chapter 6.2.1.

A stationary PC is recommended for all rooms with interactive boards. The following solution is recommended:

Stationary PC is installed in a lockable cabinet. Wireless keyboard and mouse are placed on the lectern. Interactive board/pen displays are also used as computer monitors.

Appendix B. Document cameras

Document cameras may be relevant to achieve more flexible presentation solutions.They may be used for showing objects, handwritten/photocopied notes, or for writing directly on the paper or semi-finished notes during meetings/presentations.

A document camera is placed unfastened on the conference table, connected to an interconnect box. The document camera must be able to be disconnected and moved when necessary.

It is possible to only include a connection for the document camera in the interconnect box. A pool of portable equipment may in that case be used for several rooms.

Appendix C. Blu-ray players

If playing Blu-ray discs/DVD's/CD's without using a PC is desired, the following additional functionality may be relevant:

Blu-ray player with support for DVD's and CD's is installed in a lockable cabinet.

Appendix D. Portable video conference solution

It may be relevant to share a portable video conferencing unit that can be moved between multiple meeting rooms. Each room would in that case need to be prepared for connecting this unit.

The following additional functionality must be included for each of the meeting rooms (see also UFS 119 chapter 5.3):

The room must be prepared for connecting the portable video conferencing unit. A connection panel must be installed on the wall. The sound system, video system and control system must be integrated with the portable unit.

Meeting rooms that will be used for video conferencing must have blackout curtains, but these may be manual blackout curtains..

The following functionality is recommended for the portable video conferencing unit:

A portable video conferencing unit must be supplied for use in several meeting rooms.

The unit must consist of a portable console containing two 32" flat panel monitors, a video camera, video conferencing codec and two PZM-microphones that may be placed on a conference table. The unit must have inputs for connecting external sources, and outputs for monitor/projector and loudspeaker.

Appendix E. Support for assisted presentation/operation/monitoring

In order to simplify the operation/maintenance and provide better user support, it may be sensible to include the same functionality as for auditoriums:

A system for assisted presentation/operation/monitoring of the AV equipment over IP must be included.

As a supplement to this, the following additional functionality may be relevant:

An IP camera must be supplied for observing the room during assisted presentation.

Appendix F. Touchscreen-based control panels

In order to simplify the user interface, the control panel may be upgraded from a keypad to a touchscreen. This is especially relevant for rooms with advanced functionality. It is recommended to use a movable control panel that may be placed on the lectern. It should also be possible to connect it to the wall or the equipment rack if using the room without the conference table is desired. The panel may also be flush-mounted in the wall.

If a touchscreen is used, it is recommended to also integrate lighting controls in the AV control system.

16 Meeting rooms for video conferencing

The layout and furnishing of meeting rooms for video conferencing must be carefully adjusted to ensure good functionality and the best possible communication with the remote party. This includes among other things, room layout, size, lighting, conference table design, wall surfaces and color schemes. Furnishings and conference table design should also be adapted to whether the room will be exclusively used for video conferencing, or if it is also going to be used as a traditional meeting room. See recommendations in chapter 9.1

16.1 Basic installation

Meeting rooms for video conferencing must be equipped with advanced presentation solutions for both audio and video controlled by an integrated control system.

All connections for presentation equipment must be integrated in the lectern. A flush-mounted interconnect box with connections for laptop, video camera and an external audio source (MP3 player). An interconnect box must also be installed with a minimum of 6 electrical outlets for laptops. *Must be adapted to actual needs.*

All the room's functions are presumed controlled by a touchscreen-based control panel that will be placed on the conference table. An interactive PC monitor will also be placed on the conference table.

The room should have a stationary PC installed in a lockable cabinet/rack. *(Must be adapted to the chosen solution).*Wireless keyboard and mouse are placed on the lectern. The codec must be installed in the rack with the remaining central equipment.

Recommended placement of central equipment is provided in chapter 4.2. The system description must be adapted to the chosen solution.

Video system

Two 50” flat panel monitors should be installed side-by-side on the front wall. The camera for rendering the participants should be placed centered above the monitors. In addition, and automatic scaler for video sources must be supplied.

The room should have motorized blackout curtains. *Manual blackout curtains may be used.*

Sound system

The room should have a loudspeaker solution for rendering program audio and vocal audio from the remote party. An active loudspeaker should be installed on each side of the monitor solution. Two loudspeakers adapted to the flat panel monitors may also be used.

The room must have two ceiling-mounted microphones.

Control systems

The control system should control all functions in the room, including lighting and curtains.

The system should be able to be operated by one person, but have the option of using assisted presentation when required. A system for assisted presentation/operation/monitoring of the AV equipment over IP must be included.

At every entrance a pulse switch must be installed which activates the control system for normal lighting in the room. Busy lamps must be installed outside above the entrances.

16.2 Appendix

The following extras/upgrades may be relevant for video conferencing meeting rooms:

Appendix A. Document cameras

A document camera is placed unfastened on the conference table, connected to an interconnect box. The document camera must be able to be disconnected and moved when necessary.

It is possible to only include a connection for the document camera in the interconnect box. A pool of portable equipment may in that case be used for several rooms.

Appendix B. Blu-ray players

If playing Blu-ray discs/DVD's/CD's without using a PC is desired, the following additional functionality may be relevant:

Blu-ray player with support for DVD's and CD's is installed in a lockable cabinet/rack.

Appendix C. Whiteboard

It is not recommended to use traditional blackboards during video conferences.

If the room is also being used for regular meetings (see alternate layouts for conference tables in chapter 9.1), a whiteboard may be installed on one of the side walls. Manual curtains should be installed that can be closed in front of the board during video conferencing if the board is entirely or partially covered by the video camera .

Appendix D. Support for assisted presentation

All control systems in meeting rooms for video conferencing must be supplied with a system for assisted presentation/operation/monitoring over IP. See a closer description in UFS 120 System for operational support and transmission of sound and video part II Operational support. As a supplement to this, the following additional functionality may be relevant:

An IP camera must be supplied for observing the room during assisted presentation.

Appendix E. Additional video camera

For large rooms it may be necessary to have an additional video camera to cover all the participants. See more details in chapter 9.3.2 .

INTEGRATION AND INTERFACES IV

The AV contract will have important connections to other trades and deliveries both in connection with new construction and rehabilitation. It is not apparent what should be included in the AV delivery.

In the following chapters you will find proposed boundaries for the AV contract and connections with other contractors based on the AV supplier having full responsibility for the unity and integration of the solutions for the various rooms. At the same time it is not presumed that the AV supplier is competent regarding power current. 230 V installations may be included as a sub-contract for the AV supplier.

The below proposals are adapted for new construction and must be adjusted if rehabilitating/rebuilding existing structures.

Note that for larger projects it may be relevant to have a special common interface document for all contractors. It is vital that an agreed upon interface description is made applicable for all contractors connected to the AV contract.

17 Elements not included in the AV contract

Certain elements in the rooms, with important interfaces toward the AV systems, are supplied by others.

Note that it is presumed that all induction loops and screens in rooms with AV equipment are included in the AV contract. If necessary, for the sake of progression, the actual loop cable may be installed by an electrical contractor while the delivery of the induction loop amplifier and the remaining integration with the AV system, including commissioning, adjustments and verification is performed by the AV supplier. Counter loops, IR and FM systems are included in the AV delivery in their entirety.

17.1 Furnishings

Furnishings like cabinets, consoles, conference tables, benches and chairs are included in the furnishing contract. The AV supplier is responsible for actively ensuring that these elements are suitably designed with regards to user functionality and the AV equipment that is to be installed in these. The user representatives should be involved in designing and adapting the furnishings with integrated AV equipment.

Lecterns, rostrums and rostrum extensions are included in the AV delivery.

17.2 Blackout curtains

Motorized blackout curtains in rooms with large AV systems are generally included in the AV delivery. No manual blackout curtains are included in the AV delivery.

External motorized blinds are included in another contract.

17.3 Computer equipment

PC's that are to be integrated in the AV systems, including monitors, keyboards and other natural accessories are included in another contract. This includes installation and setup of necessary software, licensing and user profiles..

Installation, commissioning and system integration in the various rooms, is the responsibility of the AV supplier.

The AV supplier may include PC's with peripheral equipment, based on specifications from the IT department at the college/university.

18 Interfacing with other contractors

18.1 230V distributed network

230V power supply for the 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 connecting elements (relays, etc.) for 230V for the rooms that will have integrated AV control systems. The positioning of the 230V elements should be coordinated with the contracted electrician. The contracted electrician mounts and connects the 230V elements.

Electrical outlets in floor boxes are connected to the power grid by the contracted electrician, but the actual outlets should be supplied and installed in the box by the AV supplier.

Electrical outlets in interconnect boxes are supplied and installed by the AV supplier and connected to electrical outlets in floor boxes via a mobile cord and plug supplied and installed by the AV supplier.

Distribution panels for electrical outlets in racks and lecterns are supplied and installed by the AV supplier.

The AV supplier should coordinate this directly with the contracted electrician, and ensure that the equipment and documentation is supplied in a timely manner. The contracted electrician installs and connects the electrical distribution.

18.2 Network outlets

Suppliers of distributed networks *(usually the contracted electrician)* installs all network outlets for connecting PC's and AV equipment to the computer network, but for floor boxes the actual outlets should be supplied and installed by the AV supplier. Note that the supplier of the distributed network is responsible for the wiring to the floor box and should also connect the outlets to the computer network.

Network outlets in interconnect boxes are supplied and installed by the AV supplier and connected to outlets in floor boxes via a mobile cord and connector supplied and installed by the AV supplier.

The AV supplier should coordinate this directly with the supplier of the distributed network, and ensure that the equipment and documentation is supplied in a timely manner.

18.3 General lighting

Lighting for the various rooms is supplied by the contracted electrician. This includes wiring, fixtures and dimmer equipment.

The AV supplier should control the lighting in all rooms with integrated AV control systems. Ballast controls, including voltage supplies for DALI buses, are included in the AV delivery.

18.4 Conduits

Conduits are in general installed by the contracted electrician. This includes wall conduits, conduits to floor boxes and main conduits in permanent construction (floors, walls and ceilings without suspended ceilings.)

It will be the responsibility of the AV supplier to indicate requirements to the contracted electrician, and verify that the planned conduits are suitable for the intended application. The AV supplier should also specify conduits for implementation by the contracted electrician.

Subsequently, the AV supplier will be the ones to attend to the supplemental channels, conduits or open placement.

18.5 Floor boxes

In rooms with floor boxes for connecting AV and PC equipment, the floor boxes, lidded accessory plates and floor conduits are supplied by the contracted electrician.

Outlets and mounting frames for floor boxes are supplied by the AV supplier.

Make and model of the floor boxes should be stated in the tender.

18.6 Communication

It is necessary to be able to communicate between on-campus classrooms and other universities/colleges in connection with distance learning, video conferencing, transfers of audio and video material, etc.

All communication is based on using the general computer network. The AV supplier must verify that the planned computer outlets and networking equipment is adequately dimensioned for handling all required real-time network traffic for audio and video. This includes requirements for port traversal and supporting specific protocols.

External traffic should be routed over the Internet for distance learning and video conferencing.

18.7 Fire alarm system

During fire alarms the AV system in rooms with control systems should automatically enter a pre-programmed mode in order to interrupt the ongoing activity in the room.

This is ensured from the fire alarm by having an output device on the detector loop of the fire alarm system, installed by/in the AV rack, send a potential-free signal to the control system. A shielded cable should be used (PTS, PFSK or similar.)

18.8 Control systems

Pulse switches installed by the entrance for controlling the AV system is supplied by the contracted electrician. The AV supplier supplies the wiring and is responsible for integration with the control system.

V CHECK LIST

The following checklist is recommended used during the planning stage to ensure that central elements have been evaluated and verified.

Some of the items are natural to verify collectively for all rooms, but the majority of the items should be verified per room.

	Item	**Reference**	**Verified**	**Date**
1	Define the functions in the room, prioritize application areas and discuss solutions with the users	Chapter 2	☐	
2	Verify and evaluate area, layout and headroom	Chapter 3.1.1	☐	
3	Verify design and visibility of the presentation area	Chapters 3.1.2-3.1.3	☐	
4	Evaluate (and possibly verify planned) lighting solutions, including controls	Chapter 3.2	☐	
5	Verify and possibly specify requirements for number and positioning of electrical and network outlets	Chapter 3.3.1	☐	
6	Verify and possibly specify requirements for 230V circuits	Chapter 3.3.2	☐	
7	Evaluate (and possibly verify planned) conduits	Chapter 3.3.3	☐	
8	Receive documentation for planned solutions for room acoustics	Chapter 3.4.2	☐	
9	Evaluate the positioning of presentation equipment, including options for placing central equipment in a technical room	Chapter 4	☐	
10	Evaluate need for vocal audio systems including microphone solutions and relevant loudspeaker solutions	Chapters 5.1-5.3	☐	
11	Evaluate the need and relevant solutions for hearing impaired	Chapter 5.5	☐	
12	Evaluate the positioning and size of boards	Chapter 6.1.1	☐	

13	Evaluate the positioning, type and size of display areas	Chapter 6.1.2	☐	
14	Evaluate relevant presentation equipment	Chapter 6.2	☐	
15	Evaluate the need for and necessary functionality and complexity of the control systems for the individual rooms	Chapter 7	☐	
16	Evaluate the need for a common system for operation support, and the competency and capacity needed for operating these solutions	Chapter 7.2 and UFS 120	☐	
17	Evaluate which rooms should have solutions for distance learning/video conferencing, and relevant solutions for these	Chapter 8, 9 and UFS 120	☐	
18	Verifying and possibly specifying proposals for surfaces and color choices for rooms intended for distance learning/video conferencing	Chapters 8.1 and 9.2	☐	
19	Verifying and possibly specifying proposals for conference table designs for meeting rooms for video conferencing	Chapter 9.1	☐	
20	Evaluate the need and relevant solutions for theft-proofing	Chapter 10	☐	
21	Define the boundaries for the AV contract and interfacing with other contractors, and ensuring that the interface description is made valid for all relevant contractors	Chapters 17 and 18	☐	
22	Review and if necessary adapt the technical and functional system requirements	UFS 119	☐	

VI

REFERENCES

References

References to **relevant regulations and instruction manuals** freely available for download:

[1] Technical regulations for the Planning and Building Code (TEK) §7-2, URL: http://www.lovdata.no/for/sf/kr/tr-19970122-0033-011.html.

[2] "Veiledning til teknisk forskrift" (Instructions for the technical regulations) (REN) §7-1- §7-2, URL: http://www.be.no/beweb/regler/veil/tekveil07/TekVeil07-072.pdf.

[3] "FOBTOT - Forskrift om brannforebyggende tiltak og tilsyn av 26. juni 2002 nr. 847", (FOBTOT - Regulations on fire preventing measures and inspection of June 26th 2002 no. 847) URL: http://www.lovdata.no/for/sf/jd/xd-20020626-0847.html.

[4] "PA 5551 Romakustikk og elektroakustiske anlegg" (PA5551 Room acoustics and electroacoustic systems), URL: http://www.statsbygg.no/FilSystem/files/Dokumenter/prosjekteringsanvisninger/5TeletekniskePA/PA_5551_Romakustikk.pdf.

[5] In the instructions from the Norwegian Labour Inspection Authority on climate and air quality at the workplace, URL: http://www.arbeidstilsynet.no/binfil/download.php?tid=29437.

[6] "Veiledning til forskrift om arbeidsplasser og arbeidslokaler" (Instructions for workplace and premise regulations) . http://www.arbeidstilsynet.no/c28863/artikkel/vis.html?tid=28647.

[7] Technical regulations for the Planning and Building Code (TEK) §8-35, URL: http://www.lovdata.no/for/sf/kr/tr-19970122-0033-016.html#8-35.

[8] "Veiledning til teknisk forskrift" (Instructions for the technical regulations) (REN) §8-3- , URL: http://www.be.no/beweb/regler/veil/tekveil07/TekVeil07-083.pdf.

[9] BE's instructions for universal design of structures and outdoor areas, URL: http://www.be.no/beweb/regler/meldinger/043UniversellUtf.pdf.

[10] Technical regulations for the Planning and Building Code (TEK) §10-42, URL: http://www.lovdata.no/for/sf/kr/tr-19970122-0033-029.html.

See references to other supporting documentation in the various sub-chapters.

A **reference database** has also been established, presenting relevant examples of good AV installation.

Note that not all of the solutions in the reference projects are necessarily in accordance with the recommendations in UFS 116-120, but the reference database is meant as a source of inspiration and an expanded basis for designing functional and customized solutions.

The reference database will be updated continually, and may be found at https://gigacampus.wiki.uninett.no/av#referansedatabase.