

1.0 **GENERAL**

1.1 **Related UBC Guidelines**

- .1 [UBC Learning Space Design Guidelines](#)

2.0 **MATERIALS AND DESIGN REQUIREMENTS**

2.1 **General**

- .1 UBC IT Audio Visual has certified Biamp and Crestron programmers on staff to manage and maintain the Digital Signal Processors. DSP's must be Biamp or Crestron, unless otherwise specified in this Section, to allow for internal support and maintenance, and include Acoustic Echo Cancellation as required for the specific application.
- .2 All audio equipment, with the exception of microphone inputs, loudspeaker outputs, and consumer (IHF) items in approved usage, is intended to operate at a nominal level of -20 dBm to +4 dBm on balanced floating 600 ohm lines. Provide buildouts, terminations, interstage attenuators and decoupling transformers as required.
- .3 Consumer items are nominally intended to operate at 200 mV on unbalanced high-impedance lines. Provide buildouts, terminations, interstage attenuators and decoupling transformers as required.
- .4 All digital audio equipment should have a minimum sampling rate of 44.1kHz and a bit depth of 16bits.
- .5 Wireless microphone systems shall be designed with an antenna distribution system to provide uninterrupted 100% coverage in the area of usage. To ensure good signal strength, the transmitter should be line of sight to the receiving antenna.

2.2 **Performance Criteria**

- .1 Sound systems intended for AV playback support must provide a minimum speech intelligibility of 0.56 STI throughout the student seating area.
- .2 Sound systems intended for speech reinforcement must provide a minimum speech intelligibility of 0.67 STI throughout the student seating area.
- .3 Coverage uniformity from 500Hz-2000Hz should be within 6dB (+/- 3dB) in the listening plane throughout the seating area for any sound system in any application. The coverage uniformity below 500Hz should be within 10dB (+/- 5dB) in the listening plane throughout the seating area. The coverage uniformity above 4000Hz should be within 8dB (+/- 4dB) in the listening plane throughout the seating area.
- .4 Sound systems should be calibrated to output at a minimum of 20 dBa over the ambient sound levels of the enclosing space (as measured during typical use), and should be capable of delivering no less than 75dBa sound level at the most distant seat in the classroom.
- .5 When AV playback is provided, the sound system shall provide complete coverage of the seating area. For AV systems with stereo audio, the left channel audio shall be routed to "audience left speaker" and the right channel audio shall be routed to "audience right speaker". For AV systems with summed mono, both left and right audio channels shall be reproduced at equal volume.

- .6 Feedback Stability Margin should be a minimum of 6dB when the classroom acoustics are within the criteria set by the UBC Classroom Acoustical Standards.
- .7 Provide loudspeaker modelling coverage results, and STI predictions, for review with Design Development submission before tendering sound or AV package.
- .8 The audio DSP shall eliminate acoustic echo in a full-duplex video conference. Ensure that the AEC has a strong signal of the incoming audio as a reference. An incoming signal that is weak could cause the AEC to miss elements that should be eliminated from the outgoing signal. The following settings shall assure the acoustic echo cancelling is working properly:
 - .1 The audio used in a reference signal shall be post-process audio. The cancellation reference should be a sample of the signal being sent to the power amplifier.
 - .2 Avoid routing far-end audio through dynamic feedback controllers. This could give a false acoustic picture of the room to the AEC.
 - .3 As the audio signal is acquired from a microphone, assure the AEC function is completed prior to any automatic gain control, noise cancelling, muting, or microphone mixing. Applying any of these functions prior to the AEC activity could cause a false acoustic picture of the room.

2.3 Lavalier Wireless Microphone Systems

- .1 UHF band FM diversity wireless microphone systems, with frequency agile transmitters/receivers.
- .2 Audio Frequency Response 80 to 15,000 Hz, +/-2 dB, with high pass filter.
- .3 Gain Adjustment Range transmitter 0 to 40 dB.
- .4 Modulation +/-15 kHz deviation compressor expander system with pre and de-emphasis.
- .5 RF Power Output 12 mW minimum, 30 mW maximum.
- .6 Dynamic Range >100 dB, A weighted.
- .7 RF Image Rejection 55 dB typical.
- .8 Spurious Rejection 75 dB typical.
- .9 The minimum effective range of the wireless system, receiver to transmitter, must be 75 meters (225 ft.) in its specified use case.
- .10 The receivers will be mounted in the equipment rack with the antennae mounted externally from the rack and extended using 50 ohm coaxial cable.
- .11 Include a lavalier type cardioid condenser microphone with appropriate wireless connector, tie clip mount and windscreen.
- .12 Battery life to be a minimum of 8 hours with AA Lithium Alkaline batteries.
- .13 The wireless system must have a minimum of 100 channels available in their operating band, or more as required by the local operating environment.
- .14 Wireless systems used within the same building must have frequency blocks selected to be compatible.

- .15 Select clear frequencies on site based on RF site survey using wireless receiver.
- .16 Typical manufacturers are:
 - .1 Shure

Shure Band	
Band G50	(470 MHz – 534 MHz)

2.4 Talkback Handheld Wireless Microphone Systems

- .1 UHF band FM diversity wireless microphone systems, with frequency agile transmitters/receivers operating.
- .2 Audio Frequency Response 80 to 15,000 Hz, +/-2 dB, with high pass filter.
- .3 Gain Adjustment Range transmitter 0 to 40 dB.
- .4 Modulation +/-15 kHz deviation compressor expander system with pre and de-emphasis.
- .5 RF Power Output 12 mW minimum, 30 mW maximum.
- .6 Dynamic Range >100 dB, A weighted.
- .7 RF Image Rejection 55 dB typical.
- .8 Spurious Rejection 75 dB typical.
- .9 The minimum effective range of the wireless system, receiver to transmitter, must be 75 meters (225 ft.) in its specified use case.
- .10 The receivers will be mounted in the equipment rack with the antennae mounted externally from the rack and extended using 50 ohm coaxial cable.
- .11 Include a handheld cardioid dynamic microphone integrated into the transmitter.
- .12 Battery life to be a minimum of 8 hours with AA Lithium Alkaline batteries.
- .13 The wireless system must have a minimum of 100 channels available in their operating band, or more as required by the local operating environment.
- .14 Wireless systems used within the same building must have frequency blocks selected to be compatible.
- .15 Select clear frequencies on site based on RF site survey using wireless receiver.
- .16 Typical manufacturers are:
 - .1 Shure

Shure Band	
Band G50	(470 MHz – 534 MHz)

2.5 Gooseneck Microphone

- .1 Fixed microphones mounted on the lectern will be equipped with a flexible gooseneck.
- .2 The microphone will feature an outboard preamplifier.
- .3 The microphone will feature a cardioid condenser microphone capsule with a response of 80Hz to 20,000kHz with high pass filter engaged.
- .4 Minimum output impedance will be 150 ohms balanced, and it will have a minimum open circuit output sensitivity of 10mV/Pa.
- .5 The microphone will be usable with phantom power from 11 to 52V.
- .6 The microphone will have a matte black finish, and will be equipped with a windscreen.
- .7 Gooseneck microphones will be equipped with a fixed mounting to permanently mounted shockmount, removable microphones will not be acceptable.
- .8 Typical manufacturers are:
 - .1 Audio-Technica
 - .2 Shure
 - .3 Beyerdynamic
 - .4 Clock Audio
 - .5 AKG Harman

2.6 Ceiling Condenser Microphones

- .1 Microphones intended for ceiling mounting.
- .2 The microphone will feature a condenser microphone capsule with a response of 100Hz to 10kHz with high pass filter engaged along with all recommended manufacturer filters.
- .3 Minimum output impedance will be 150 ohms balanced, and it will have a minimum open circuit output sensitivity of 37mV/Pa.
- .4 The microphone will be usable with phantom power from 11 to 52V.
- .5 Typical manufacturers are:
 - .1 Audix
 - .2 Audio Technica
 - .3 Biamp
 - .4 Clear One
 - .5 Shure

2.7 Ceiling Tile Microphones

- .1 Microphones intended for mounting in rooms with ceiling tile ceilings.
- .2 The microphone will fit in 2'x2' ceiling tile grids and have a frequency response of 180Hz to 15 kHz with high pass filter engaged along with all recommended manufacturer filters.
- .3 The microphone will have a signal to noise ratio of 83 dB(A) and a minimum dynamic range of 82 dB(A).
- .4 The microphones will be powered via PoE.

- .5 The microphone audio output will be Digital Dante Network Audio.
- .6 Typical manufacturers are:
 - .1 Sennheiser
 - .2 Shure

2.8 Digital Audio Processor (Large Expandable)

- .1 DSP-based software configurable audio processor with a modular input and outputs, with a minimum capacity of 12 dual input or output modules, usable for inputs or outputs.
- .2 Compatible input modules with Acoustic Echo Cancelling must be available.
- .3 The DSP programming will not be limited by a fixed signal flow architecture, but fully configurable using a modular object interface.
- .4 Expandability will utilize an AVB or Dante backbone, allowing input and output expansion and shared DSP resources over an Ethernet network.
- .5 The mixer shall have a: frequency response within +/- 0.5dB between 20Hz-20kHz; signal-to-noise ratio of >80dB; output level of +24dB with less than 0.15%THD.
- .6 The unit will be configured through computer software, but a computer will not be required for operation.
- .7 The unit will be controllable through the AV control system via RS-232 or Ethernet.
- .8 Approved products are:
 - .1 Biamp Tesira

2.9 Digital Audio Processor (Small Expandable)

- .1 DSP-based software configurable audio processor with a fixed input and output configurations, with the option of local connections to other units over a proprietary expansion bus on short multiconductor cables or AVB.
- .2 The DSP programming will not be limited by a fixed signal flow architecture, but fully configurable using a modular object interface.
- .3 The mixer shall have a: frequency response within +/- 0.5dB between 20Hz-20kHz; signal-to-noise ratio of >80dB; output level of +24dB with less than 0.15%THD.
- .4 The unit will be configured through computer software, but a computer will not be required for operation.
- .5 The unit will be controllable through the AV control system via RS-232 or Ethernet.
- .6 Approved products are:
 - .1 Biamp Tesira Forte Series

2.10 Digital Audio Processor Fixed Application

- .1 DSP-based software configurable audio processor with a fixed input and output configurations.
- .2 The DSP programming may have a fixed signal flow architecture.

- .3 The mixer shall have a: frequency response within +/- 0.5dB between 20Hz-20kHz; signal-to-noise ratio of >80dB; output level of +24dB with less than 0.15%THD.
- .4 The unit will be configured through computer software, but a computer will not be required for operation.
- .5 The unit will be controllable through the AV control system via RS-232 or Ethernet.
- .6 Typical products are:
 - .1 Extron DMP series
 - .2 Extron MVC series
 - .3 Biamp Tesira
 - .4 Crestron Avia

2.11 USB Audio Mixer Fixed Application

- .1 The USB mixer shall have microphone and/or line level inputs with +48 volt phantom power, one USB 2.0 and one line level output
- .2 The USB mixer shall have a: frequency response within +/- 0.5dB between 20Hz-20kHz; signal-to-noise ratio of >80dB; output level of +24dB with less than 0.15%THD
- .3 The USB mixer input level and master volume level shall be manually adjustable control.
- .4 The USB mixer USB 2.0 output shall be Windows and Mac compatible.
- .5 Approved product manufacturers are Crestron and Art.

2.12 Power Amplifiers (70V)

- .6 Amplifiers for driving 70V ceiling loudspeakers or other distributed loudspeaker systems.
- .7 Amplifier power should be selected to have at least 2dB of headroom above the calculated load of loudspeaker taps plus insertion loss of speaker transformers, and should have a minimum of 30% more power than the sum total of all loudspeaker taps.
- .8 Amplifiers may have 70V output transformers, or may be a direct coupled constant voltage output. Amplifiers that use 70V transformers must include suitable high pass filtering to prevent output transformer saturation.
- .9 Amplifiers may be single channel or multi-channel, as best suits the particular needs of the project and the power density needed.
- .10 Amplifiers should have a minimum frequency response of 50Hz-15,000Hz including the output transformer.
- .11 Total Harmonic Distortion (THD) should be under 0.5% at full rated power including the output transformer.
- .12 Input connections by terminal strip, Phoenix connector, or XLR connector. ¼" TRS phone jacks are not acceptable.
- .13 Output connections by terminal strip, 5 way binding posts or Neutrik Speak-On.
- .14 Typical manufacturers are:
 - .1 Crestron
 - .2 Crown

- .3 TOA
- .4 Extron
- .5 QSC
- .6 Kramer

2.13 Power Amplifiers 50W and Up (Low Impedance)

- .1 Amplifiers for driving low impedance loudspeakers directly in medium to high power applications (50W or higher).
- .2 Amplifier power should be selected to have at least 3dB of headroom above the maximum expected power demands.
- .3 Amplifiers that are direct coupled low impedance output should have a minimum load impedance below 4 ohms and feature protection against short circuits and overheating.
- .4 Amplifiers may be single channel or multi-channel, as best suits the particular needs of the project and the power density needed.
- .5 Amplifiers should have a minimum frequency response of 50Hz-15,000Hz including the output transformer.
- .6 Total Harmonic Distortion (THD) should be under 0.5% at full rated power including the output transformer.
- .7 Input connections by terminal strip, Phoenix connector, or XLR connector. ¼" TRS phone jacks are not acceptable.
- .8 Output connections by terminal strip, 5 way binding posts or Neutrik Speak-On.
- .9 Typical manufacturers are:
 - .1 Crestron
 - .2 Crown
 - .3 Extron
 - .4 QSC
 - .5 Ashley
 - .6 Kramer

2.14 Power Amplifiers 2W – 50W (Low Impedance)

- .1 Amplifiers for driving low impedance loudspeakers directly in medium to high power applications (2W – 50W).
- .2 Amplifier power can be selected to match the maximum expected power demands.
- .3 Amplifiers that are direct coupled low impedance output should have a minimum load impedance below 4 ohms and feature protection against short circuits and overheating.
- .4 Amplifiers may be single channel or multi-channel, as best suits the particular needs of the project and the power density needed.
- .5 Amplifiers should have a minimum frequency response of 50Hz-15,000Hz including the output transformer.
- .6 Total Harmonic Distortion (THD) should be under 0.5% at full rated power including the output transformer.
- .7 Input connections by terminal strip, Phoenix connector, or XLR connector. ¼" TRS phone jacks are not acceptable.

- .8 Output connections by terminal strip, 5 way binding posts or Neutrik Speak-On.
- .9 Approved manufacturers are:
 - .1 Extron
 - .2 Crestron
 - .3 Stewart
 - .4 Kramer

2.15 Ceiling Loudspeakers for Learning space Speech Reinforcement Systems

- .1 Ceiling loudspeakers used in speech reinforcement systems must exhibit uniform 1/3 octave directivity from 1000Hz - 4000Hz with a nominal directivity index of 6 (+/- 4). The coverage pattern should never be narrower than 90 degree conical in that 1-4kHz bandwidth.
- .2 Speech reinforcement ceiling speakers should be concentric coaxial rather than "tweeter on a post" construction to meet the above directivity requirement.
- .3 Frequency response for ceiling speakers should be 90Hz to 18,000Hz +/- 3dB.
- .4 Ceiling speakers should include 70V transformers with a minimum of a 9dB range of taps. Wattage taps to be verified prior to install.
- .5 Ceiling speakers should have a minimum sensitivity of 85dB @ 1W @1 m.
- .6 Ceiling speakers must be seismically restrained in suspended ceilings.
- .7 Typical manufacturers are:
 - .1 Crestron
 - .2 Tannoy
 - .3 Community
 - .4 JBL
 - .5 Soundtube
 - .6 Kramer

2.16 Ceiling Loudspeakers for General Purpose Use

- .1 Ceiling loudspeakers used in general purpose paging systems must have a frequency response of 90Hz to 15,000Hz +/- 5dB.
- .2 Ceiling speakers should include 70V transformers with a minimum of a 12dB range of taps. Wattage taps to be verified prior to install
- .3 Ceiling speakers should have a minimum sensitivity of 85dB @ 1W @1 m.
- .4 Ceiling speakers must be seismically restrained in suspended ceilings.
- .5 Typical manufacturers are:
 - .1 [Community](#)
 - .2 [Tannoy](#)
 - .3 Crestron
 - .4 JBL
 - .5 Extron
 - .6 Kramer

2.17 AV Playback Loudspeakers for Small Learning spaces

- .1 AV playback speakers for use in learning spaces under 50 seats.

- .2 Playback speakers should be able to provide a sound level of 75dBA in the most distant seats in the classroom, and should have a wide enough coverage that all students can hear both stereo channels.
- .3 Loudspeakers should have a frequency response of 90Hz to 18,000Hz +/- 5dB.
- .4 Loudspeakers should have a minimum sensitivity of 85dB @ 1W @1 m.
- .5 Typical manufacturers are:
 - .1 Crestron
 - .2 JBL Control series
 - .3 Tannoy
 - .4 Kramer

2.18 AV Playback Loudspeakers for Large Learning spaces

- .1 AV playback speakers for use in learning spaces over 50 seats.
- .2 Loudspeakers for use in learning spaces and lecture theatres over 50 seats should be chosen based on the coverage uniformity results of a loudspeaker modelling package to provide performance as outlined in section 2.2
- .3 Playback speakers should be able to provide a sound level of 75dBA in the most distant seats in the learning spaces, and should have a wide enough coverage that all students can hear both stereo channels.
- .4 Loudspeakers should have a frequency response of 60Hz to 18,000Hz +/- 5dB.
- .5 Loudspeakers should have a minimum sensitivity of 85dB @ 1W @1 m.
- .6 Typical manufacturers are:
 - .1 Crestron
 - .2 Community
 - .3 JBL Pro
 - .4 Tannoy
 - .5 Bose
 - .6 TOA

3.0 EXECUTION

3.1 Mounting, Rigging and Seismic Restraint

- .1 Where the Sound Contractor uses loudspeaker enclosures or systems that are factory equipped with rigging or mounting points, the rigging or mounting hardware and the attachment to the building or support structure must be certified. Component mounting in the enclosures must make use of bolts and threaded inserts or locknuts. Self-threading wood or sheet metal screws are not acceptable for driver mounting to the baffle. Loudspeaker mounting clamps that grip the edge of the loudspeaker frame, and are put in compression by a through bolt are not acceptable. All loudspeakers must be mounted by bolts through mounting holes in the frame.
- .2 Loudspeaker components such as moulded fibreglass horns, cast or injection moulded plastic speaker enclosures or horns, etc. must never be supported by a system using the drilled or moulded holes through the plastic material. All mounting holes or attachment points must have aluminium or steel reinforcement to prevent breakaway or tear-out of the

material surrounding the holes.

- .3 All loudspeakers installed in acoustic ceiling tile grids must use appropriate tile bridge hardware, and be seismically restrained to building structure.

3.2 Wiring

- .1 Route microphone cables in separate conduit or raceways and maintain separation of all other cables in tray system and equipment racks by level and function: microphone circuits, line level circuits, foldback circuits, loudspeaker circuits, intercom circuits, video circuits, control circuits and 120 volt AC power circuits.
- .2 All connections using shielded pair audio cable should include cable dressing as follows.
 - .1 The shield, or drain wire should have a clear Teflon, or green PVC, or heatshrink sleeve covering exposed conductor between the connector, or termination and the cable jacket.
 - .2 A heat shrink boot, or Hellerman sleeve should be used on any cable that uses a braided shield or spiral wrap shield where the cable is dressed for termination.
- .3 All audio circuits, unless otherwise specified, shall be balanced, floating and shielded two wire circuits with the red or white wire hot (connected to pin 2 of XLR3 connectors and to the Tip of phone connectors) and the black wire cold (connected to pin 3 of XLR3 connectors and to the Ring of phone connectors).
- .4 Make input connections to power amplifiers with XLR3 connectors, or with spade lugs on barrier terminal strips, or Phoenix connectors. Do not make input connections with 1/4 inch phone plugs.
- .5 Use ring lugs or high current locking connectors, such as Neutrik Speakons for connections to enclosed loudspeaker systems.

3.3 Grounding and Shielding

- .1 Connect all racks containing sound system equipment to only the dedicated sound system ground point.
- .2 For microphone cables, provide continuous shield from microphone receptacle to microphone mixer input. Ground only at mixer.
- .3 Pin 1 on XLR type connectors must not be connected to the connector barrel or shell.

3.4 Testing

- .1 Conduct tests to demonstrate that the sound system is properly functional:
 - .1 After installation, measure and document the sum of the harmonic distortion, noise floor and gain for a typical path from microphone level input to amplifier output.
 - .2 Measure and document gain structure through the signal path from input to output for each typical signal level. Repeat with sine wave sweep from 50 Hz to 15kHz to record any additional adjustments required by equalization. Repeat with full bandwidth pink

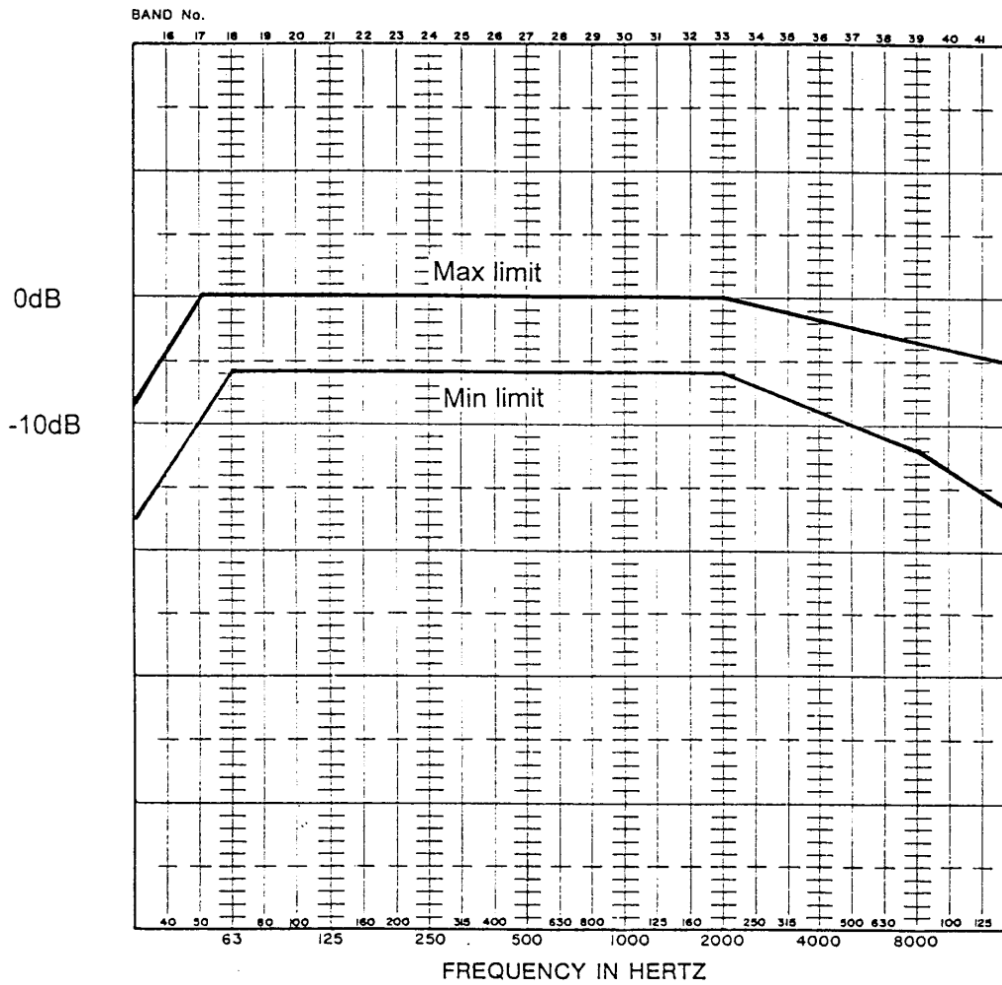
noise signal, or swept test signal to record equalizer wide-band gain.

- .3 Ensure that system is free of spurious oscillation and RF noise up to 5 MHz.
- .4 Test polarity of microphones, microphone cables, and signal wiring: pin 1 = shield, pin 2 = hot, pin 3 = cold. Test polarity of connector plate plugs and jacks: sleeve = shield, ring = cold, tip = hot. Test polarity of signal equipment and amplifiers. Test polarity of loudspeaker wiring: red = (+), black = (-). Drive all loudspeakers in polarity, and in absolute polarity. Test absolute polarity of the voice and playback systems, input to output, and ensure that the sum of all signal paths is in polarity. If it is necessary to invert signal polarity at any stage or interconnect point to preserve system polarity, document that polarity change on as-built drawings.
- .5 Measure uncorrected direct sound response of the loudspeakers at no less than three (3) positions representative of the middle and edges of the seating. Adjust equalization to shape house response. Measured response after equalization shall fall within the limits defined on Figure #1.
- .6 With pink noise input, record maximum sound pressure level after equalization.

3.5 Test Equipment

- .1 Provide the following audio test equipment on site during check-out where necessary to measure and document the system performance outlined in section 3.8:
 - .1 Time domain measurement system (**TEF** or JBL/EAW Smaart or EASERA) for setting of direct sound equalization.
 - .2 Sound level meter with linear response and 1/2 inch free field microphone.
 - .3 Audio test set with low distortion signal generator, true RMS meter, and facility to measure THD. (Audio Precision, Neutrik, HP, etc.)
 - .4 5 MHz oscilloscope.
 - .5 Pink noise generator.
 - .6 All cables, connectors and adaptors necessary to interface with the sound system.
- .2 Provide test equipment of professional quality and in good working order. Substandard equipment will be cause for rejection. The Owner, or their designated Consultant reserves the right to demand proof of equipment accuracy.

Figure # 1 Sound System Response Limits



*** END OF SECTION***