Attachment D

AUDIO FREQUENCY INDUCTION LOOPS AUDIT IN PARLIAMENT HOUSE

For the Purpose of OH&S Compliance

Version 0.1 December 2008

Prepared by

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0.1	17/11/2008	First Draft	Mirek Ciolek

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Executive Summary

This report presents the results of an Audit carried out in all Induction Loop Systems located in Parliament House and maintained by DPS. The Parliamentary buildings are equipped with Loop systems in a number of public and private areas.

The User/Customer must be equipped with a Hearing Aid compatible with Telecoil technology to take advantage of the Audio Frequency Induction Loop Signal Transmission. The magnetic field strength must be chosen so that there is sufficient signal strength for a good quality audio signal without overload of the hearing aid during louder passages.

In each venue, the Induction Loop Amplifier** was checked and set up as per manufacturers' recommendations. The room was then tested with a calibrated Induction Loop Receiver choosing suitable reference points and the results were tabulated. The background noise was also recorded to confirm a suitable signal levels above background (electromagnetic) noise.

A summary of Compliance can be found in **Table 1** in **Section 3.5**.

Appendix A contains extensive information as compiled from tests in all venues.

It is desirable to achieve a signal to noise ration of 45dB with a minimum of 25dB. After a number of tests, it became obvious that loop topography utilised has resulted in poor system performance. A 20% coverage is achievable in most venues, but not in critical areas ie witness seats in committee rooms.

The Signage is both comprehensive and complete throughout the public areas of Parliament House and it meets the Australian standards.

A list of Recommendations:

Upgrade loop design to achieve better coverage in venues.

Upgrade older amplifiers to achieve simplified calibration process

Where required, fit an equaliser to optimise metal loss compensation.

In order to achieve value for money, any AFILs rework performed in Parliament House should be supervised and commissioned by a Broadcast Support Officer who has experience with Induction Loop systems.

(**Due to the fact that 3 different manufacturers' equipment is used, the amplifier output had to be tailored for optimum performance, see Appendix B)

TABLE OF CONTENTS

1. INTRODUCTION

1.1 STAKEHOLDERS

The current Stakeholders for the AFILs Systems are:

1. DPS
2. Chamber Departments

1.2 INTENDED AUDIENCE

The intended audience for this document is DPS staff (ie internal information only) for the purpose of enhancing systems to meet OH&S compliance.

1.3 DOCUMENT PURPOSE

This report firstly presents the opportunity to evaluate existing systems as built for an earlier Australian Standard and secondly to look at improving the existing systems. By embracing better and proven technologies, DPS would be in a position to enhance the systems to meet 2007 standards.

The tabulated results present the opportunity to evaluate compliance and the extra information gathered in this exercise gives us the opportunity to consider enhancements or redesign of loops to meet the current standards.

The department is under obligations to have the Parliament House buildings conform to the Buildings Code of Australia AS 1428 (which directs us to AS 60188.4, preceded by AS 1088.4 see section “1.4 Document references”)

1.4 DOCUMENT REFERENCES

Ref No	Title	Version	Date
1	Magnetic Field Strength in Audio Frequency Induction Loops for Hearing Aid Purposes	AS 60118.4	2007
2	Superceded Reference: Magnetic Field Strength in Audio Frequency Induction Loops for Hearing Aid Purposes	AS 1088.4	1987
3	Equivalent Reference: Magnetic Filed Strength in Audio Frequency Induction Loops for Hearing Aid Purposes	IEC 60118-4 Ed. 2.0	2006
4			
5			

1.5 DEFINITIONS, ACRONYMS AND ABBREVIATIONS

This subsection provides the definitions of all terms, acronyms and abbreviations required to properly interpret this document.

Acronym	Extended Form
AFILs	Audio Frequency Induction Loops
AS	Australians Standards
dB Peak	In reference to Induction Loop Calibrator (referenced to 100mA/m)
c-weighted	Bandwidth 20Hz to 20kHz (unaltered Baseband Audio frequency range)
a-weighted	Modified curve attenuating lower and upper audio spectrum
RMS	Root Mean Square: Mathematical reference in Testing and Measurement
VA	Volt Ampere: Unit of power
mA/m	milliAmps/metre: unit of measure of Magnetic Filed Strength

2. OVERVIEW

2.1 PURPOSE

The purpose of this document is to identify compliance of AFILs systems in Parliament House (as identified), to AS 60118.4 (2007) With the exception of the technical procedures, test results and equipment descriptions, it has been presented at the general (layman's) level, rather than pure engineering level of understanding.

2.2 SCOPE

2.2.1 In Scope

All central Committee Rooms, House of Representatives Floor and Galleries, Senate Galleries and miscellaneous facilities serviced by DPS.

2.2.2 Out of Scope

Great Hall and certain public area which would benefit from an AFILs system, but are currently not fitted out. Such areas include Information Desk in the Marble Foyer, Post Office Counter, Security Desk (Marble Foyer), etc.

House of Representatives 2nd Floor North/South Galleries

For this audit Committee Rooms 1R5, 1R6, 1S5 and 1S6 are also excluded because they were not originally fitted or upgraded with AFILs.

The Media Galleries in both chambers are also excluded due to operational requirements and agreement with the Media.

2.3 ASSUMPTIONS

This document has been prepared in accordance with the following assumptions:

1. As far as possible, this document was produced as an independent evaluation of the AFILs systems in Parliament House and must be respected as such.
2. The technical staff in Broadcast Support adhered to correct engineering principles in order to achieve Compliance Testing. The same procedures have been utilised in the past for testing and commissioning of new systems in Broadcasting Assets. This processes can be verified by an external consulting electroacoustic engineer if required.

3. BODY

3.1 EQUIPMENT REQUIRED

Brand, Model and Description:

1. LM Audio ILM12 Induction Loop Monitor
2. Neutrik MiniRator MR1 Test Signal Generator
3. Fluke 79 Mk3 RMS Multimeter
4. Connectivity leads, suitable for the 3 different amplifiers
5. Technical Manuals relating to the Loop amplifiers

3.2 TEST PROCEDURE FOR LOOP RESPONSE

As per description

1. Isolate loop amplifier from system
2. Set up current monitor on output of amplifier
3. Inject 0dBu into amplifier input, adjust output until 0dBpk can be measured on perimeter areas of loop (typically just reaches 0dB ref on Loop Amplifier)
4. Check loop current is within specification (preferably with some headroom)
5. Perform basic check with Loop Monitor to confirm reasonable loop output
6. Collect Loop Monitor data adhering to a defined grid
7. Tabulate results
8. Note any irregularities

3.3 TEST PROCEDURE FOR BACKGROUND NOISE

As per description:

1. Turn loop amplifier "OFF"
2. Select critical test points and sweep the room noting any sources of noise
3. Tabulate readings on venue map for reference

3.4 QUALITY METHOD

It is desirable to achieve Signal Levels of 0dB peak (down to -6dB) and a signal to noise ration of 45dB with a minimum of 25dB.

The decision on compliance of the Committee Rooms was weighted for an acceptable level for Members/Senators seating as well as Witness Desks in the "classic" Estimates'

configuration. In this configuration the extra seating for support staff and next witnesses is also important.

Due to the random access to seating in the Chamber public galleries, it would be desirable to have 100% coverage and therefore compliance was weighted for this requirement.

Listed below are Compliance classifications:

1. Fully implies 80-100%
2. Partially implies 20-80% (ie walkabout to find a good reception spot!!)
3. Marginally implies <20% area of suitable level
4. Non implies low base level and excessive signal attenuation

3.5 ABBREVIATED SUMMARY OF DATA FROM RESULTS

To assist with compliance, the fully functional and non-functional venues in this document shall be classified, where applicable, with one of the above classification codes.

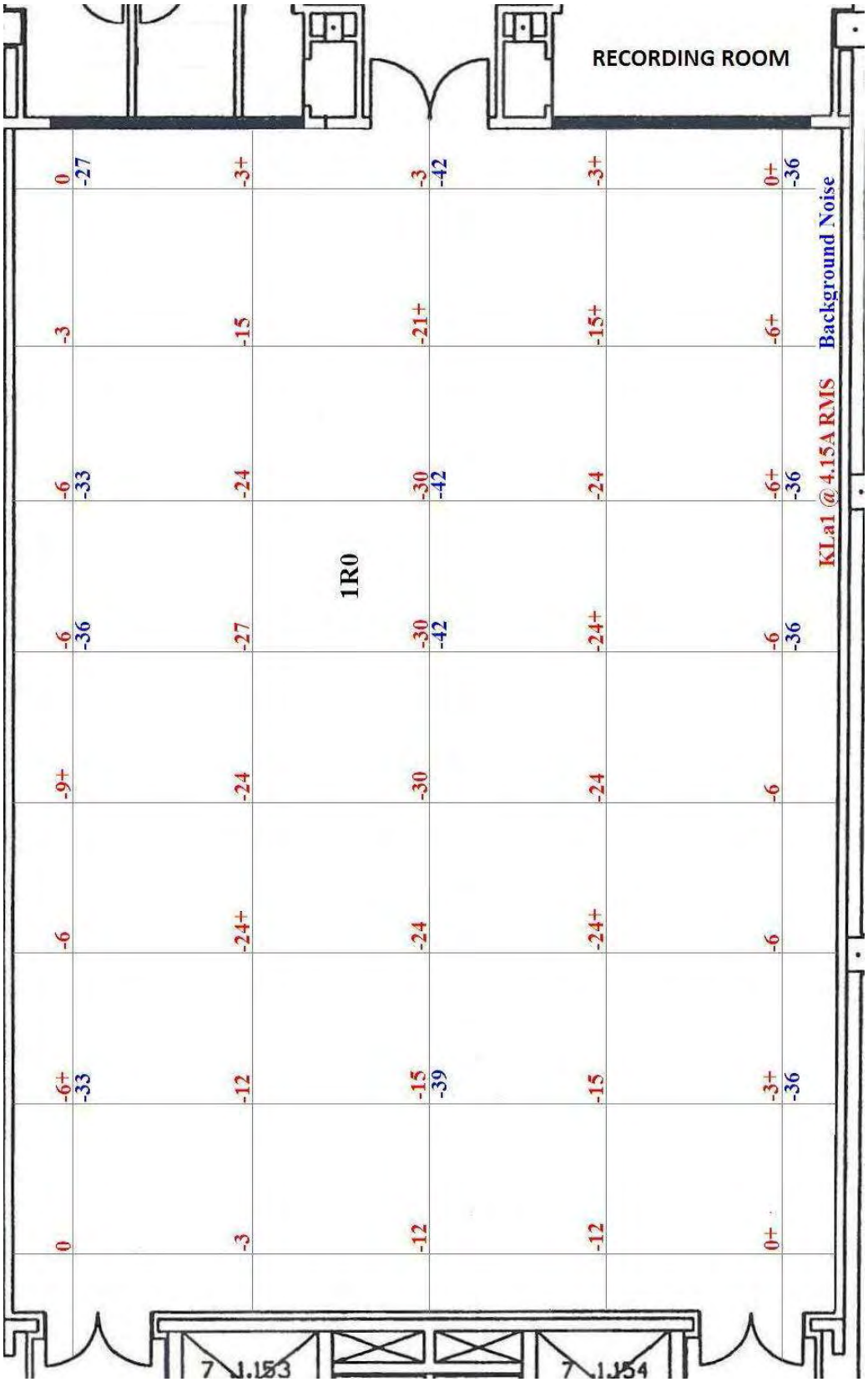
Table 1: SUMMARY OF COMPLIANCE

Ref	*Venue*	*Description*
A1	Main CR (1R0)	Non Compliant
A2	1R0 Gallery	Partially Compliant
A3	CR 1R1	Non Compliant
A4	CR 1R2	Non Compliant
A5	CR 1R3	Fully Compliant
A6	CR 1R4	Marginally Compliant
A7	CR 2R1	Marginally Compliant
A8	CR 2R2	Fully Compliant
A9	CR 2R3	Non Compliant
A10	CR 1S2	Marginally Compliant
A11	CR 1S3	Non Compliant

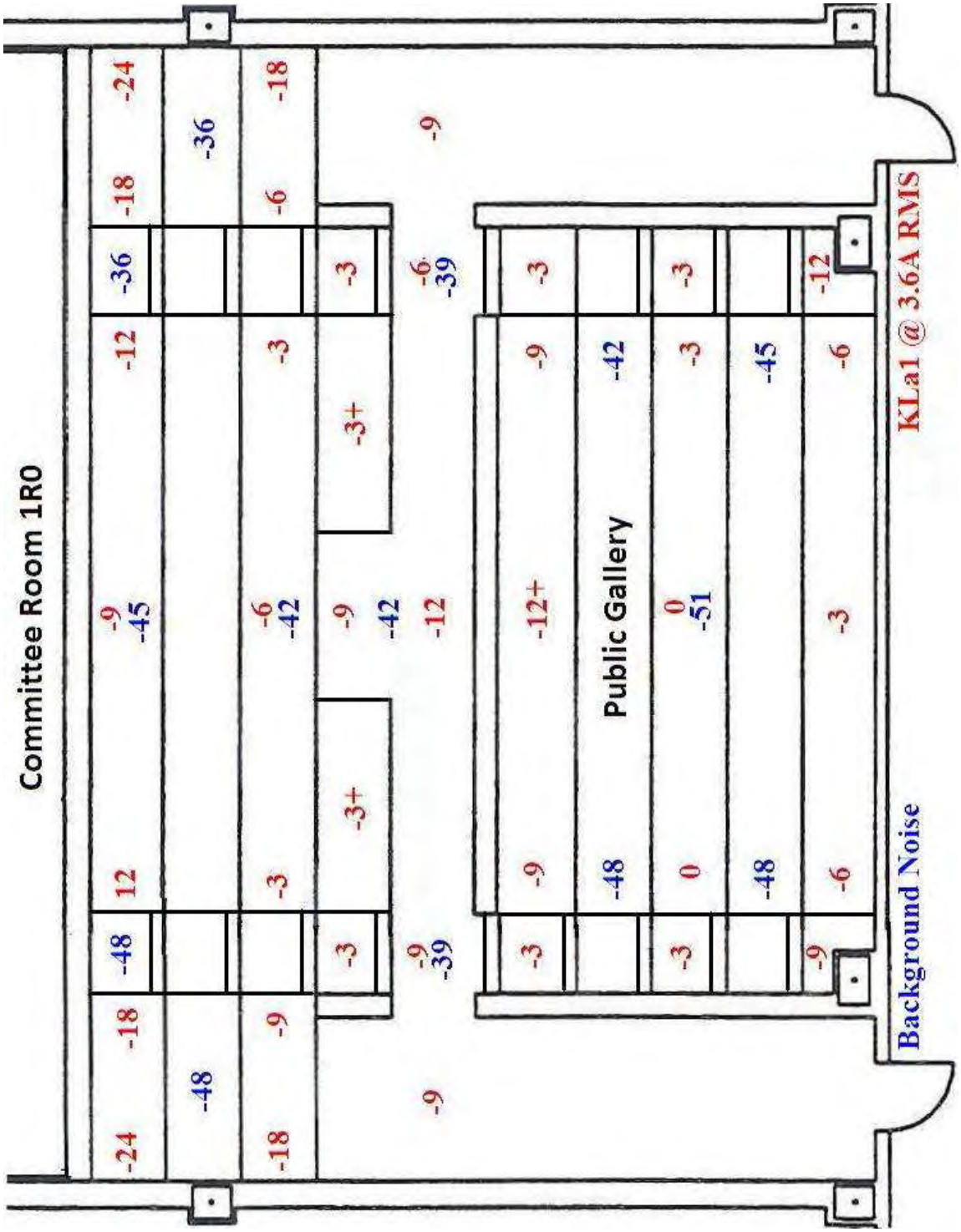
Table 1: SUMMARY OF COMPLIANCE		
A12	CR 1S4	Non Compliant
A13	CR 2S1	Non Compliant
A14	CR 2S2	Fully Compliant
A15	CR 2S3	Non Compliant
A16	HoR (Floor0	Fully Compliant
A17	HoR Gal 2nd West	Fully Compliant
A18	Hor Gal 1st West	Non Compliant
A19	HoR Gal 1st Nth	Non Compliant
A20	HoR Gal 1st Sth	Non Compliant
A21	Sen Gal 2nd East	Fully Compliant
A22	Sen Gal 2nd Nth	Partial Compliant
A23	Sen Gal 2nd Sth	Non Compliant
A24	Sen Gal 1st East	Fully Compliant
A25	Sen Gal 1st Nth	Non Compliant
A26	Sen Gal 1st Sth	Non Compliant
A27	Theatre	Partial Compliant (Compliant with labelling as indicated)
A28	EPCR Blue Room	Fully Compliant
A29	Govt Party Room	Non Compliant
A30	Opp. Party Room	Non Compliant
A31	Cabinet Room	Fully Compliant

Appendix A Data from Venues

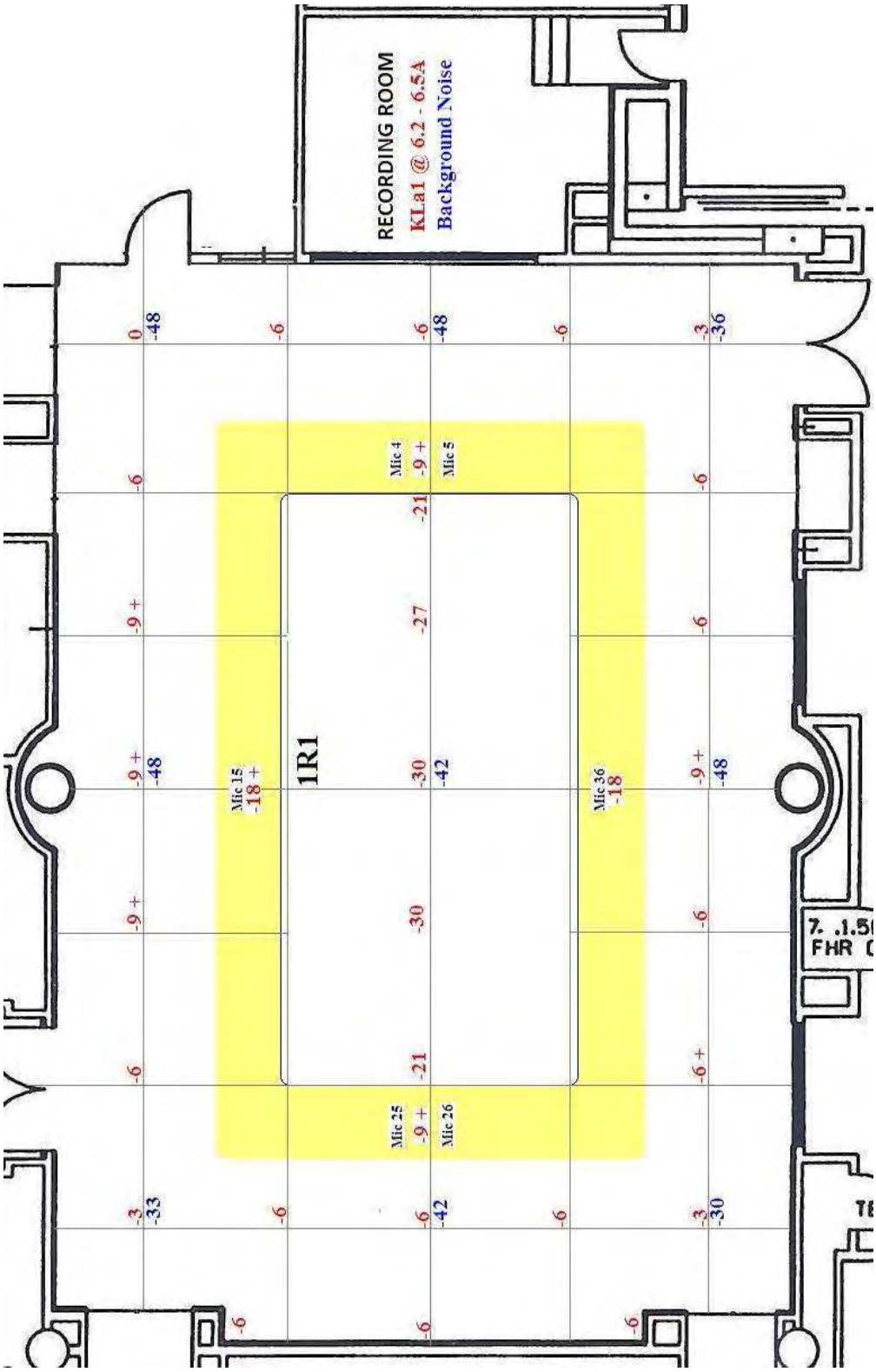
A1 Committee Room 1R0 (Main)



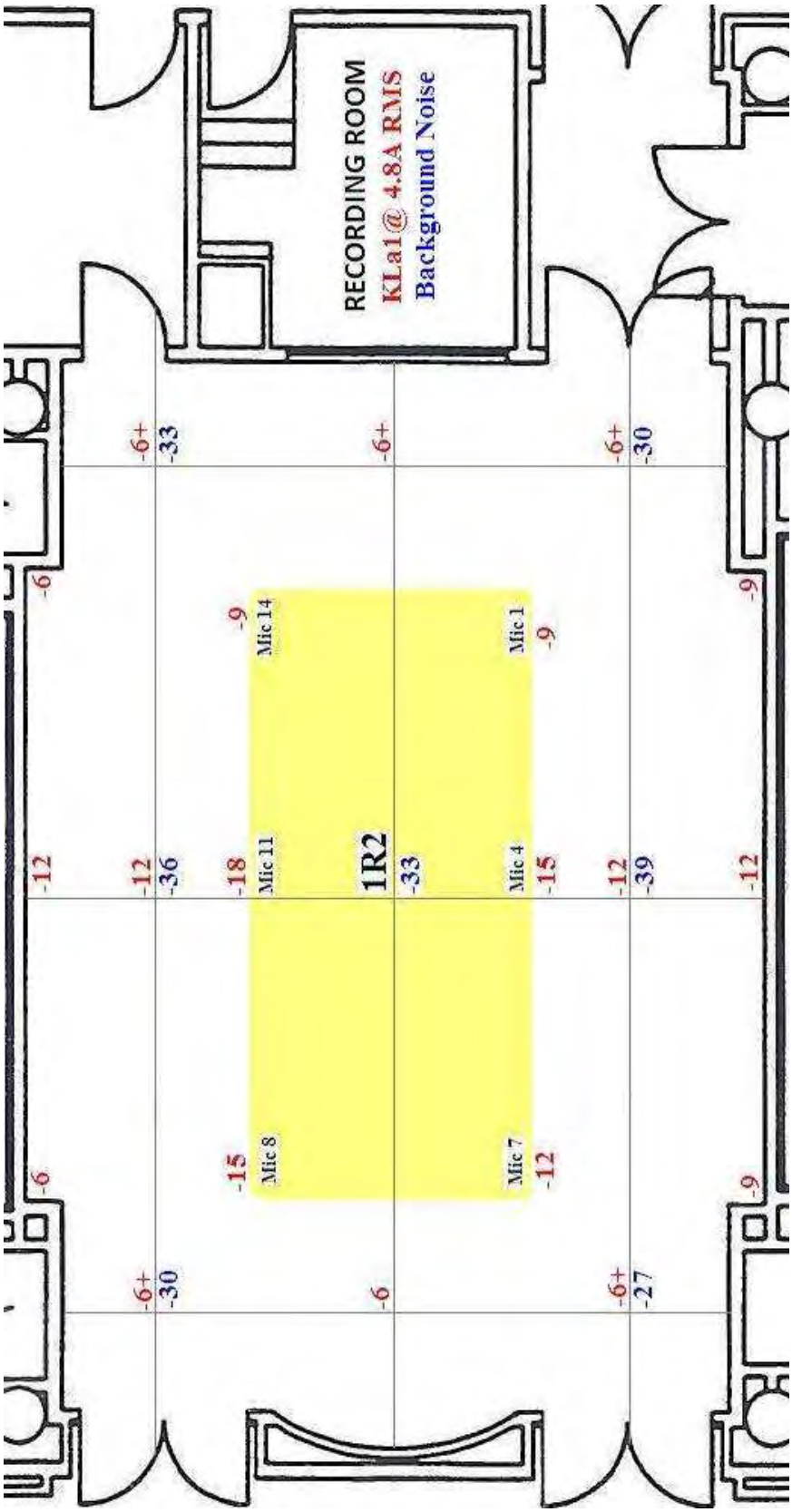
A2 Committee Room 1R0 (Gallery)



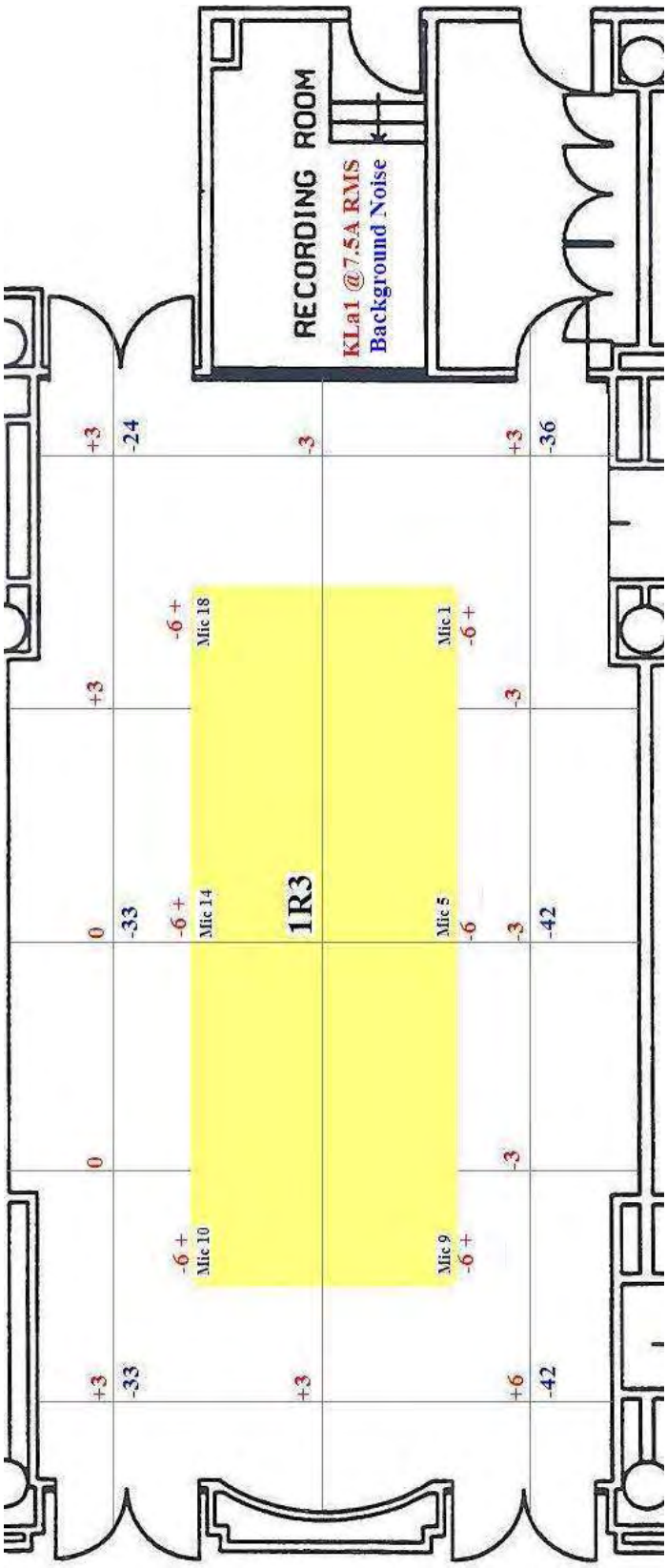
A3 Committee Room 1R1



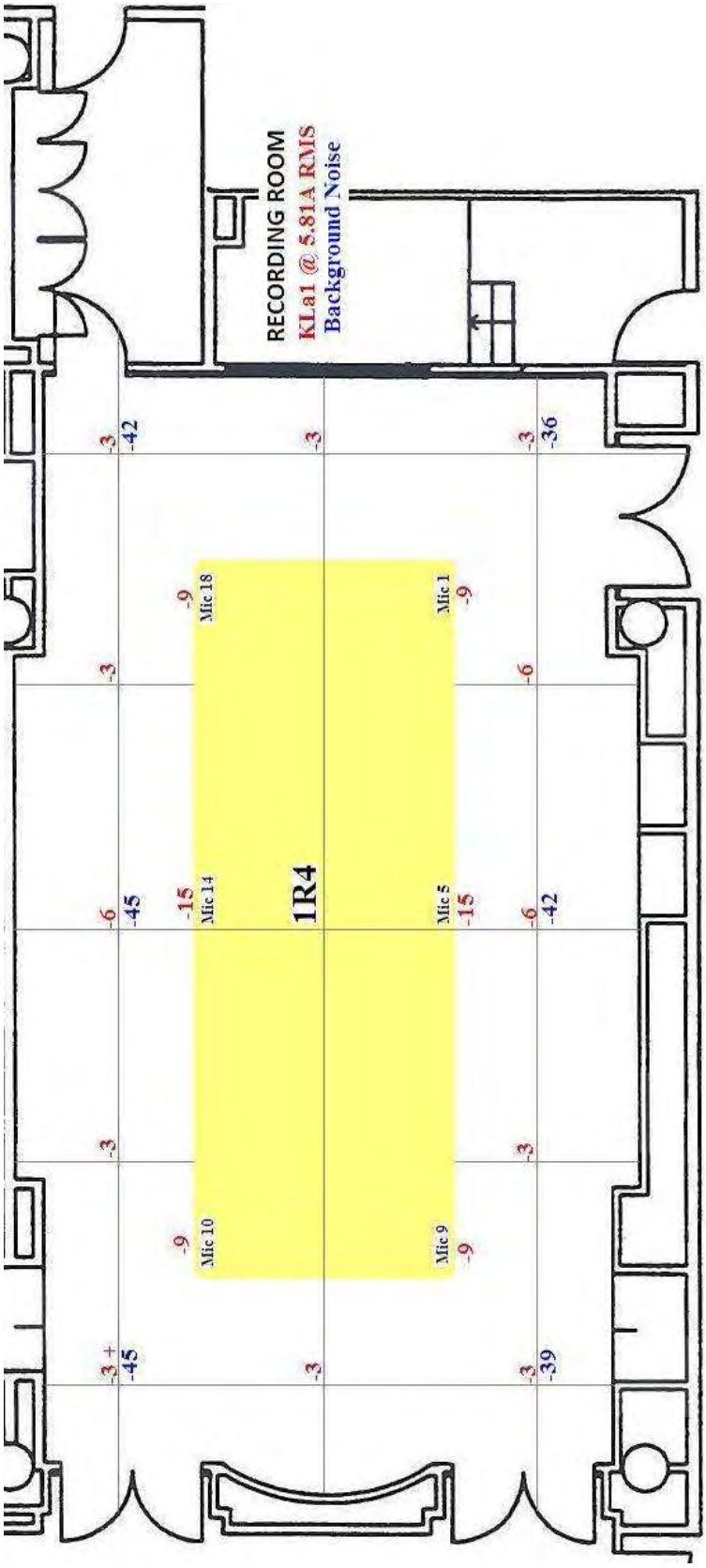
A4 Committee Room 1R2



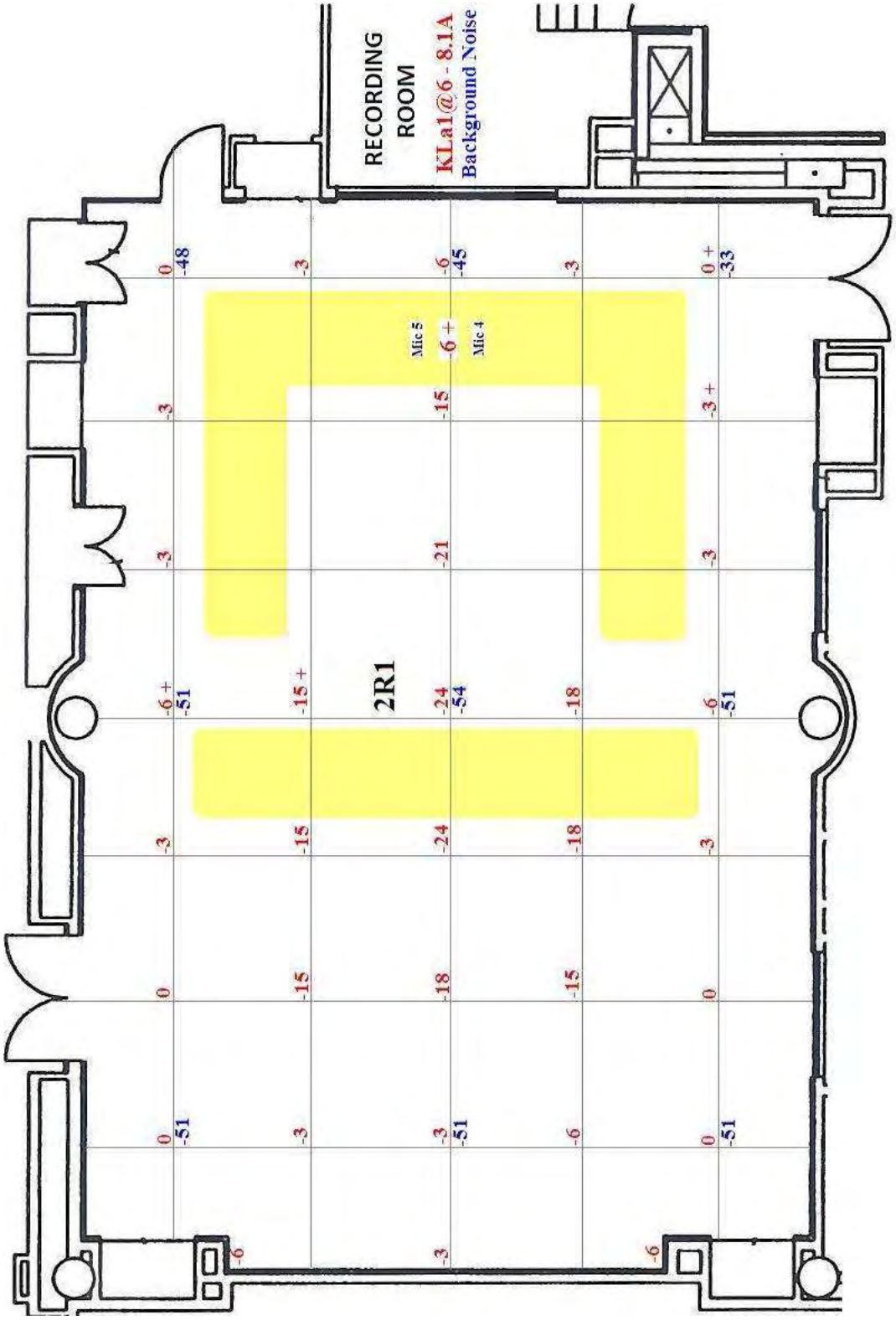
A5 Committee Room 1R3



A6 Committee Room 1R4



A7 Committee Room 2R1



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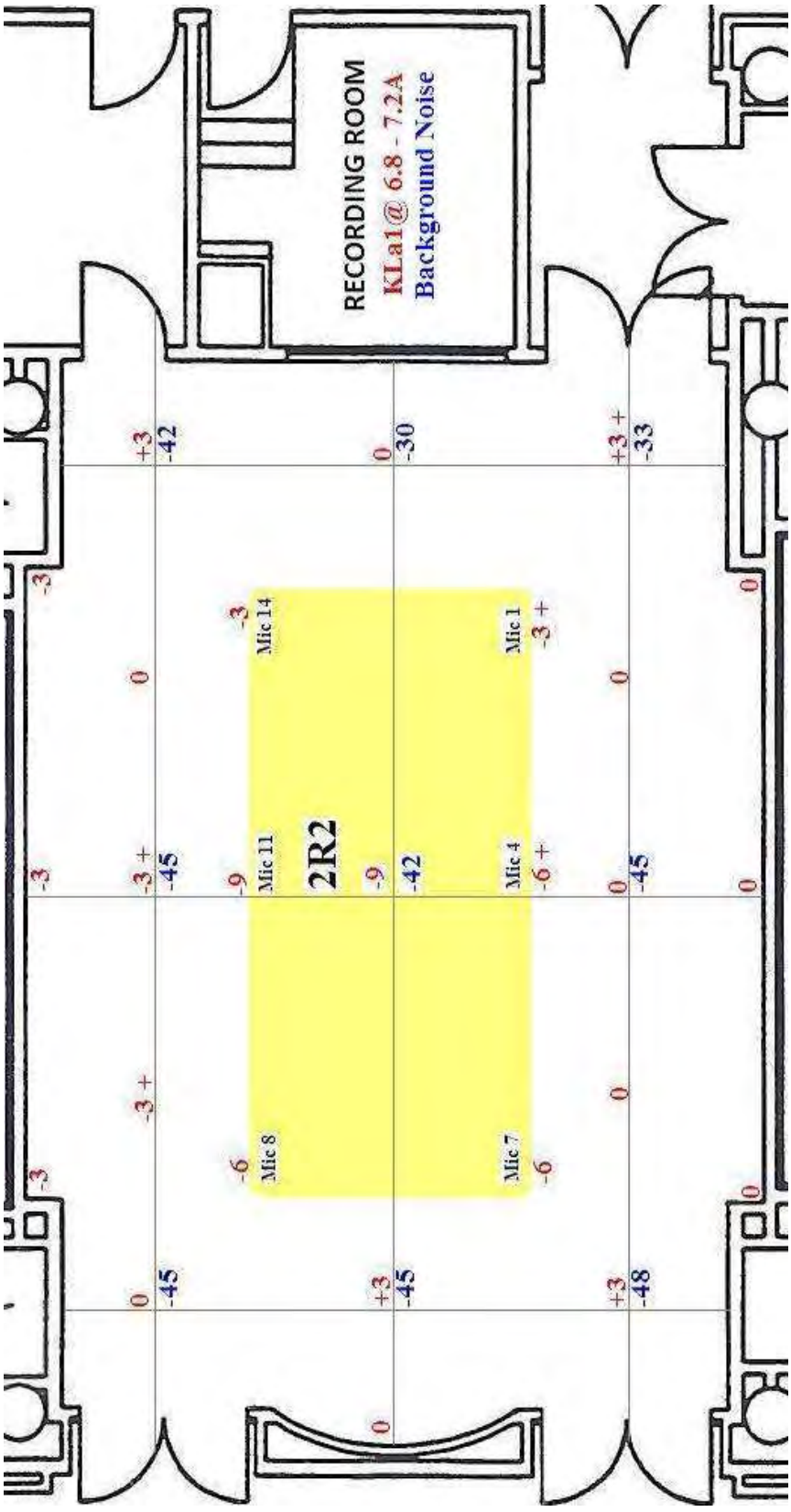
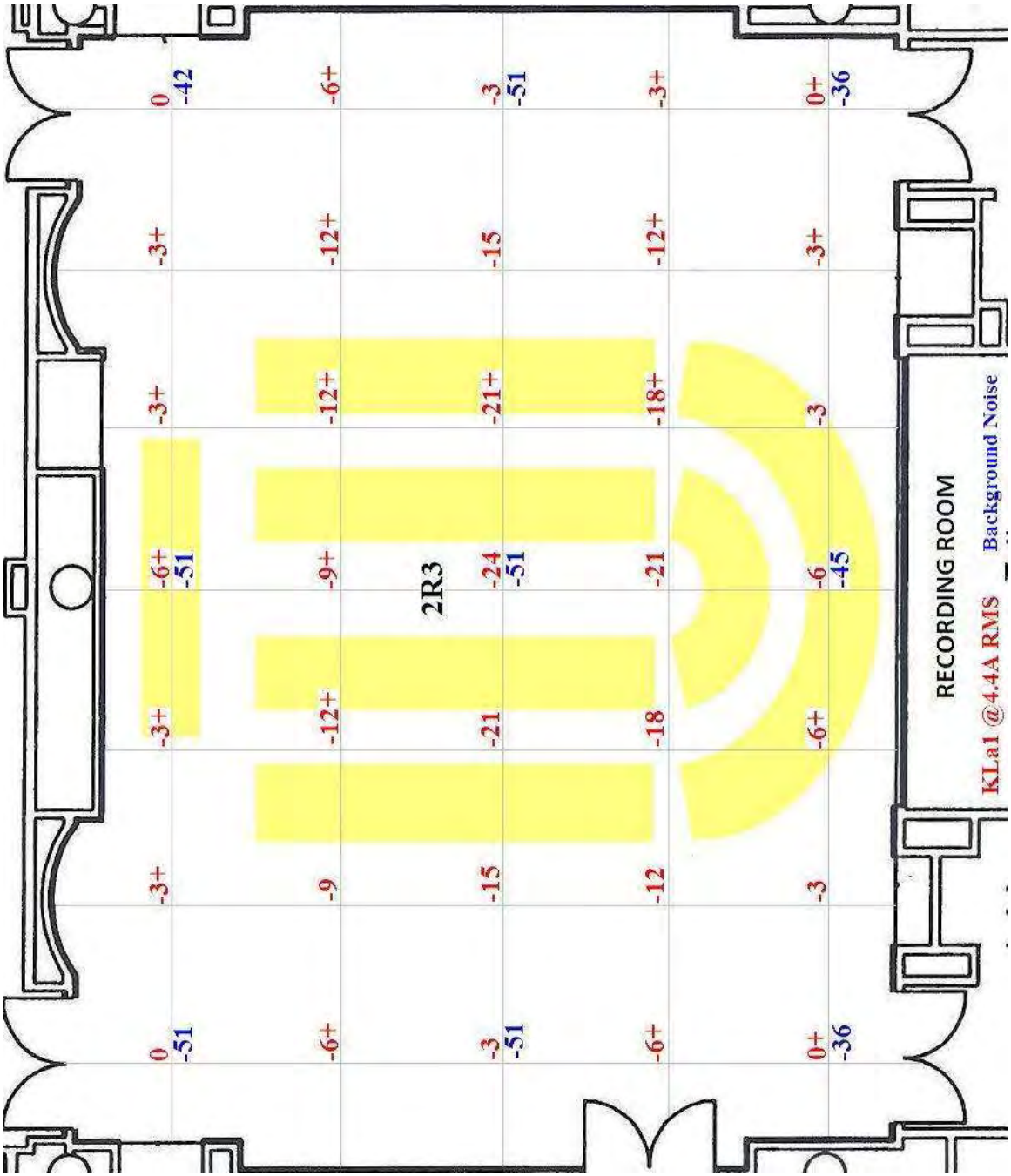
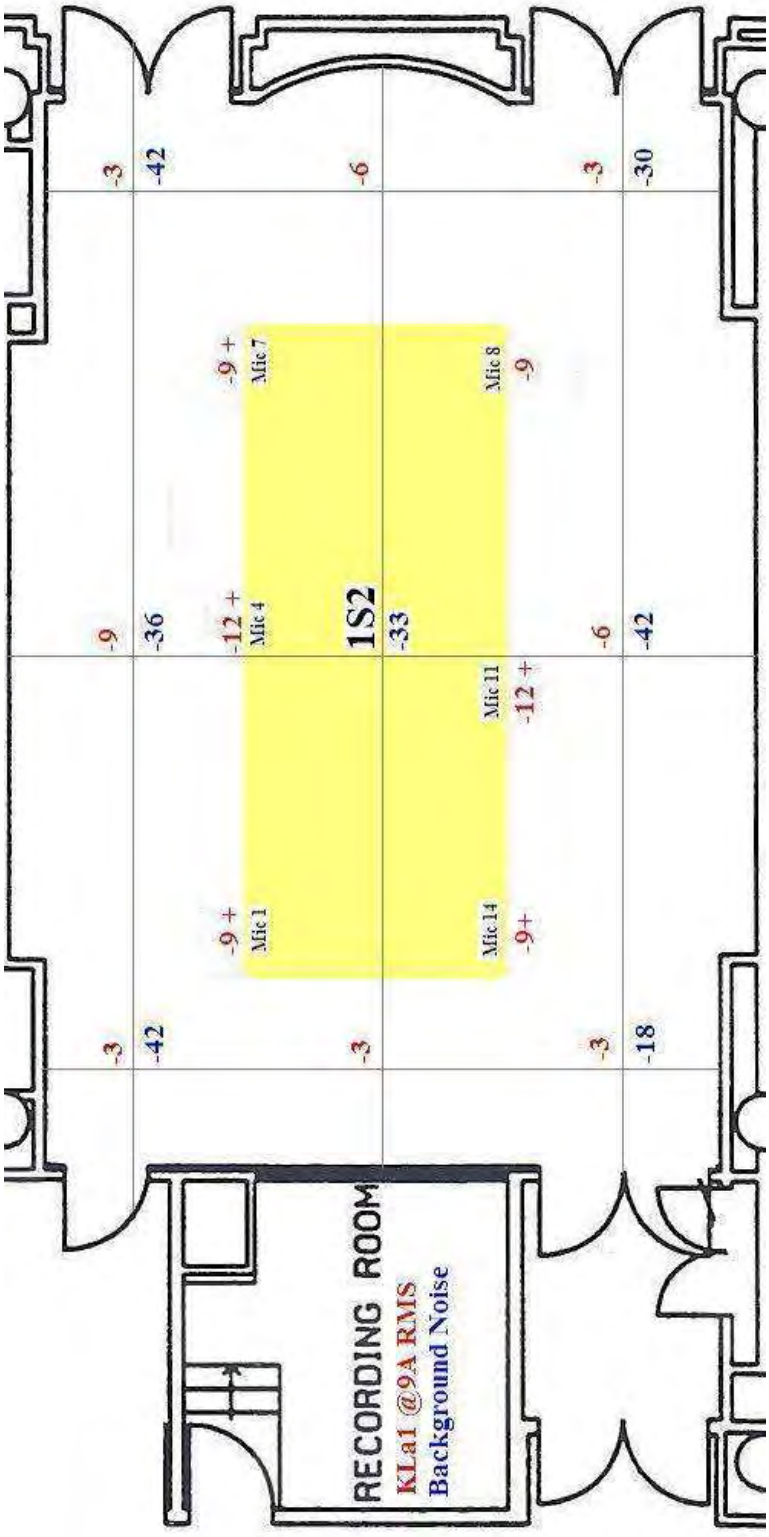


A9 Committee Room 2R3



A10 Committee Room 1S2



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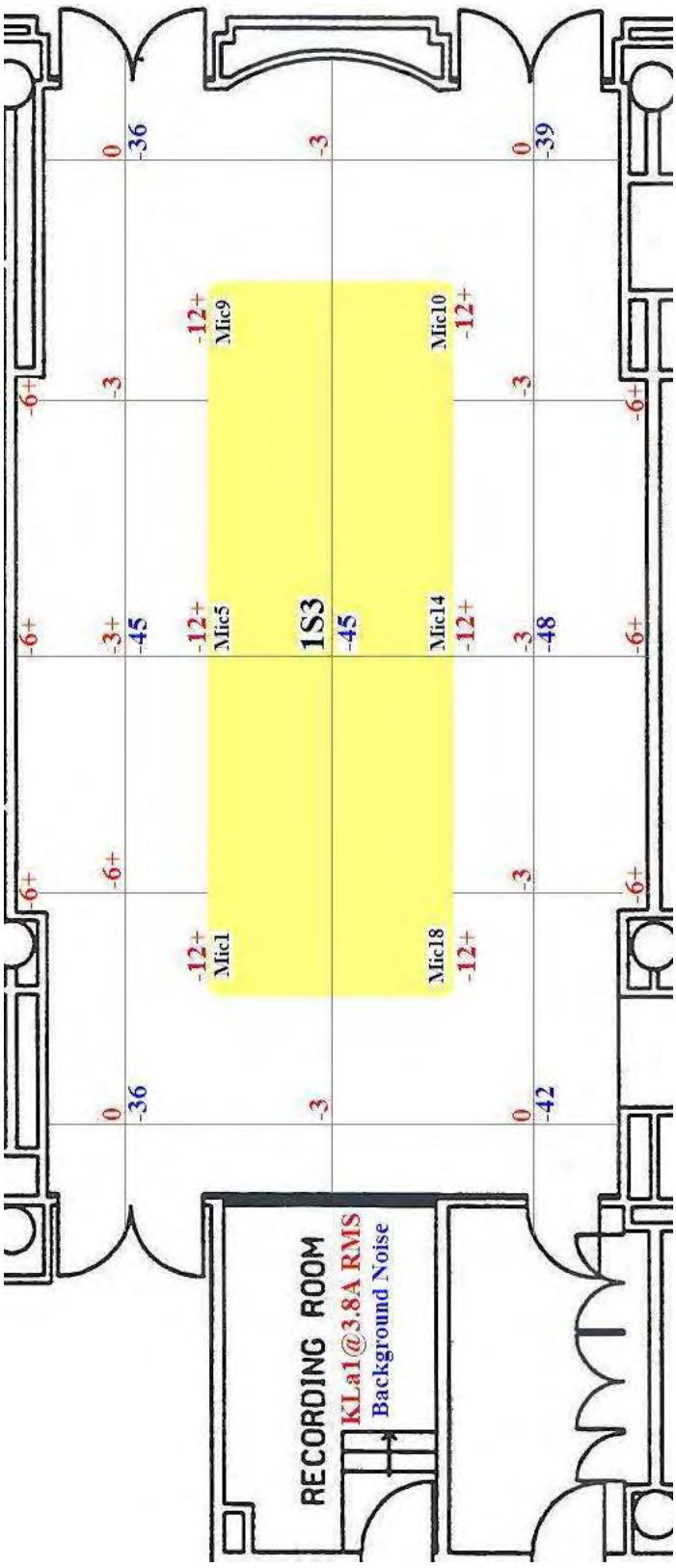
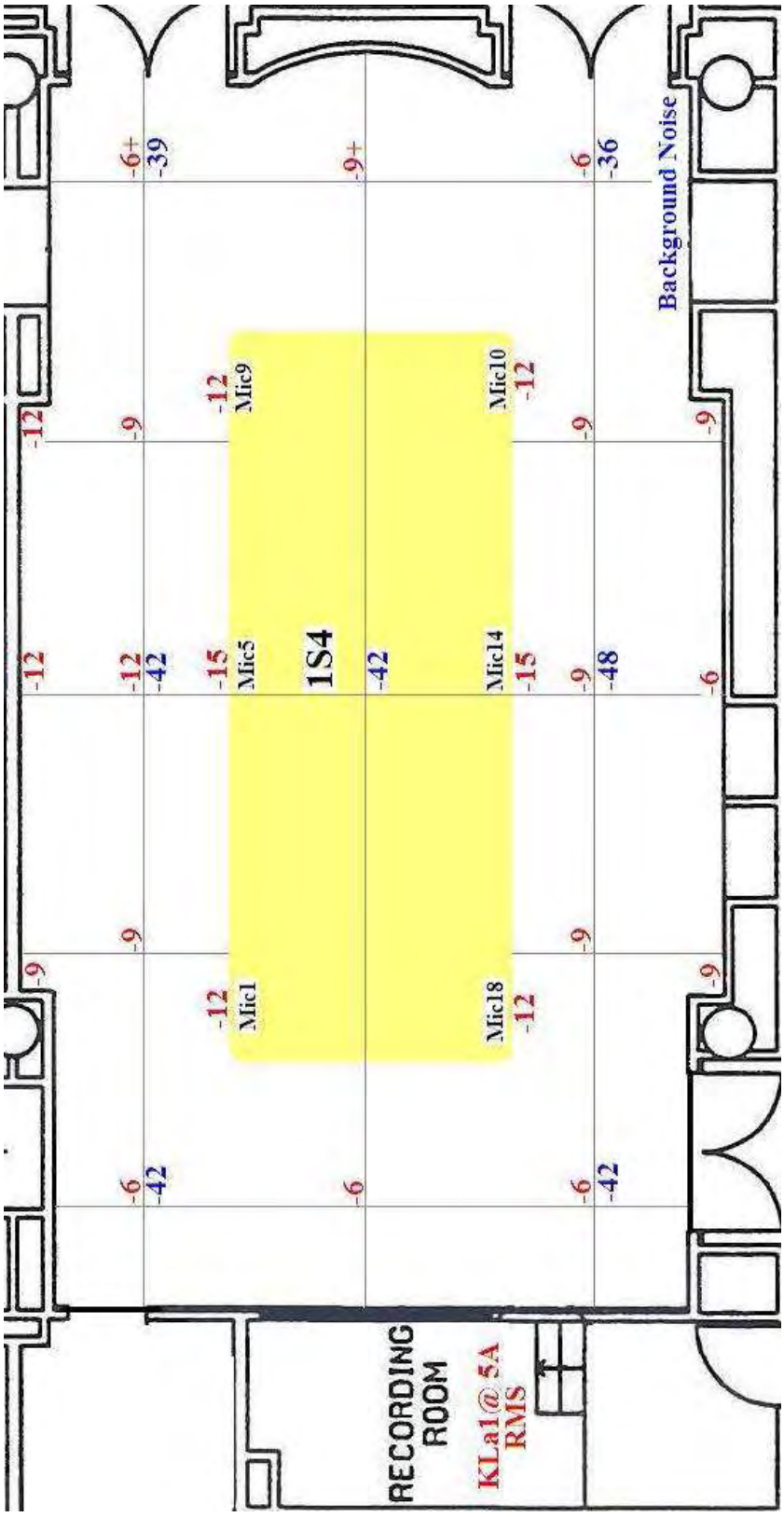
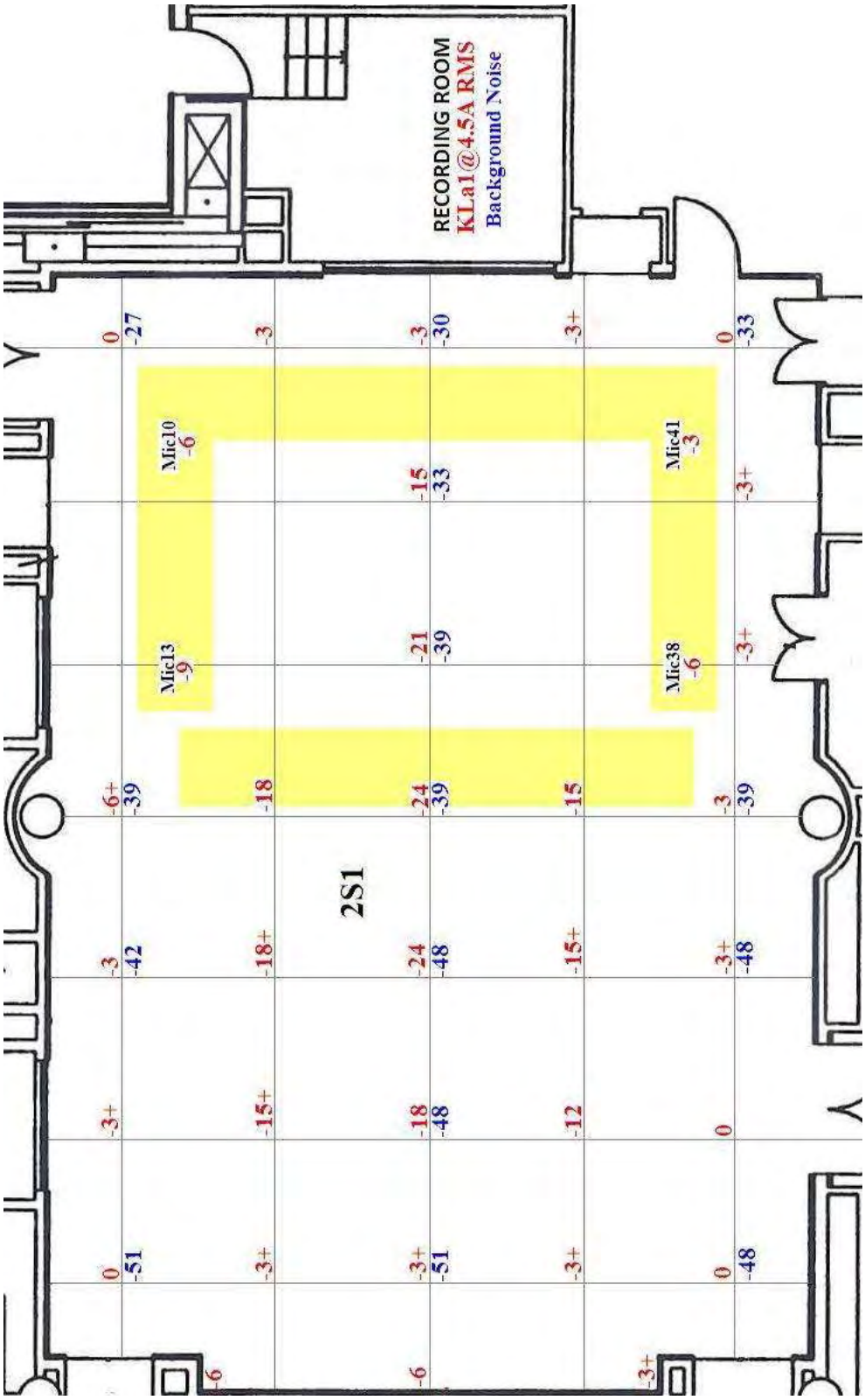


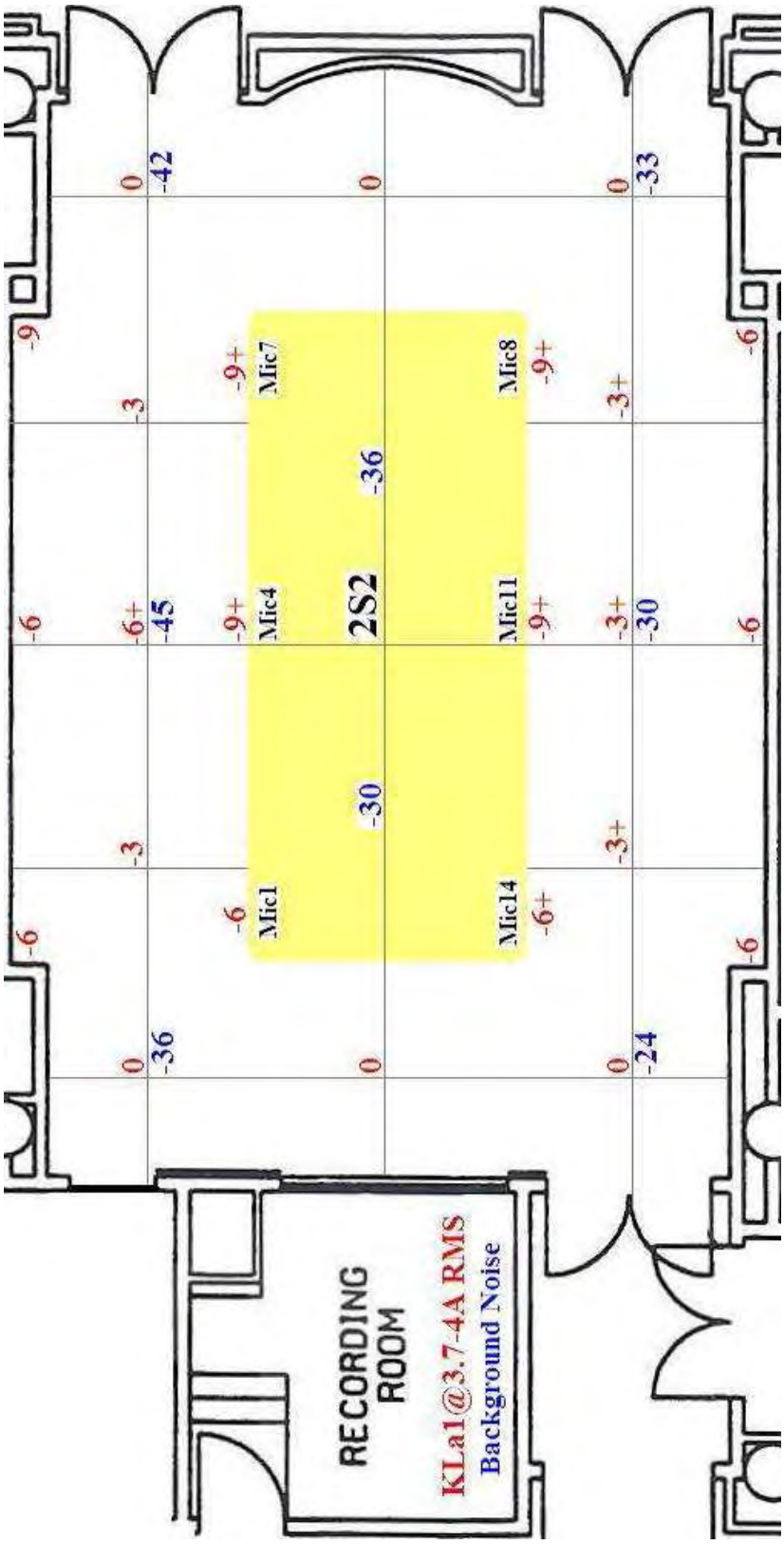
A12 Committee Room 1S4



A13 Committee Room 2S1



A14 Committee Room 2S2



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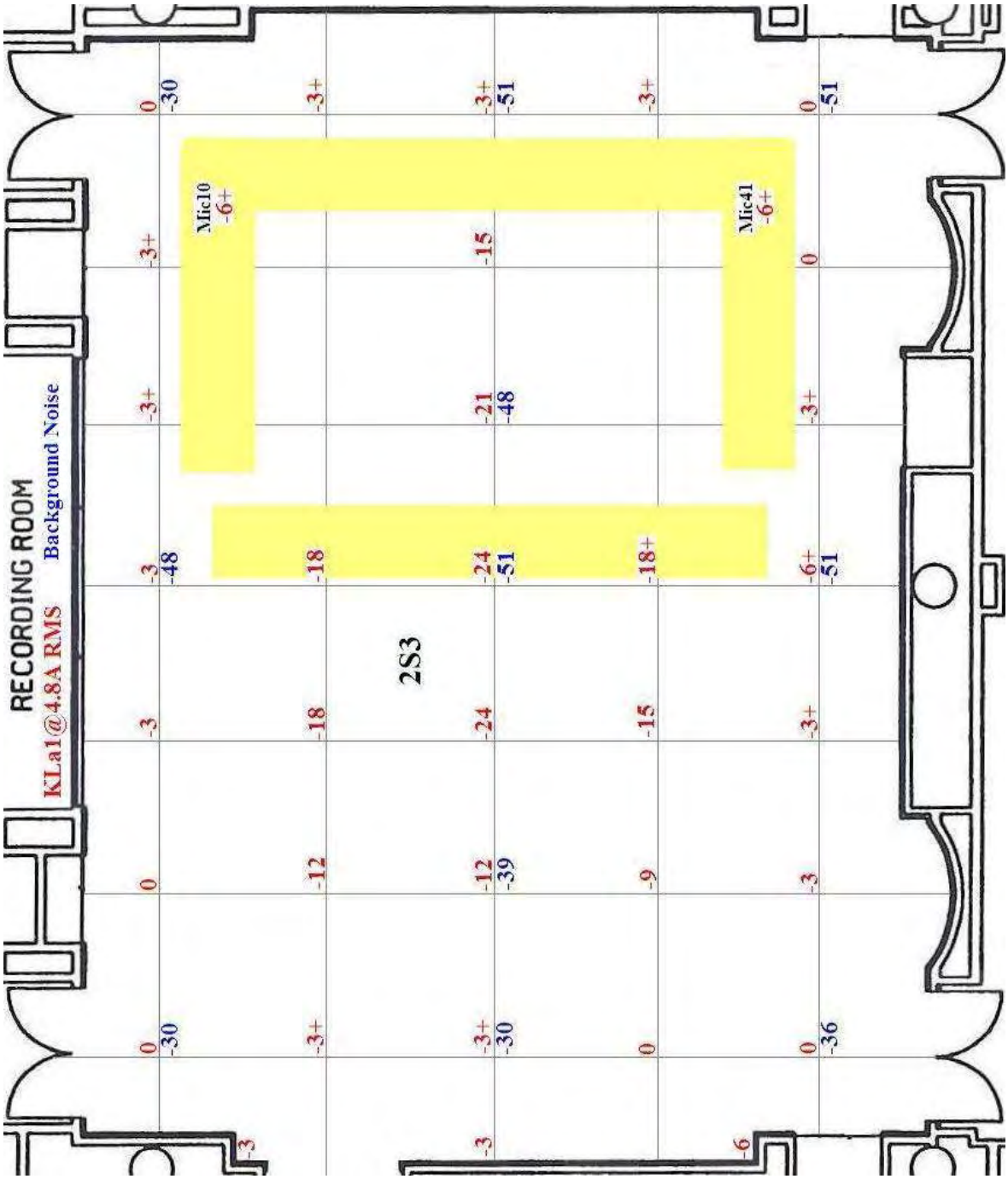
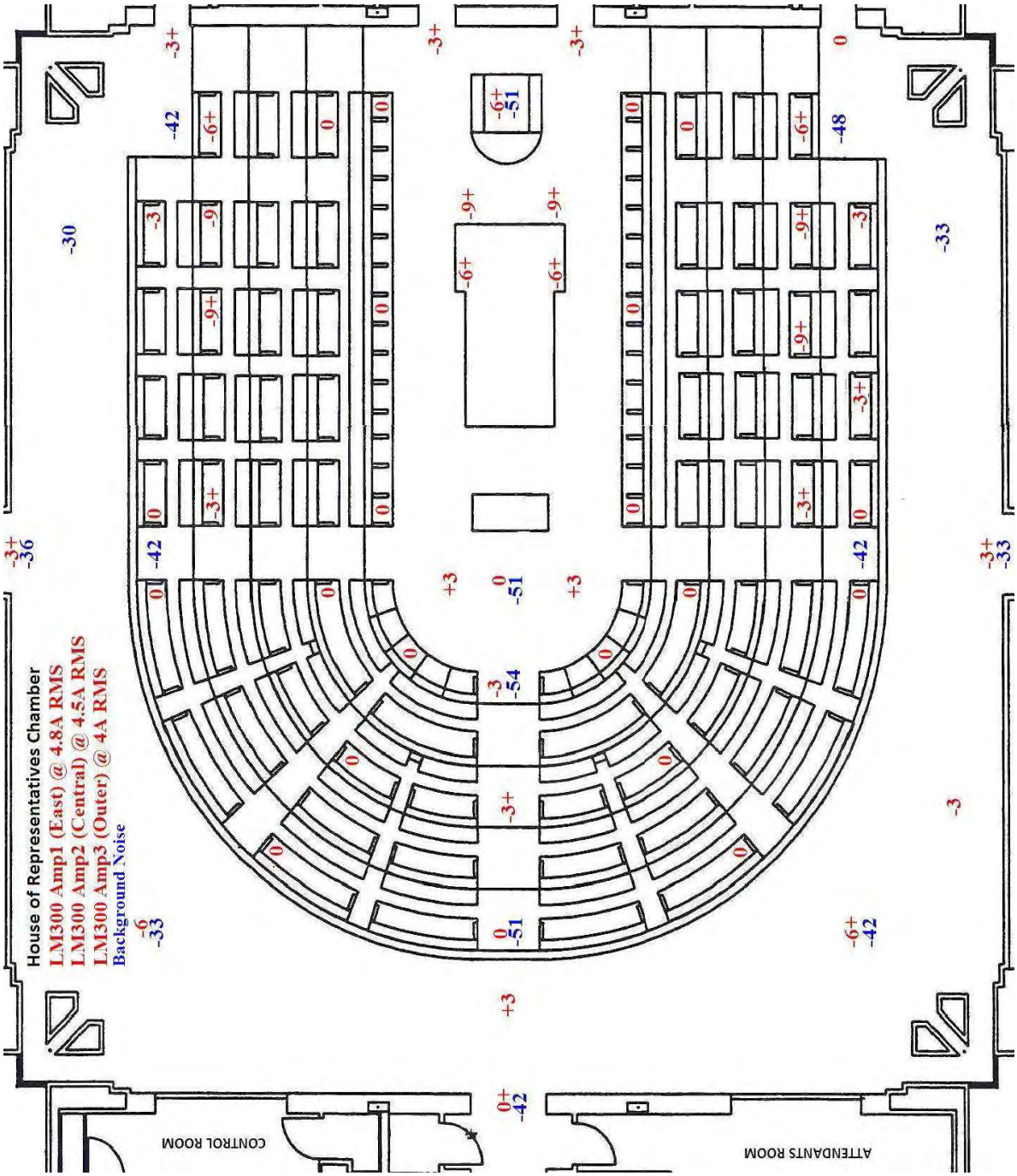
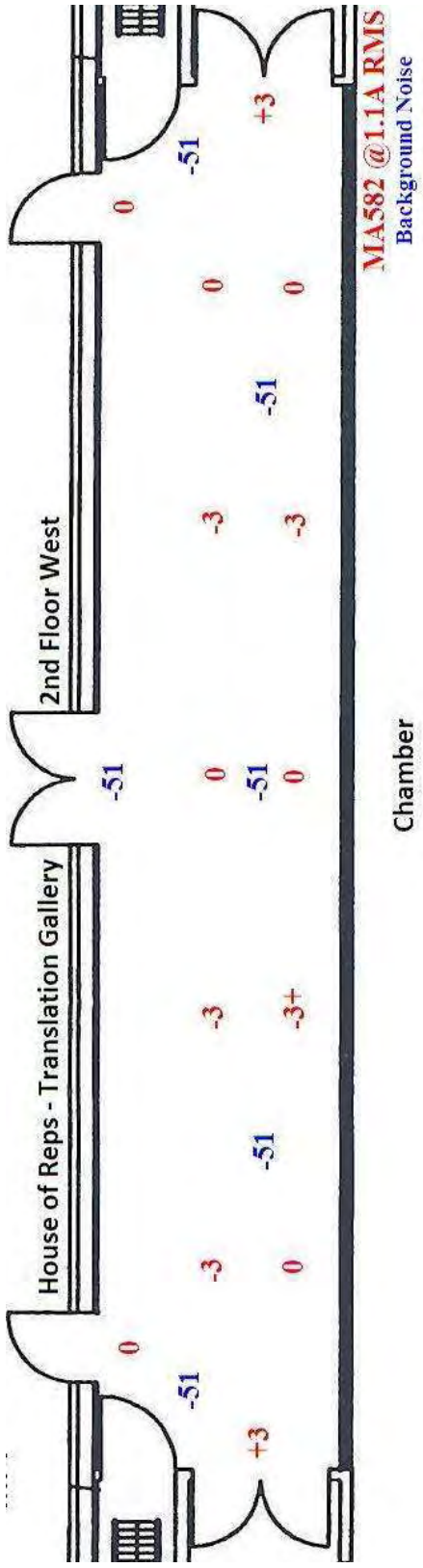


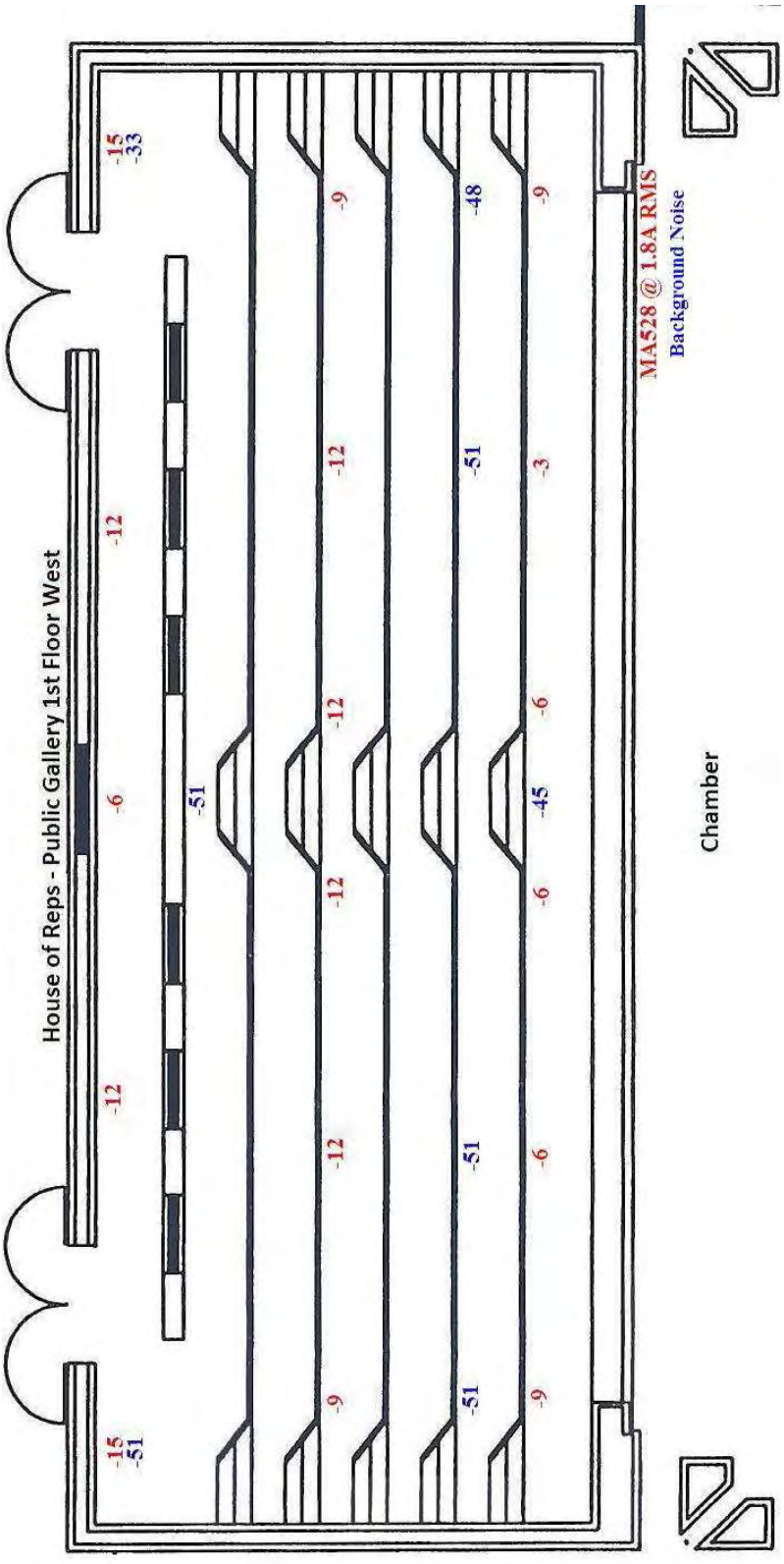
A16 HoR Floor (Chamber)



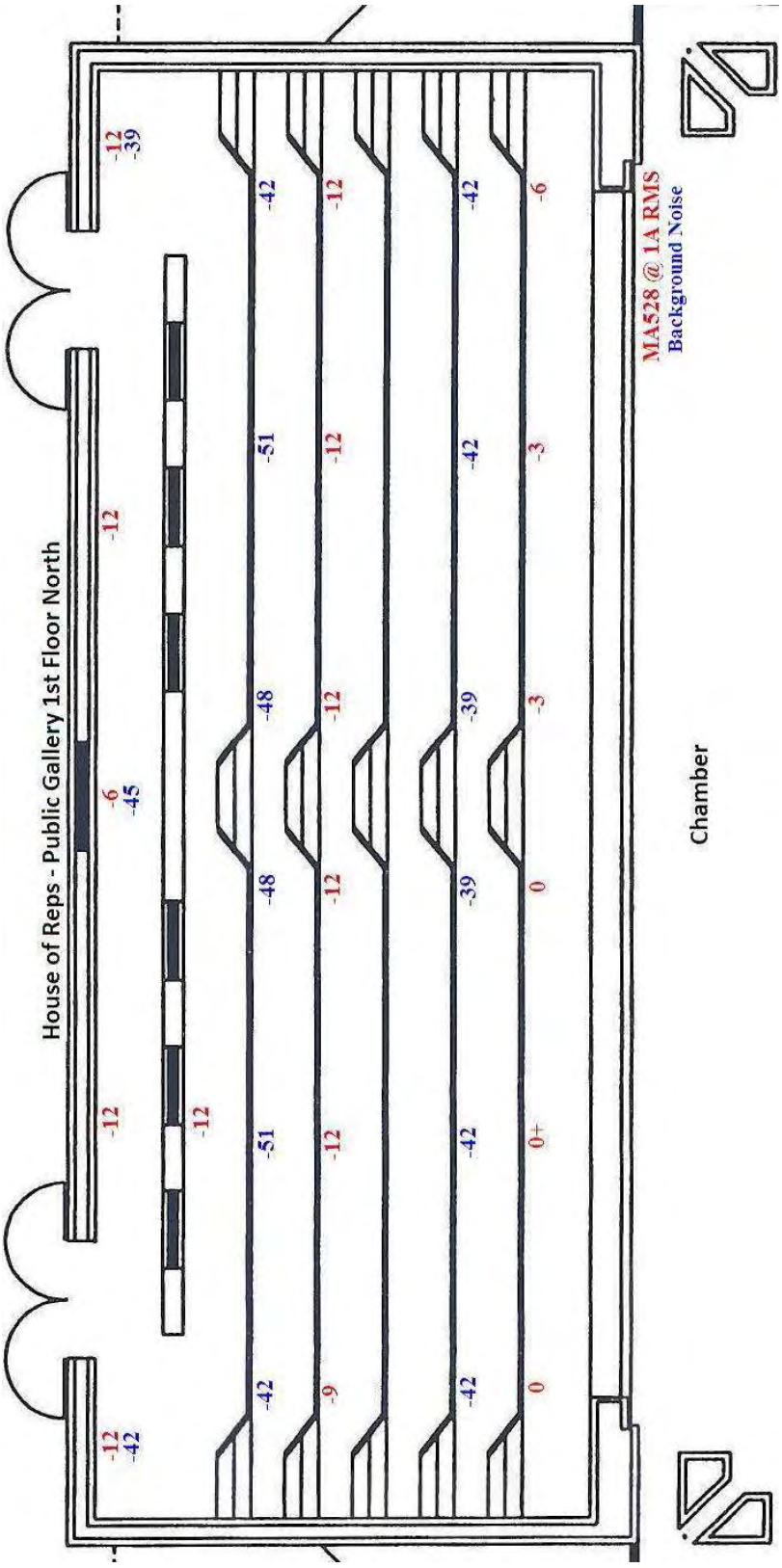
A17 HoR Gallery 2nd West



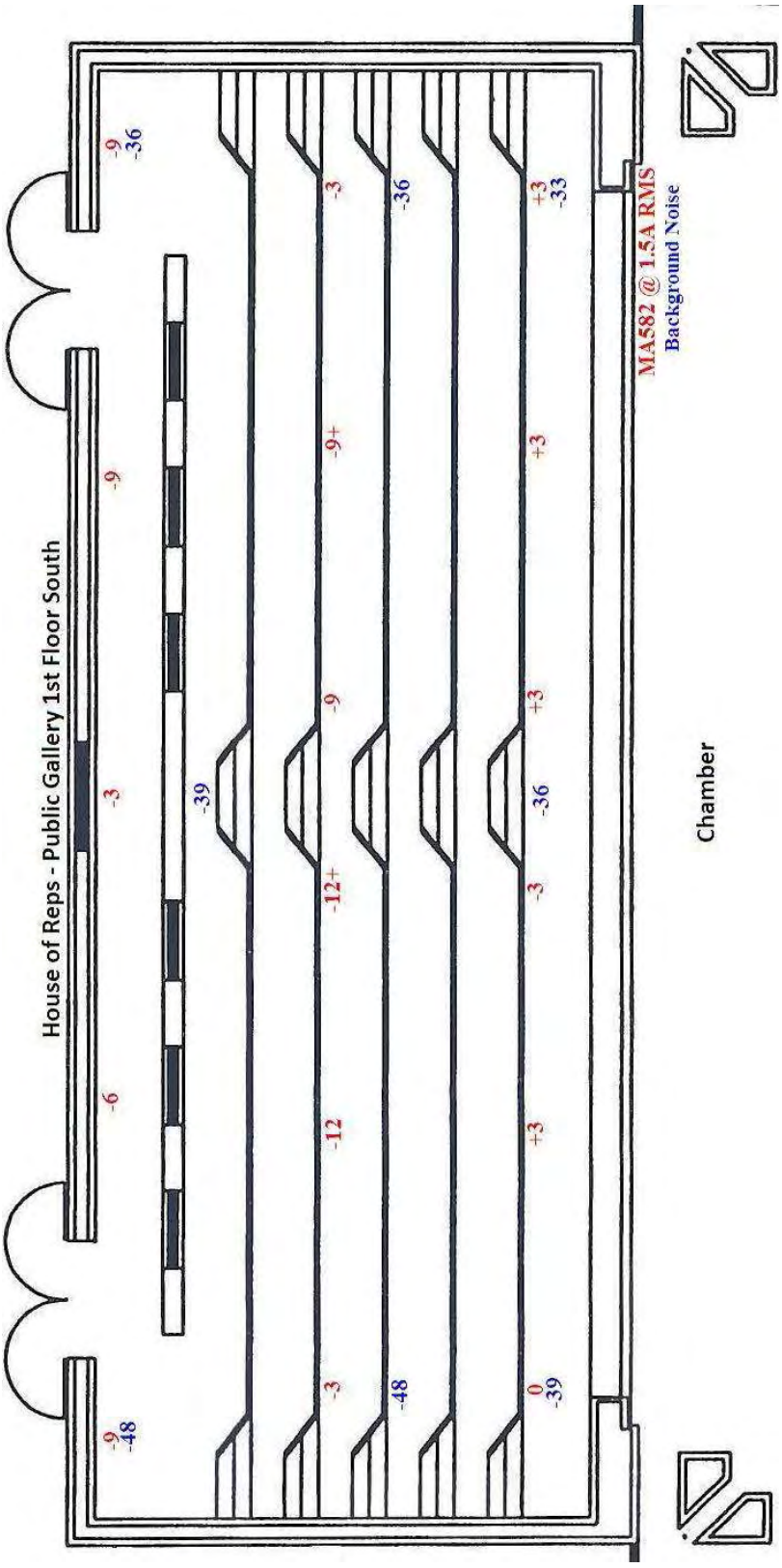
A18 HoR Gallery 1st West



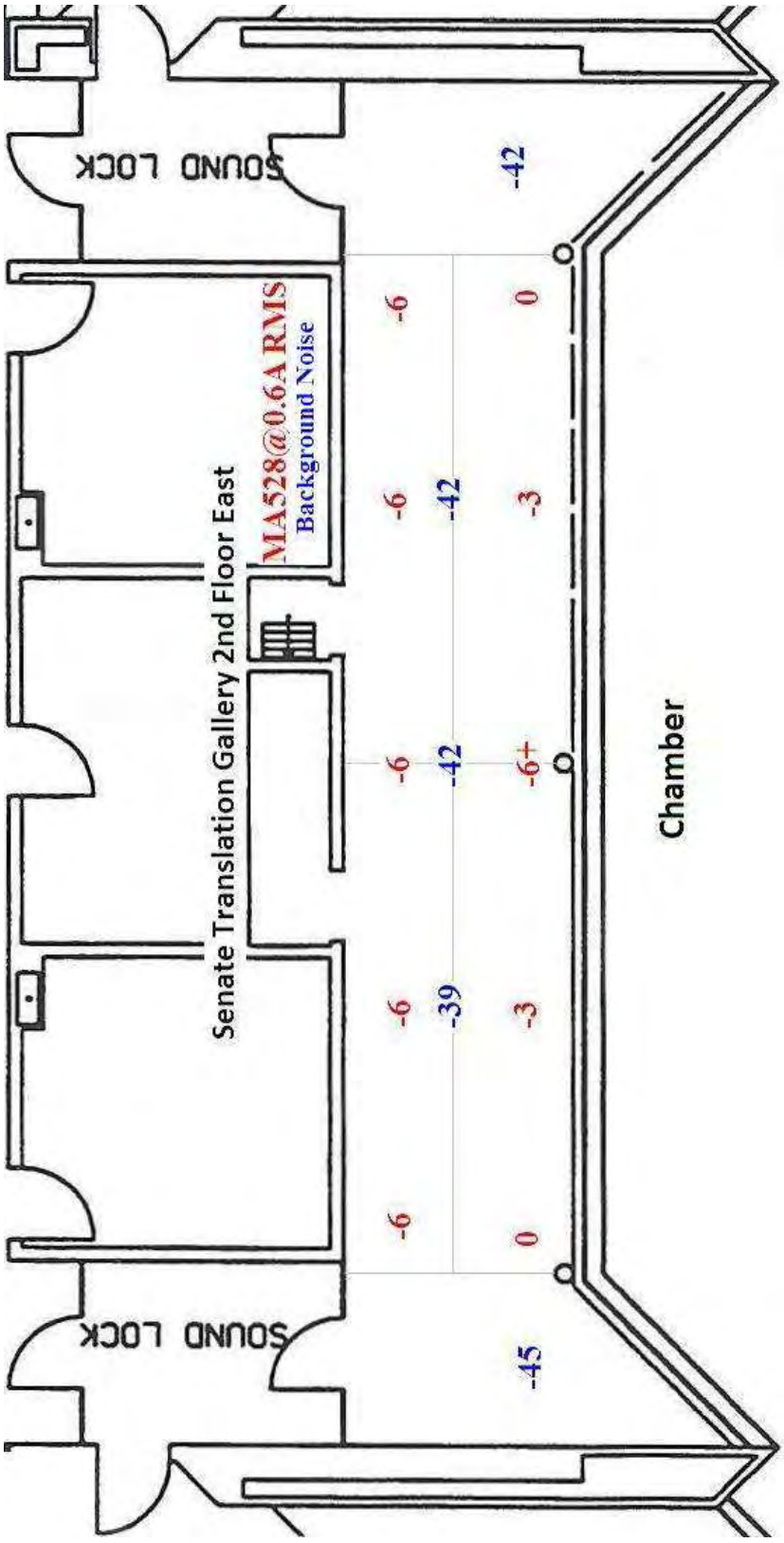
A19 HoR Gallery 1st North



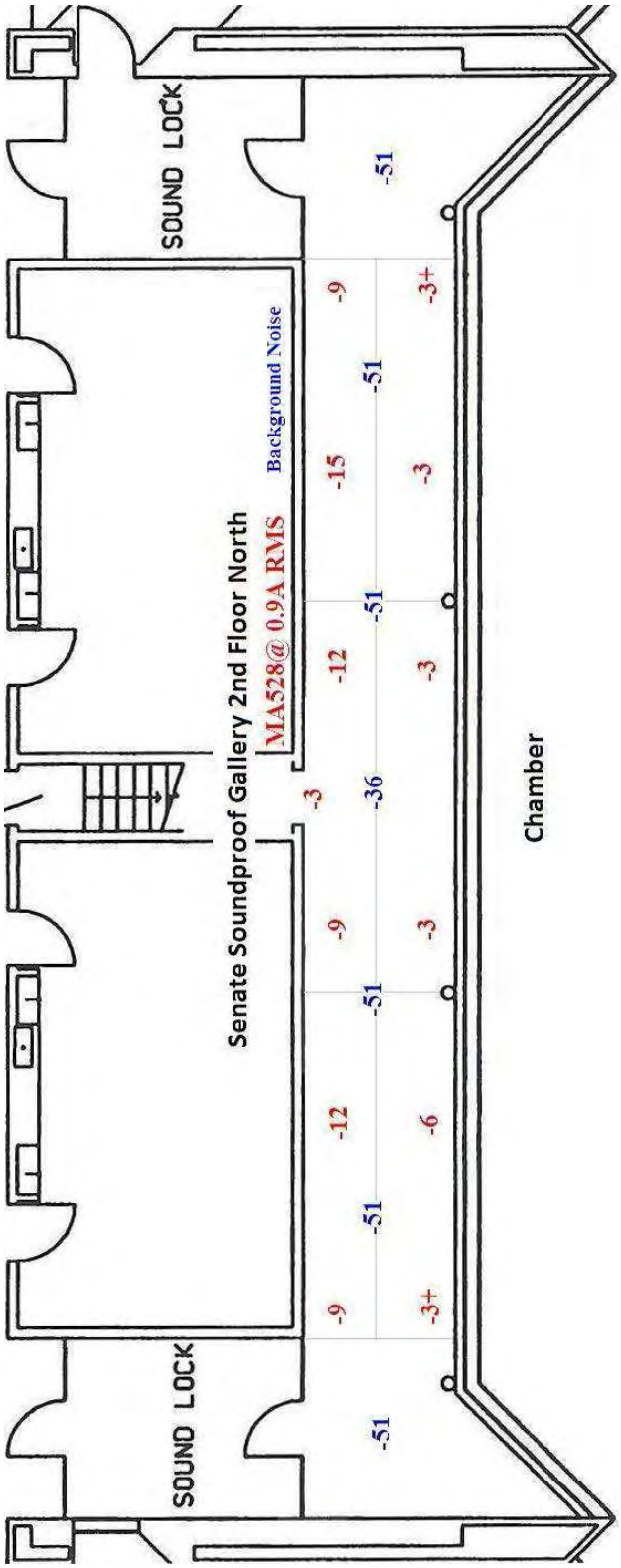
A20 HoR Gallery 1st South



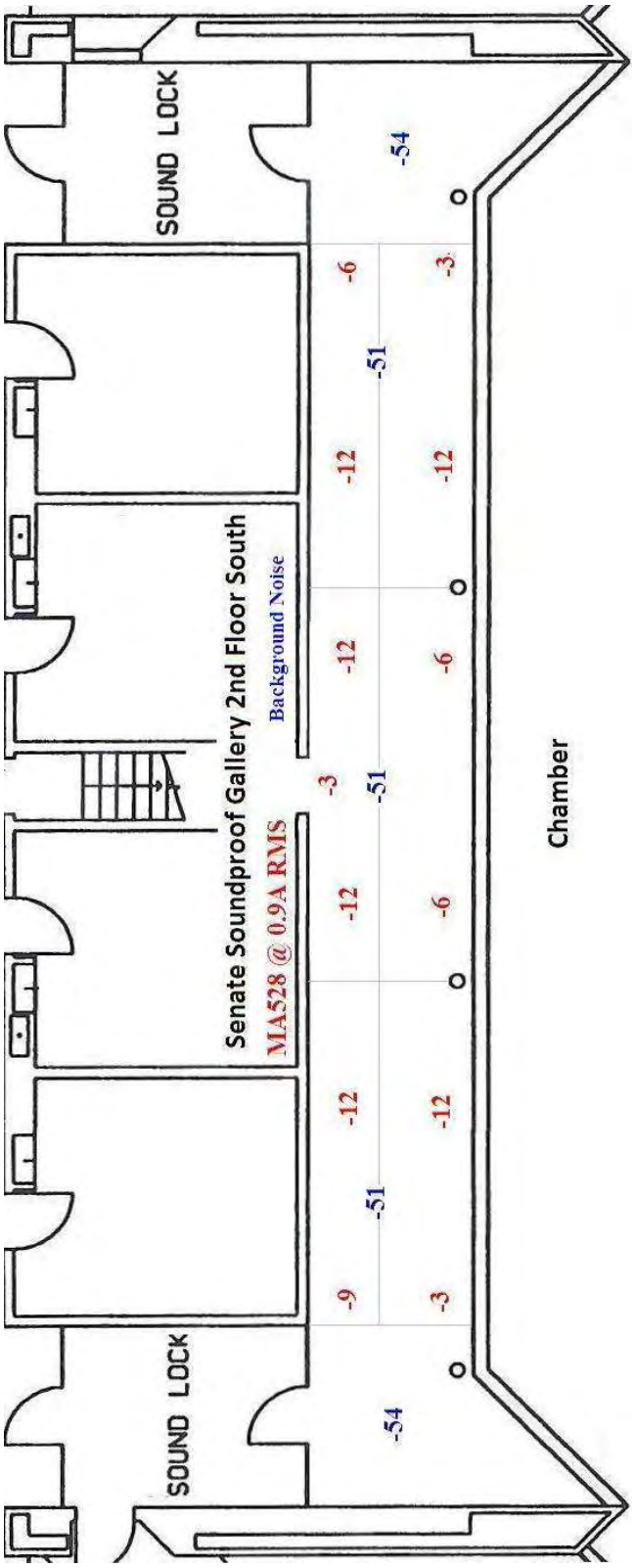
A21 Senate Gallery 2nd East



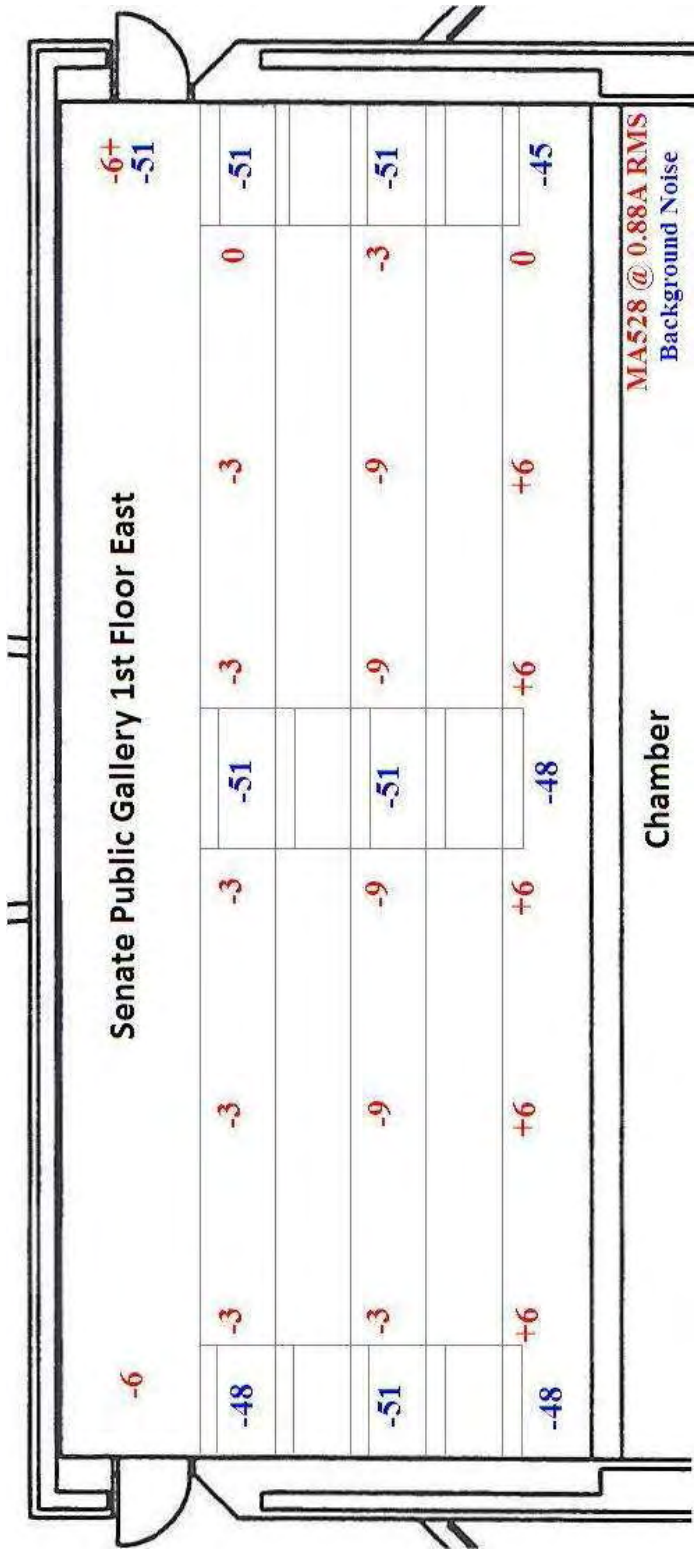
A22 Senate Gallery 2nd North



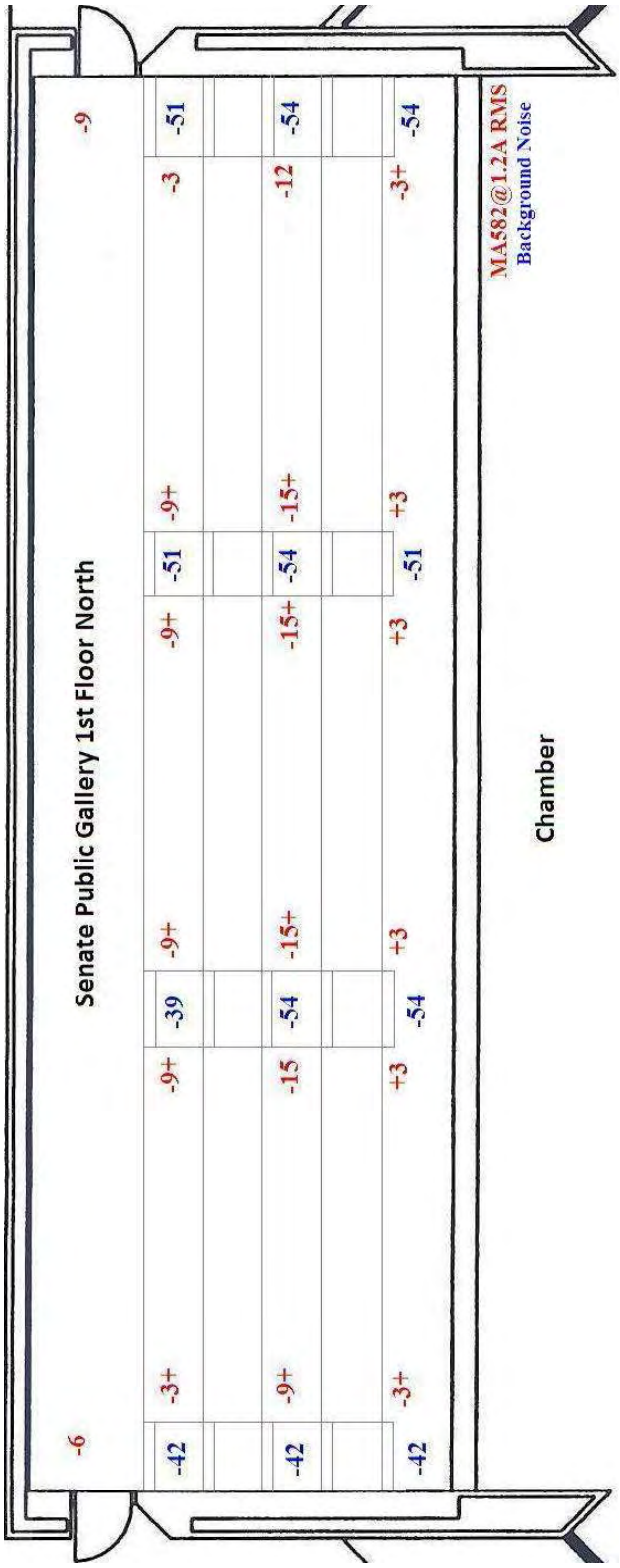
A23 Senate Gallery 2nd South



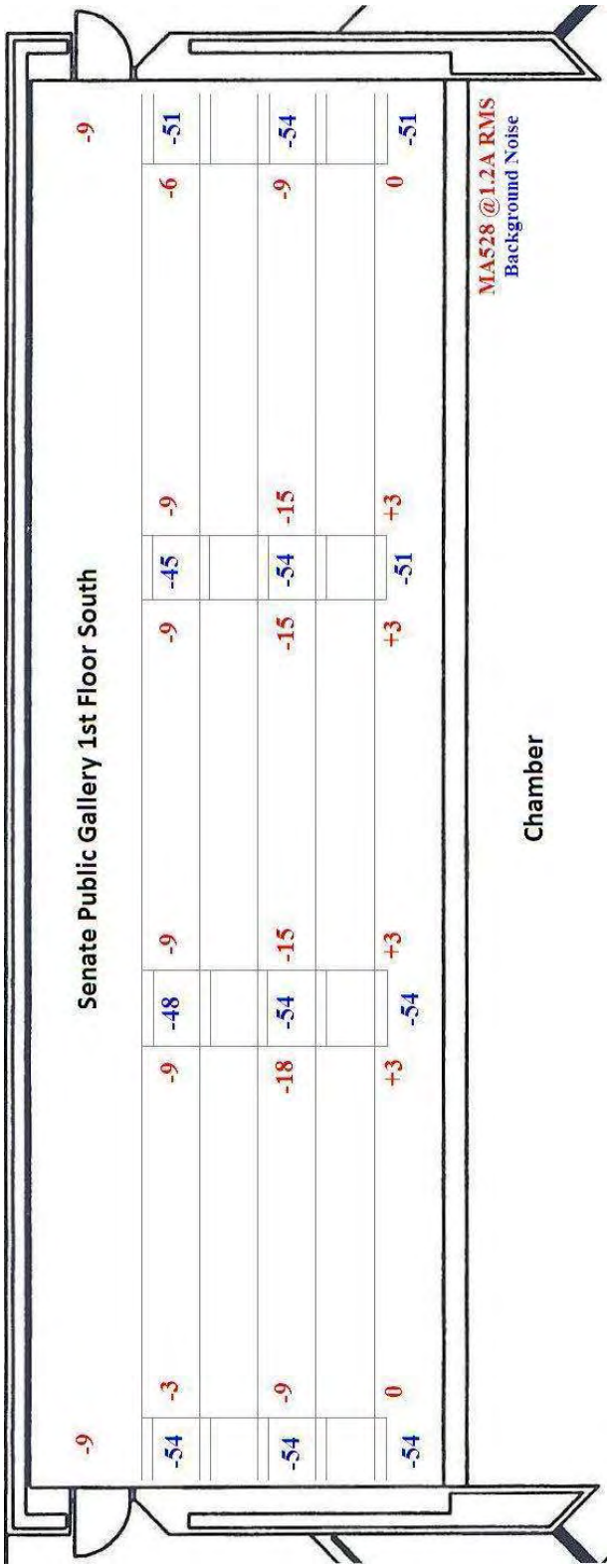
A24 Senate Gallery 1st East



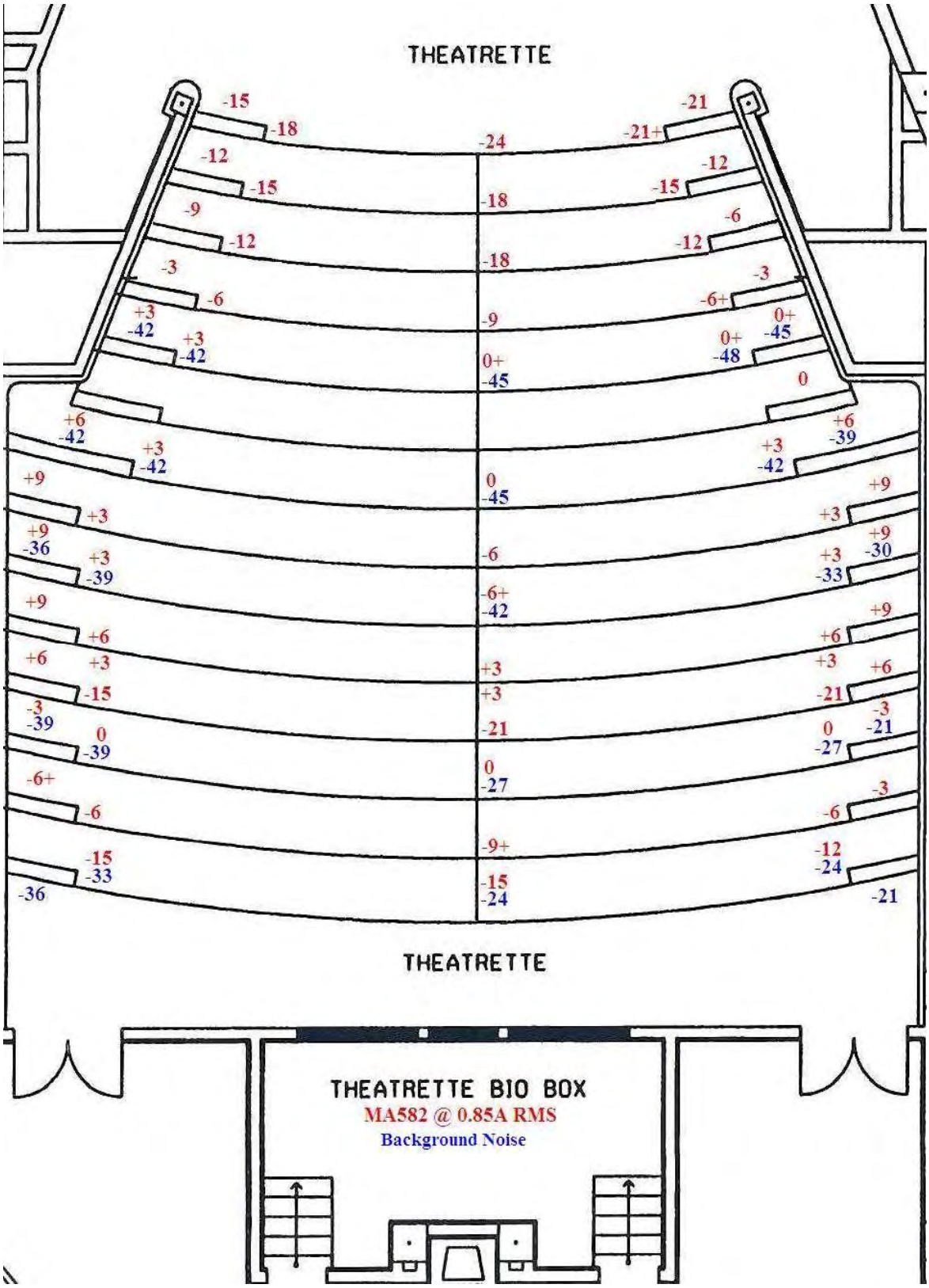
A25 Senate Gallery 1st North



A26 Senate Gallery 1st South



A27 Theatre


THEATRETTE
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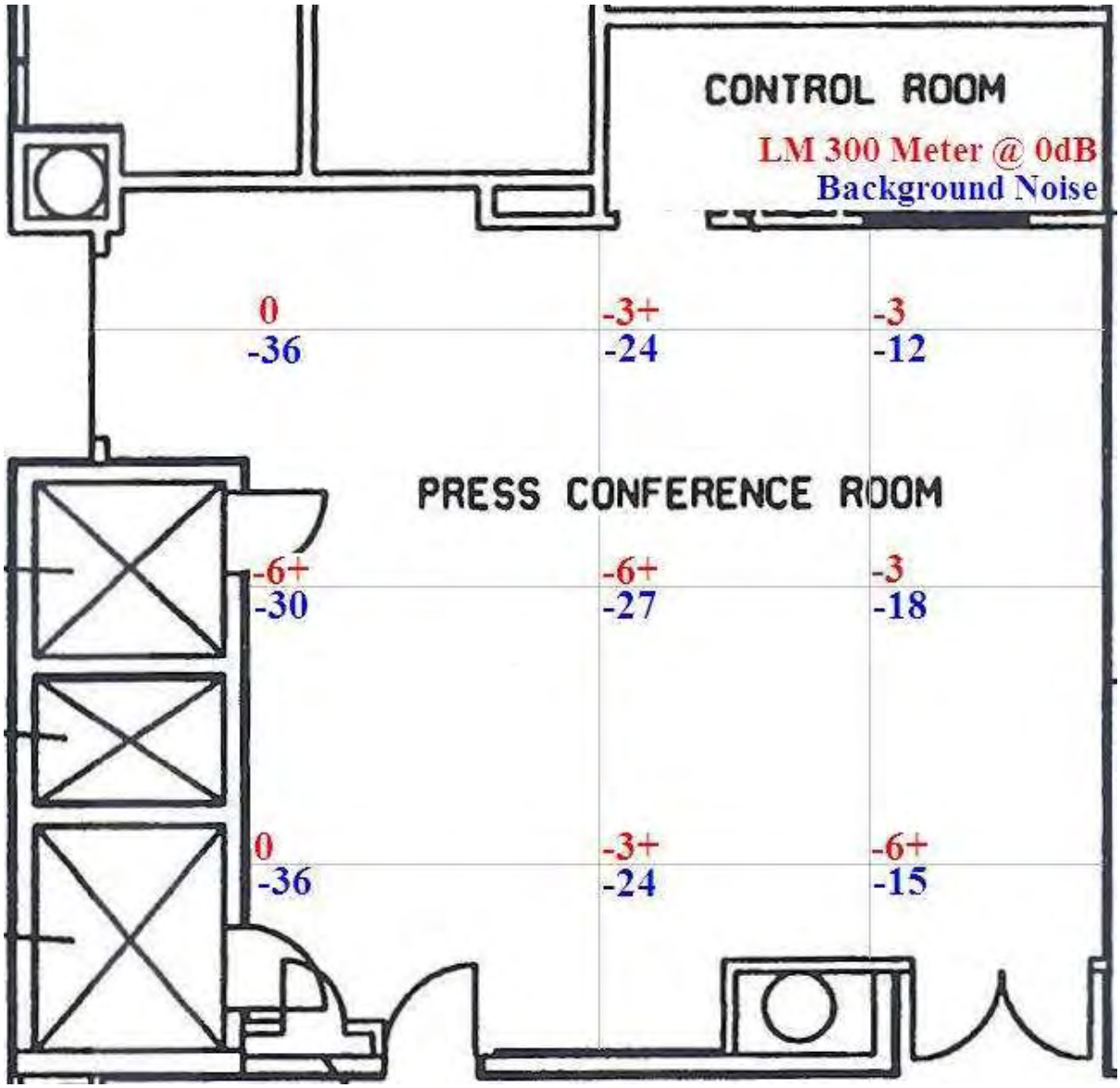
-3
-21
0
-27
-3
-6
-12
-24
-21
THEATRETTE
THEATRETTE BIO BOX
MA582 @ 0.85A RMS
Background Noise

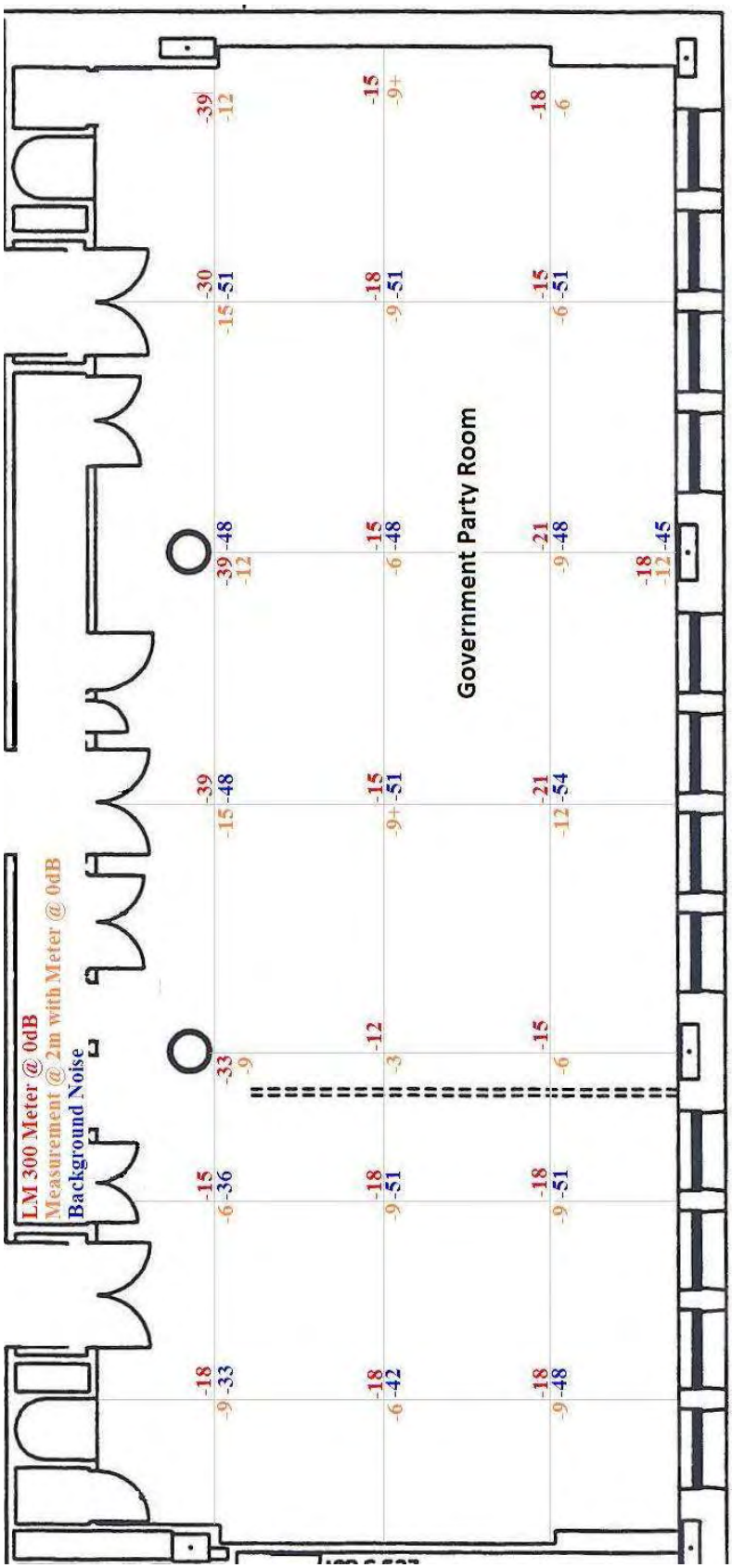
A28 EPCR (Blue Room)



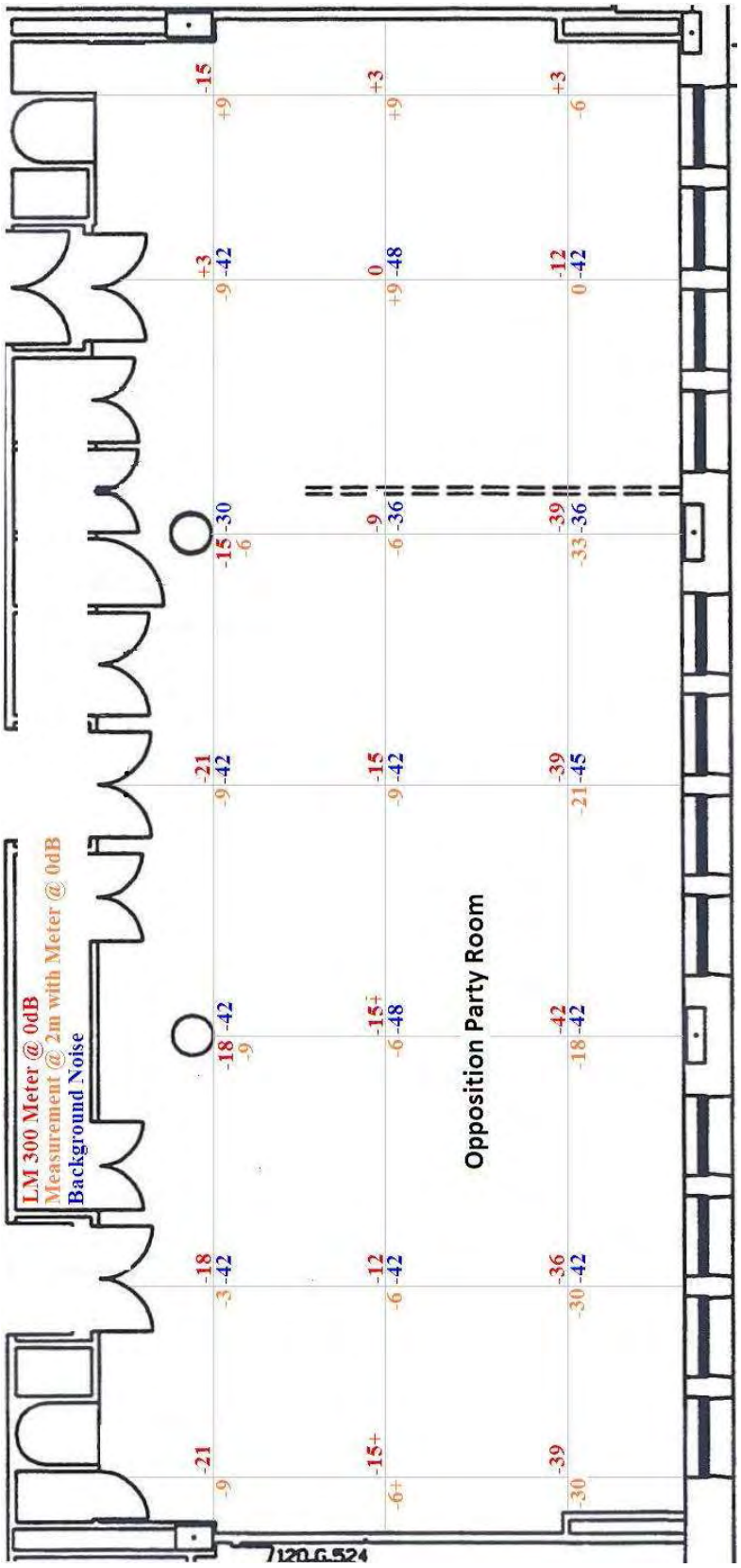
Note: This room has a number of Television Studio Lamps and associated mains wiring which produces above normal amounts of Hum.

There is a sharp rise in The North East corner (top right)

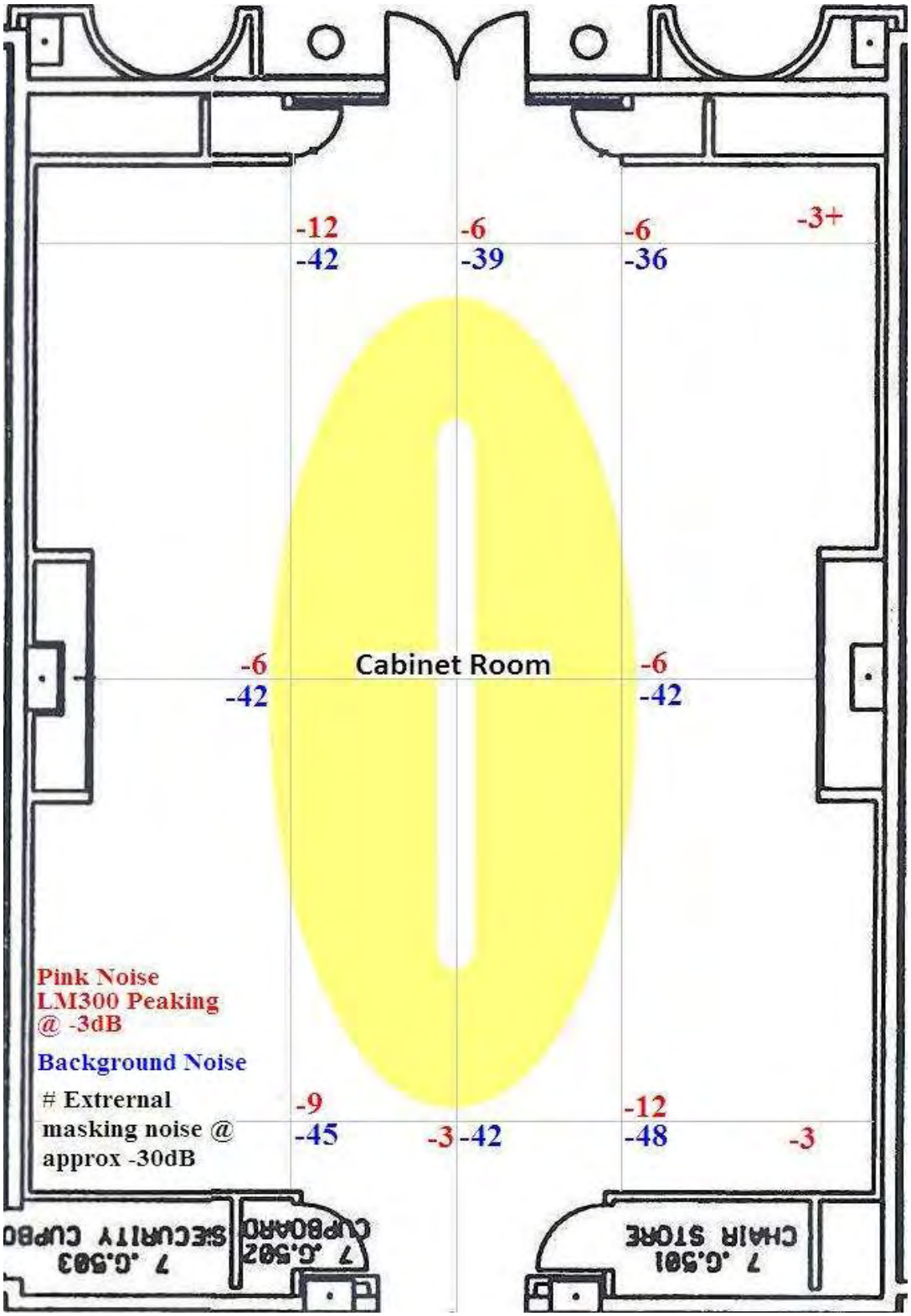
A29 Government Party Room



A30 Opposition Party Room



A31 Cabinet Room



Due to system integrity issues, this room was only partially tested with a low level pink noise source. During commissioning and certification by T4, this venue was compliant to a very stringent standard.

Appendix B Amplifier Descriptions

While each of the following amplifiers are capable of driving a loop successfully, there are some subtle differences, therefore require a tailored setup which result in some variations, especially when handling extended transients. For optimum results, it is best to feed AFILs amplifiers with a processed signal (eg: 2:1 compressor and a suitable limiter) especially when mixed brands of amplifiers are used in the one venue.

B1 Murray MA528: Transconductance Amplifier

Rating: 300VA, 9Amps RMS (Current Indicated in 100V Transformer Circuit)

No compressor possible overload on higher levels

Extremely destructive to Program at overload levels

Older Technology, suffers from excessive heat (convection cooled) but robust.

Direct or Line Transformer coupling available, Loop current monitoring in Transformer coupling mode cannot be easily monitored. One would expect losses when utilising transformer coupling method.

B2 Australian Monitor : KLa1

Rating: ?VA, 6Amps Peak (Nominal)

Dual stage level/drive control

Utilises compressor/limiter in processing circuit and inherently safe output stage

Very robust, fan cooled but generates excessive heat at high levels

Beware of setting up into compression mode during alignment

B3 LM Audio: LM300R (now GPT 300-II)

Rating: 300VA, 9Amps Peak

New generation amplifier incorporating inherently safe output stage, very effective Compressor/Limiter processing

Convection cooled, designed for minimal heat dissipation, fairly robust.

Probably the easiest “textbook” setup for a loop amplifier

Appendix C The Standard Signal and Loop Performance

C1 Basic Setup

In a standard Installation, a nominal signal of +4dBu (1kHz tone) is injected into the amplifier and the output is adjusted for an indication of 0dB peak current on the Induction Loop tester (calibrated for 100mA/m) The preferred output across the Loop Area is 0dBpk +/-3dB.

In a practical room, it is common to find 0dBpk as a maximum and a range down to -9dBpk in some parts of the room (-12dBpk may still useable depending on the signal to noise ration and performance of the hearing aid in question).

The Background Noise measurements are actually measured in C-weighted response due the Filter topology in the Induction Loop Monitor. This is an actual measurement of potentially destructive signals in the background environment usually of an electromagnetic nature, often derived from 240V mains equipment or simply the presence of mains wiring.

C2 Parliament House Setup

In Parliament House we use 0dBu as the alignment level, but we have other complications. The programme may contain a large dynamic range with a consistent levels around +3dBu to +6dBu for extended periods. Calibration of the loop amplifier must leave sufficient headroom to avoid distortion and yet have sufficient level for a good signal to noise ratio during normal programme.

C3 Issues with Crest Factor

It is assumed that the Crest factor for speech is 4; therefore the 100mA/m standard field strength required for Loop calibration, often ends up as 400mA/m for short terms eg 125mS, in order to deliver signal integrity placing a huge demand on amplifier/loop design. (this then becomes the 12dB difference in 400mA/m standard)

Currently more work is being done to define the standards with greater accuracy and therefore ultimately better service delivery with the use of AFILs.

C4 Loop Types

Originally, Perimeter loops with “Voltage” amplifiers were used which gave an incorrectly equalised audio signal into Telecoil enhanced Hearing Aid receivers.

Today we are able to fit multiple loops with correctly engineered, purpose built amplifiers and achieve much better results. This includes “good fidelity” in the range 100Hz to 5kHz (acceptable range for speech inteligibility) This bandwidth is useful in removing air-conditioner noise and mains hum to some degree as well as any high frequencies which may mask speech definition.

C5 Metal Loss

In today's building much use is made of metal and composite materials for reinforcement of concrete, trays for wiring and extensive plumbing for water, sewerage and air-conditioning flow and control.

Unfortunately, the extensive use of metal products in building construction adds to the phenomena of signal loss (absorption) due to the presence of certain metals and results in a non-predictable signal pattern often at the expense of reception in certain areas of a loop or degradation of frequency spectrum. Metal loss compensation can be added to a loop system, and in some cases achieving very good results.

C6 Standards under further Revision

Under the current standard, public meeting places in excess of 120 square metres, required a minimum of 20% of fitted out with a compliant AFILs system.

This is being revisited and authorities are looking at up to 100% coverage in all venues and potentially going to 400mA/m.

Appendix D Extract of Australian Standards

STANDARDS ASSOCIATION OF AUSTRALIA

Australian Standard

for

HEARING AIDS

PART 4—MAGNETIC FIELD STRENGTH IN AUDIO-FREQUENCY INDUCTION LOOPS FOR HEARING AID PURPOSES

INTRODUCTION

Induction loop systems generate an alternating magnetic field which may be detected, over a definable area, by receivers equipped with induction pick-up coils. Induction loop systems are used for various applications, e.g. in public address, paging and simultaneous interpretation systems, and as an aid for the hearing-impaired. Audio-frequency induction loop systems, in particular, are often employed in schools for hearing-impaired children, as attachments to domestic radio and television receivers and in churches, theatres and cinemas, for the benefit of hearing-impaired people.

The pick-up device for an audio-frequency induction loop system will usually be a personal hearing aid, of a type fitted with a pick-up coil; however, special induction loop receivers may be used in certain applications. Transmission of an audio-frequency signal via an induction loop system can often establish an acceptable signal-to-noise ratio in conditions where a purely acoustical transmission would be degraded by reverberation and background noise.

The use of personal hearing aids as loop system receivers enables the wearers of these aids to take advantage of induction loop signal transmission wherever such loops are provided. For this advantage to be most effective it is necessary for a standard value of magnetic field strength to be adopted, thus allowing a corresponding adjustment of the sensitivity of the pick-up coil in the hearing aid. The magnetic field strength must be chosen so that:

a) it is high enough to produce an acceptable signal-to-noise ratio over ambient electro-magnetic noise from power installations, etc.;

b) it is not so high as to cause overloading of the hearing aid.

The value of magnetic field strength recommended in this standard has been chosen so that these requirements are met. The lower limit of magnetic field strength is governed by the expected level of ambient electro-magnetic noise, measurements of which have been made in a number of homes, churches, schools, theatres, etc., in order to determine typical values. Measurements have also been made on hearing aids currently in use, to determine an acceptable range of input levels and on which the higher limit is based.

An induction loop system will typically incorporate a driving amplifier which is not specified in this standard. However, a recommendation of the frequency dependence of the magnetic field strength is included.

The recommended value for magnetic field strength may also be applicable to transmitting coils intended for very short range (i.e. close contact) inductive coupling of other devices, such as radio and television receivers, to hearing aids.

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In the case of large areas or magnetic disturbances from mains or lighting regulation systems, it may be necessary to deviate from this standard or refrain from using an induction loop system.

1. Scope

This standard applies to audio-frequency induction loop systems producing an alternating magnetic field and intended to provide an input signal for hearing aids operating with an induction pick-up coil.

2. Object

The object of this standard is to specify a standard value of magnetic field strength in audio-frequency induction loops for hearing aid purposes, such as will give an adequate signal-to-noise ratio without overloading the hearing aid.

3. Explanation of terms

3.1 *Recommended average value for magnetic field strength*

The magnetic field strength obtainable within a specified area, corresponding to the long-time average of the speech signal applied to the system.

3.2 *Maximum magnetic field strength*

The magnetic field strength obtainable within a specified area, corresponding to the maximum short-time average of the speech signal (approximately 0.125 s, referring to the integration time used during the averaging process) applied to the system.

3.3 *Specified magnetic field area*

The area within which the hearing aid induction coil will be located under normal use of the hearing aid and within which the magnetic field strength is required to meet the recommended specifications.

Note. — The specified magnetic field area is not necessarily the geometrical area of the plane of the induction loop.

3.4 *Specified vector component of the magnetic field strength*

3.4.1 For many purposes, such as in spaces where the users of hearing aids are standing or sitting in upright positions, the vertical component of the magnetic field will be the significant one. In such cases the specified vector component relates to the vertical component. If other field components may be of importance, these should be reported and the direction stated.

3.4.2 For other cases, such as small transmitting coils used for close contact coupling, orientation of the coil for maximum sensitivity may be possible. Therefore the specified vector component relates to the field strength at the location and in the direction for maximum sensitivity of the user's induction pick-up coil.

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3.5 *Specified frequency response of the magnetic field*

The variation with frequency of the magnetic field strength in relation to that at 1 000 Hz for a constant input level to the system.

4. Recommended magnetic field strength

4.1 *Recommended average value for magnetic field strength in the specified magnetic field area*

The recommended value for magnetic field strength is:

$$(-20 \pm 3) \text{ dB re } 1 \text{ A/m}$$

created by a 1 000 Hz sinusoidal input signal, of level equal to the long-time average level of the speech signal applied to the input of the system.

Note. — The maximum value of magnetic field strength, for a system set up to this recommended field strength, will be approximately:

$$-8 \text{ dB re } 1 \text{ A/m}$$

This maximum is derived on the basis that the difference of the maximum short-time average level between a speech signal (approximately 0.125 s) and the long-time average level is approximately 12 dB.

4.2 *Recommended frequency response of the magnetic field*

For an electrical input signal to the system which has a constant value over a frequency range of 100 Hz to 5 000 Hz, the measured frequency response of the magnetic field over that range should not differ by more than ±3 dB from the value at 1 000 Hz.

Note. — At schools for hearing-impaired children, it may be desirable to introduce a low-frequency boost to compensate for the falling low-frequency response characteristic of induction loop transmission.

5. Interference

Interference may occur to telecommunication equipment or wiring which is very close to the induction loop, particularly where the loop covers a large area.

Special measures may be necessary to limit this interference to an acceptable level.