HOW DO POORLY DESIGNED

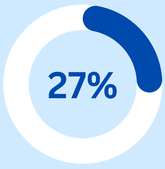
01 Introduction

Government Priority:

Enabling children with special educational needs to receive an education is a priority for the Government of Ireland.

10% Increase

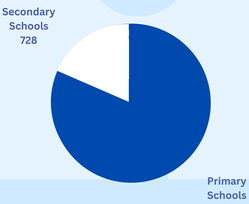
€2.6 Billion



The Department of Education have increased their spending on special education by 10% from last year. This means they will spend over €2.6 billion in 2023 on special education which equates to 27% of the departments allocation.

Schools in Ireland:

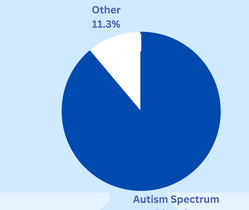
3,967 Schools



In Ireland, there are 3,967 schools. This is split into;

- 3,239 First level educational schools
- 728 Second level educational schools

2,510 Special Classes



In Ireland, there are 2,510 special classes within mainstream schools. These are split into:

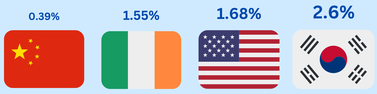
- 1,775 Special classes in primary schools
- 735 Special classes in secondary schools

Of the 2,510 special classes in mainstream schools in Ireland, 2,227 are designed for the autistic user. This is 88.73% of all special classes.

Prevalence:

4 in 10,000

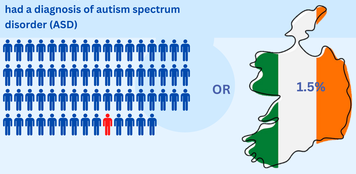
In the 1940s, prevalence was about four diagnosis' of autism in every 10,000 people (0.04%).



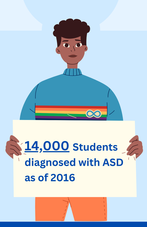
Prevalence percentages around the world

1 in 65

Of the school going population in Ireland had a diagnosis of autism spectrum disorder (ASD)



Boys are 5 times more likely to be diagnosed with autism than girls



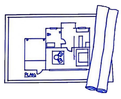
14,000 Students diagnosed with ASD as of 2016

02 Aims

- This research aims to examine an existing ASD unit to test if it meets the current acoustical building standards. This research should show if the standards set in Ireland are realistic or if they can be improved.
- This study also aims to inspire more people to undertake research involving designing environments for the autistic user.

03 Objectives

1 - To compare and contrast what standards exist for ASD Units in Ireland and abroad.



2 - To learn and investigate what acoustic properties were specified in the case study building.

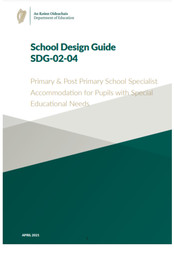
3 - To test the acoustic properties of a case study ASD classroom and record results to compare them to the current building standards.

4 - To discover how the existing airborne sound insulation details could be improved through Insul software.

04 Motivation

Government Mandate:

An Roinn Oideachais
Department of Education



In the School Design Guide-02-04, it states that "The accommodation suite for pupils with SEN will be an integral part of any new school building or integrated as an extension to an existing school."

Lack of Architectural Research:

Many research papers suggest that the autistic community have been ignored by the architectural community by being excluded from building standards.

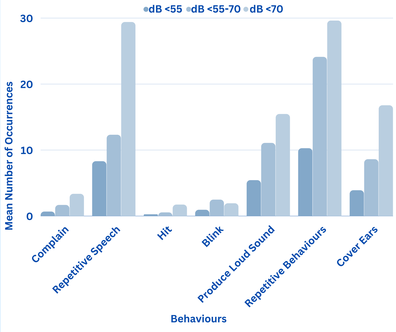
Acoustical Impacts Among Autistic Users:

Multiple studies have proved that poor acoustical environments have the biggest influence on autistic behaviour among the sensory stimuli.

64% of Teachers

79.3% of Parents

Rank acoustics as the most influential architectural factor on autistic behaviour.

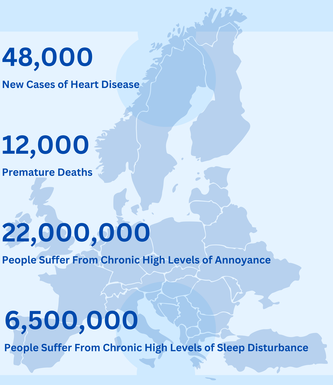


Results of a study which showed that the higher level of ambient noise there was in a room, the more frequent behavioural outbreaks occured.

05 Literature Review

Noise:

"Excessive noise can seriously harm human health and interfere with people's daily activities at school, at work, at home and during leisure time. It can cause stress, disturb sleep, cause psychophysiological effects, and provoke annoyance responses, and changes in social behaviour"

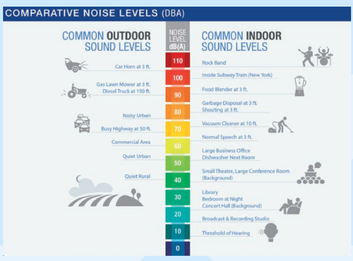


48,000
New Cases of Heart Disease

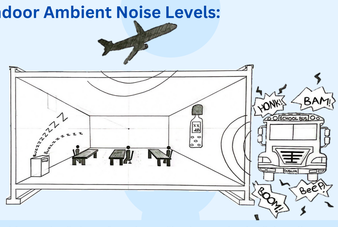
12,000
Premature Deaths

22,000,000
People Suffer From Chronic High Levels of Annoyance

6,500,000
People Suffer From Chronic High Levels of Sleep Disturbance



Indoor Ambient Noise Levels:

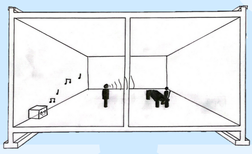


"Ambient noise," also referred to as "background noise," describes all noise that is present in a particular location, with the exception of the primary sound that a person is directly listening to or making as a result of their work activities

35 L'Aeq (dB)

The Irish standard for indoor ambient noise levels in primary and post primary school classrooms.

Airborne Sound:

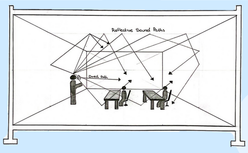


Airborne sound is noise that is carried through the air. Airborne noise is transmitted from outside of the building to the inside, as well as from floor to floor or from room to room, for example, music playing from a radio.

45 DnT,w (dB)

The Irish standard for airborne sound insulation in primary and post primary schools when both the source and receiving rooms are classrooms.

Reverberation:



Reverberation is the persistence of sound in a confined space due to reflections from surfaces. Reverberation time (RT) is the time taken for sound waves to decay by 60 decibels (dB) once the sound source has ceased.

0.6 s For Primary Schools

0.8 s For Post Primary Schools

The Irish standard for reverberation times in primary and post primary school classrooms.

Sound Proofing:

Hard objects reflect sounds, but soft materials absorb sounds and silence them. When sound waves reach a soft material, their energy is soaked up and they travel no further. Things that absorb sound can be useful for reducing noise.

Increases Productivity

Improves Speech Intelligibility

Niall Burke
C19748105
DT-175
Acoustics in ASD Classrooms

ACOUSTICAL SPACES AFFECT PEOPLE WITH AUTISM IN THE

06 Field Testing

Case Study:

The field testing was mainly carried out in classroom 1 and classroom 2 with additional testing completed for the central activity area and practical activity room.

The field tests that were completed were:

1. Airborne Sound Insulation Test for Common Wall Between Classroom 1 and Classroom 2
2. Airborne Sound Insulation Test for folding partition wall between the central activity area and practical activity room (with a Door Set)
3. Airborne Sound Insulation Test for Wall between Classroom 1 and The Central Activity Area (with a Door Set)
4. Indoor Ambient Noise Levels for Classroom 2
5. Reverberation Times for Classroom 1
6. Reverberation Times for Classroom 2
7. Reverberation Times for practical activity room

Testing Equipment:

Headphones

Trolley

Tri-pod

NTi Audio Dodecahedron Speaker DS2

NTi Audio XL2 Sound Level Analyser & NTi Audio M2230 Microphone

NTi Acoustics Power Amplifier

Site & Testing Photos:

Sound Measurement in Progress

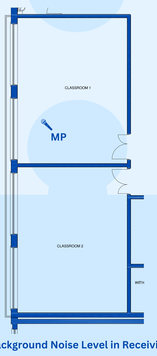
Classroom 2

Equipment Set-up

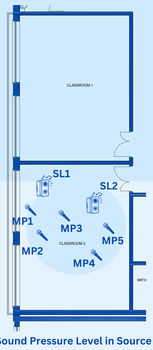
Central Activity Area

Sound Measurement in Progress

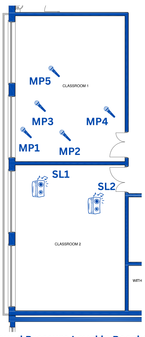
Airborne Sound Insulation Test Procedure & Result for Wall Between Classroom 1 and Classroom 2:



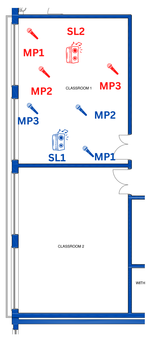
Step 1 - Background Noise Level in Receiving Room



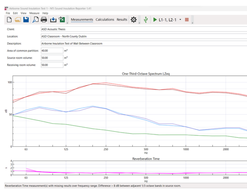
Step 2 - Sound Pressure Level in Source Room



Step 3 - Sound Pressure Level in Receiving Room



Step 4 - Reverberation Time for Receiving Room



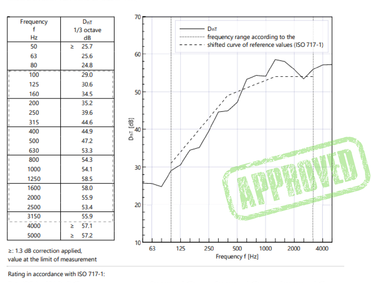
Step 5 - Input Sound Measurements into the NTi Sound Reporter Software to Calculate Results

		Source Room	
Minimum DnT,w (dB)		Primary School: classroom	Post primary School: classrooms
Receiving Room	Primary School: classrooms	45	n/a
	Post-primary School: classrooms	n/a	45

The Current Irish Standard for Airborne Sound Insulation for a Common Wall Between two Classrooms

Sound Level Meter: A2A-09612-E0 (M2230: 5339)

Frequency f Hz	D_{nT} 1/3 octave dB
50	≥ 25.7
63	25.6
80	24.8
100	29.0
125	30.6
160	34.5
200	35.2
250	39.6
315	44.6
400	44.9
500	47.2
630	53.3
800	54.3
1000	54.1
1250	58.5
1600	58.0
2000	55.9
2500	53.4
3150	55.9
4000	≥ 57.1
5000	≥ 57.2



≥: 1.3 dB correction applied, value at the limit of measurement

Rating in accordance with ISO 717-1:

$D_{nT,w}(C;C_{Tr})$ = 50 (-2; -6) dB

$C_{50-3150}$ = -2 dB; $C_{50-5000}$ = -1 dB; $C_{100-5000}$ = -1 dB

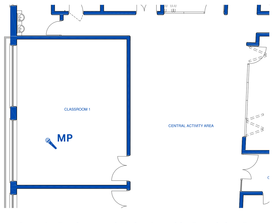
$C_{Tr,50-3150}$ = -10 dB; $C_{Tr,50-5000}$ = -10 dB; $C_{Tr,100-5000}$ = -6 dB

Evaluation based on field measurement using results obtained by an engineering method.

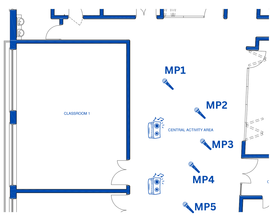
50 DnT,w (dB)

The Irish standard states a minimum of 45 DnT,w (dB) should be achieved for this test. This test exceeds the standard.

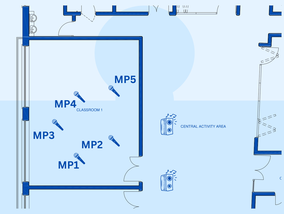
Airborne Sound Insulation Test Procedure & Result for Central Activity Area & Classroom 1:



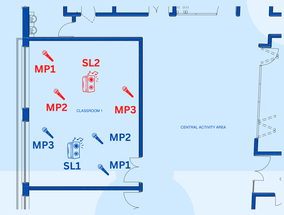
Step 1 - Background Noise Level in Receiving Room



Step 2 - Sound Pressure Level in Source Room



Step 3 - Sound Pressure Level in Receiving Room



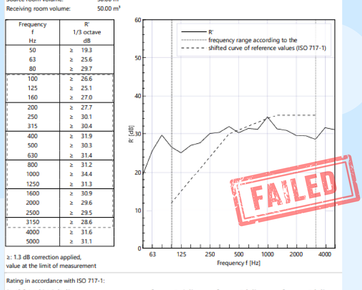
Step 4 - Reverberation Time for Receiving Room

Type of Space Used by Students	Maximum RW (dB)	
	Wall including any glazing	Wall including any glazing
All Spaces Except Music Rooms	40	30

The Current Irish Standard for Airborne Sound Insulation for a Common Wall Between two Classrooms

Sound Level Meter: A2A-09612-E0 (M2230: 5339)
Area of common partition: 40.00 m²
Source room volume: 50.00 m³
Receiving room volume: 50.00 m³

Frequency f Hz	R' 1/3 octave dB
50	≥ 19.3
63	≥ 25.6
80	≥ 29.7
100	≥ 26.6
125	≥ 25.1
160	≥ 27.0
200	≥ 27.7
250	≥ 30.1
315	≥ 30.4
400	≥ 31.9
500	≥ 30.3
630	≥ 31.4
800	≥ 31.2
1000	≥ 34.4
1250	≥ 31.3
1600	≥ 30.9
2000	≥ 29.6
2500	≥ 29.5
3150	≥ 28.6
4000	≥ 31.6
5000	≥ 31.1



≥: 1.3 dB correction applied, value at the limit of measurement

Rating in accordance with ISO 717-1:

$R'_w(C;C_{Tr})$ = 31 (-1; 0) dB

$C_{50-3150}$ = -1 dB; $C_{50-5000}$ = 0 dB; $C_{100-5000}$ = 0 dB

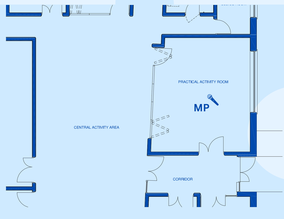
$C_{Tr,50-3150}$ = -1 dB; $C_{Tr,50-5000}$ = -1 dB; $C_{Tr,100-5000}$ = 0 dB

Evaluation based on field measurement using results obtained by an engineering method.

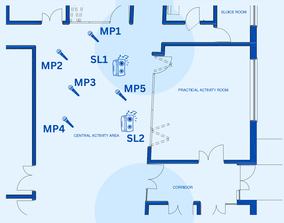
31 RW (dB)

The Irish standard states a maximum of 30 RW (dB) should be achieved for this test. This result shows that the wall that separates classroom 1 from the central activity area with the door set does not meet the current criteria.

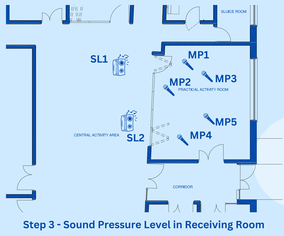
Airborne Sound Insulation Test Procedure & Result for Central Activity Area & Practical Activity Room:



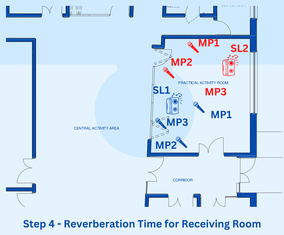
Step 1 - Background Noise Level in Receiving Room



Step 2 - Sound Pressure Level in Source Room



Step 3 - Sound Pressure Level in Receiving Room

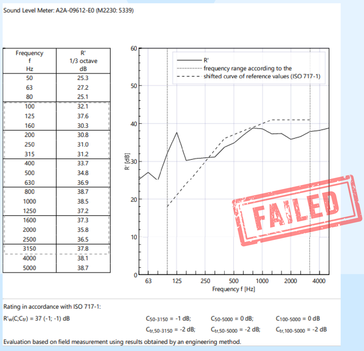


Step 4 - Reverberation Time for Receiving Room

LEARNING ENVIRONMENT?

Type of Space Used by Students	Maximum RW (dB)	
	Wall including any glazing	Wall including any glazing
All Spaces Except Music Rooms	40	30

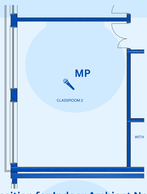
The Current Irish Standard for Airborne Sound Insulation for a Common Wall Between two Classroms



37 RW (dB)

The Irish standard states a maximum of 30 RW (dB) should be achieved for this test. This result shows that this test fails to meet the current Irish standard.

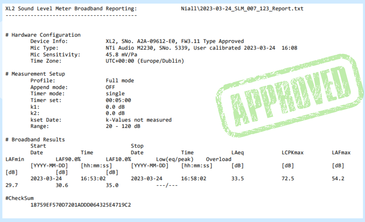
Indoor Ambient Noise Levels Test Procedure for Classroom 2:



Microphone position for Indoor Ambient Noise Levels Test

Type of Room	Upper Limit for IANL, L'Aeq,30min (dB)
Primary School: classrooms	35
Post-Primary School: classrooms	35

The Irish Standard for Indoor Ambient Noise Levels



33.5 L'Aeq (dB)

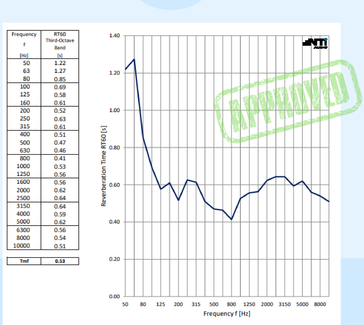
The Irish standard states that the maximum indoor ambient noise levels in a classroom are 35 L'Aeq (dB). The indoor ambient noise levels in classroom 2 were 33.5 35 L'Aeq (dB), meaning this once again meets the standard.

Reverberation Time Test Procedure & result for Classroom 1:

Speaker & Microphone Positions for Reverberation Measurements

Type of Room	Mid-frequency reverberation time, Tmf 1 (seconds), in finished, normally furnished but unoccupied spaces.
Primary School: classrooms	≤0.6
Post-Primary School: classrooms	≤0.8

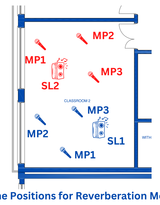
The Current Irish Standard for Reverberation Times



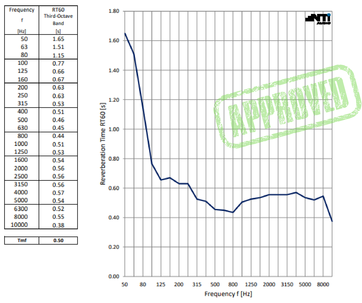
0.53 s

The Irish standard states that a maximum reverberation time in a classroom should be no more than 0.8 s. Classroom 1 has a reverberation time of 0.53 s. This exceeds the standards.

Reverberation Time Test Procedure & result for Classroom 2:



Speaker & Microphone Positions for Reverberation Measurements

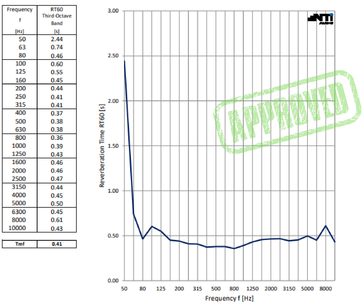


0.50 s

The Irish standard states that a maximum reverberation time in a classroom should be no more than 0.8 s. Classroom 2 has a reverberation time of 0.50 s. This exceeds the standards.

Reverberation Time Test Procedure & result for Practical Activity Room:

Speaker & Microphone Positions for Reverberation Measurements



0.41 s

The Irish standard states that a maximum reverberation time in a classroom should be no more than 0.8 s. The practical activity room has a reverberation time of 0.41 s. This exceeds the standards.

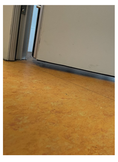
Field Test Results Summary:

5 of 7 or 71.4%

of the field tests completed met the minimum requirements for acoustical standards in schools.

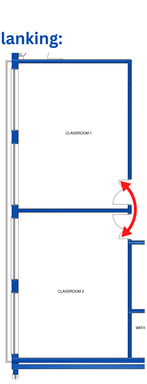
Both failed tests were airborne insulation tests between spaces used by students and circulation spaces with door-sets. Why is this?

Testing to see if a card can slide under the door. This shows a clear gap where sound could travel through.



Site photos showing no seals on the door-sets. This could lead to airborne noise intruding the room

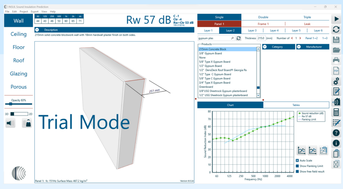
Flanking:



Sound can enter rooms in unexpected ways, such as through gaps and cracks around the edges of building elements. These noise paths are commonly referred to as flanking paths and are often a cause of poor sound reduction.

07 Digital Siumlation

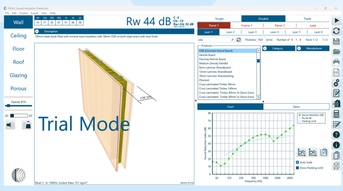
Existing Common Wall Between Classroom 1 & 2:



Rw 57 dB

The existing internal walls are rated 57dB on the sound reduction index through the Insul software which predicts the sound insulation of build-ups

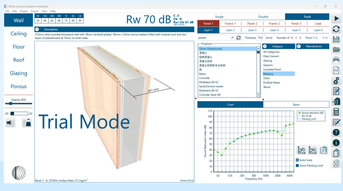
Existing Folding Partition Between Central Activity Area & Practical Activity Room:



Rw 44 dB

The existing folding partition wall that separates the central activity room from the practical activity room has a rating of 44dB on the sound reduction index

Proposed Higher Performing Sound Insulated Internal Wall:



Rw 70 dB

The image shows a proposed build-up for a higher performing wall with a Rw rating of 70dB. This could help reduce noise being transmitted through the air and could help bring the failed tests up to standard.

08 Conclusion & Reflection

Higher Acoustical Standards:

With literature outlining how vital the considerations of acoustical design for people with ASD, it is surprising to see that there are no specific criteria for people with ASD in the learning environments.

Question Still Remains:

With no specific standards set for people with ASD, the question still remains, should there be even stricter regulations and standards when it comes to designing these spaces for autistic people?

09 Further Research

Standards Specific to Autism:

Further research should be done into creating the correct criteria for acoustical environments for the autistic user. With literature proving that poorly acoustical surroundings can have an impact on people with ASD safety and ability to learn, testing should be done to find the ideal acoustical standards specific to people with ASD

Doors & Seals:

Further studies should also look into the sealing of doors in ASD units to see if the problems with them in the case study building is consistent with others. This would have a big affect into noise levels in the learning environment.