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Building a university music facility in a reused printery building

Matthew Ottley (1)

(1) Marshall Day Acoustics, Sydney, Australia

ABSTRACT

In 2015 Western Sydney University embarked on a project to refit two existing buildings to create a new music precinct. The building housing the recording facilities previously accommodated the University's printery, essentially a lightweight workshop building. The new use required the building to house two studio control rooms, a teaching control room, four isolation rooms, a live recording room, ensemble rehearsal spaces and music practice rooms. At project commencement, there existed a significant incompatibility between the ambitious acoustic requirements in the project brief, the project budget, the size of the building, the number of rooms required and the limitations of the existing building structure. This paper outlines the design process undertaken to reconcile the competing requirements of the project and deliver a high performance, fit for purpose music and recording facility. Key points covered include; stakeholder engagement to derive the true acoustic criteria required; design compromises related to existing structure, spatial allowances and budget; Odeon 3D room modelling of control rooms and comparison with 3D room impulse response measurements on completion.

1 INTRODUCTION

Western Sydney University has recently relocated its music teaching facilities into two refurnished buildings to create a new music precinct. The building housing the recording facilities (known as Building F) previously accommodated the University's printery, essentially a lightweight workshop building. The new use required the building to house two studio control rooms, a teaching control room, four isolation rooms, a live recording room, ensemble rehearsal spaces and music practice rooms. A second building (Building C) was converted to house tutorial rooms, computer labs and office spaces.

At project commencement, there existed an incompatibility between competing project constraints including:

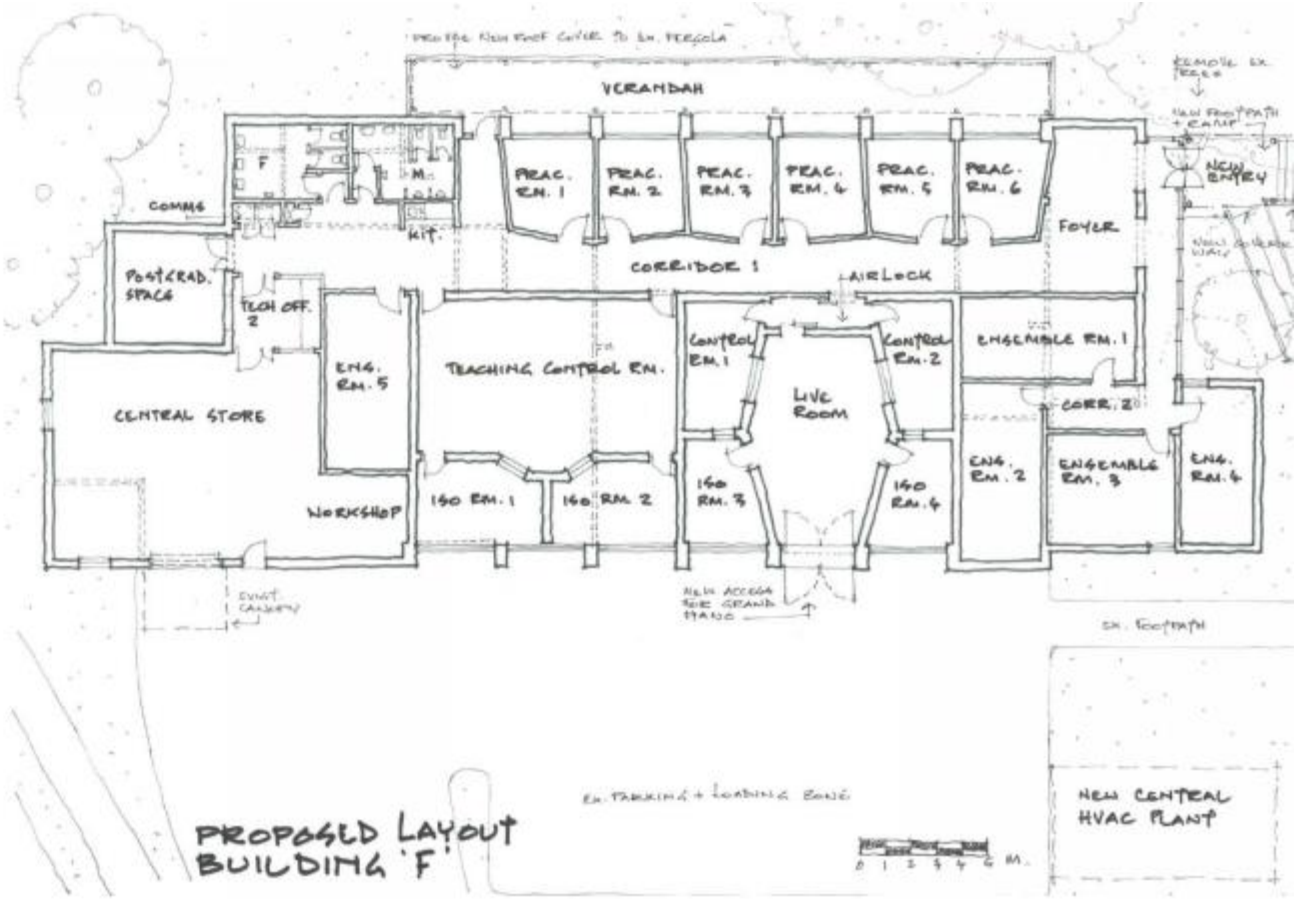
- the reuse of the existing lightweight buildings
- a small construction budget (initial allocation was less than $3M)
- a desire for a large number of spaces
- ambitious acoustic targets

This paper outlines the design process undertaken to reconcile the competing requirements of the project and deliver a high performance, fit for purpose music and recording facility.

2 CLIENT BRIEF AND ESTABLISHMENT OF CRITERIA

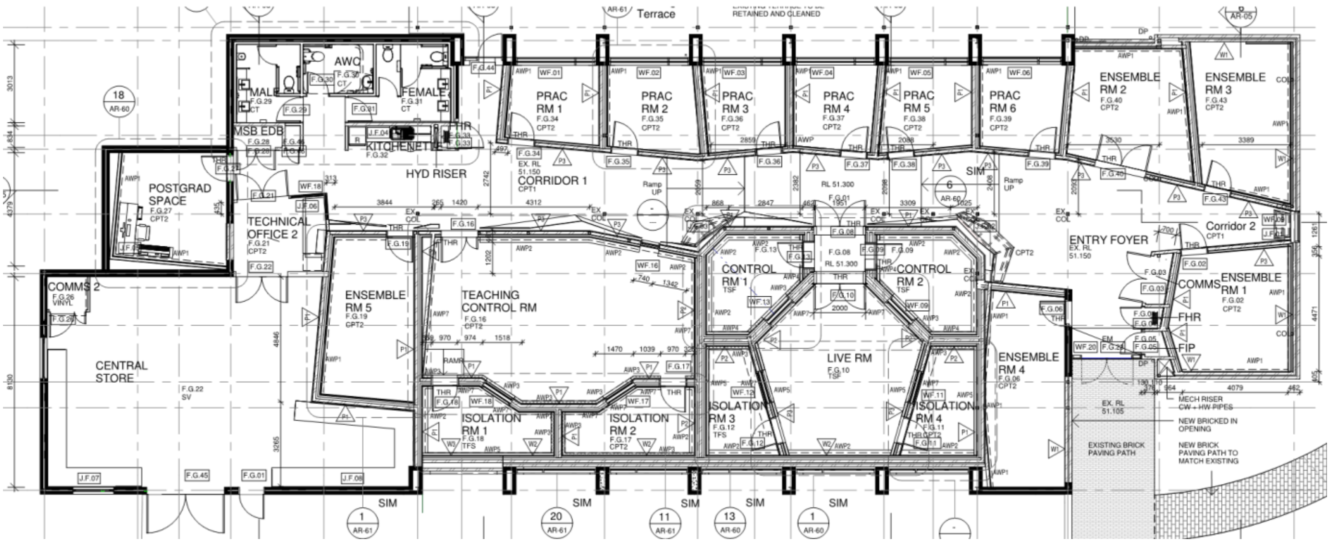
2.1 Client Brief

The initial brief from the client, which was the basis of contracted outcomes required, included both a concept layout and acoustic design targets. The “preliminary concept layout” shown in the brief is reproduced below as Figure 1.



Source (WSU Request For Quotation, 2015)
Figure 1: Building F Preliminary Concept Layout

It is worth noting the density and number of discreet spaces required, limited number of sound locks and number of sensitive spaces separated by common partitions. This 'preliminary concept' was in practice a layout that was largely fixed and closely resembles the finished building, as shown in Figure 2.



Source (Brewster Hjorth Architects, 2016)
Figure 2: Building F Layout for Construction

The acoustic design targets in the brief ranged from vague, such as "vibration control from plant and structure-born noise [must be addressed]" to requirements that were both prescriptive and ambitious in the context of the limitations offered by the existing building:

> *Isolation - sound transmission between spaces within the building to achieve a sound transmission loss of minimum 60dB or more in each ISO octave-band through floors, partitions, doors and ceilings.*

2.2 Return brief and negotiating requirements

Given the conflicts inherent within the client brief it was critical to engage with the client and determine what was actually required of the facility. In this case the 'client' in fact comprised a number of stakeholders including capital works managers, academic staff, end users and finance controllers. These negotiations required all sides to align their expectations with the resources available to the project and identify what was needed from the facility versus those that were desirable. It was important through this process to establish the trust of those involved, not only that we had the technical expertise to achieve the required project outcomes but also that we understood and respected each party's interests (for example that budget and accessibility outcomes were important, not just acoustics).

One key aspect in this process, in common with many projects, is that the design was required to allow for a high degree of flexibility of usage across the spaces. For example, the client's original intention was that Isolation Room 3, Isolation Room 4 and the Live Room could be in use simultaneously by three different parties, with recording occurring via each of the three Control Rooms (Control Rooms 1 & 2 and the Teaching Control Room).

As part of the negotiations and analysis of the users' needs it was established that this was unlikely to ever occur, especially as the Isolation Rooms needed to be accessed by walking through the Live Room. In establishing a more realistic use scenario the acoustic rating (and therefore construction complexity) between the Live Room and adjacent Isolation Rooms was able to be reduced, rather than over designed for a hypothetical use scenario that would practically not occur.

By establishing two way trust and respect with the stakeholders we were able to establish acoustic design goals for the project that both reflected the true requirements for the facility and aligned with the project constraints.

2.3 Final criteria

Following the stakeholder engagement and initial value engineering exercises the final criteria of the project were agreed. Tables 1 and 2 summarise the agreed criteria in a number of rooms. For simplicity, the criteria are summarised as single figure values but in practice the frequency content formed a key part of the design. Reverberation time targets for all practice and rehearsal rooms were all nominally set the same low target of 0.3 seconds, whilst some of the isolation rooms were designed to be slightly more reverberant. It is worth noting that the small size of most of these rooms dictated that the reverberation time would be low.

Table 1: Room to room sound isolation criteria

Source Room	Receive Room	Target Dw
Practice or Ensemble	Practice or Ensemble	55
Control	Live (associated space)	55
Control	Ensemble (non-associated space)	60
Live	Isolation (associated space)	45

Table 2: Internal noise level and reverberation time criteria

Room	Ambient noise level dBA	Ambient noise level NR	Reverberation Time $RT_{60,s}$
Practice	35	30	0.3
Ensemble	35	30	0.3
Control	28	20	0.2-0.3
Live	28	20	0.7-0.8
Isolation Room 1 & 3	28	20	0.4
Isolation Room 2 & 4	28	20	0.3

3 DESIGNING WITHIN CONSTRAINTS

3.1 Where to compromise

An important step during the early phases of the project was to prioritise areas where acoustics was a priority. A decision was made by the client during these negotiations that the acoustics in Building F (studios and rehearsal areas) were the priority and that cuts could be made to Building C (administration and teaching areas) in order to focus resources on the critical spaces. Furthermore the end users had a clear hierarchy in mind of acoustic priority, with the core rooms of the Live Room, Control Rooms 1 & 2 and Isolation Rooms 3 & 4 being at the top.

By establishing a clear hierarchy of priorities early the inevitable value management decisions that came later in the process could be made on an agreed basis.

As soon as this hierarchy was established important acoustic design decisions could be made early in the process. Perhaps the most important was deciding which rooms required isolated floors or "box-in-box" construction. Making this decision early, particularly in a project reusing an existing building, is important as it defines the floor heights. Elevated sections of floor required ramps to allow universal access and the location of these ramps needed to be determined early in the special planning / layout phase.

3.2 Room acoustic design

In designing the room acoustics with the project constraints in mind there were a number of strategies employed. Firstly the acoustic goals needed to be clearly identified and the design philosophy established. For example once the user groups preferences were understood the control rooms design approach was able to be formed. The adopted layout comprised a symmetrical room (along centre line) and with a Live End – Dead End (LEDE) approach (with diffuse rear wall).

Room layouts were further refined in order to minimise the surface treatments that would otherwise be required. This is illustrated in changes in room shapes between Figures 1 & 2, with control rooms becoming symmetrical and parallel walls in other spaces modified accordingly.

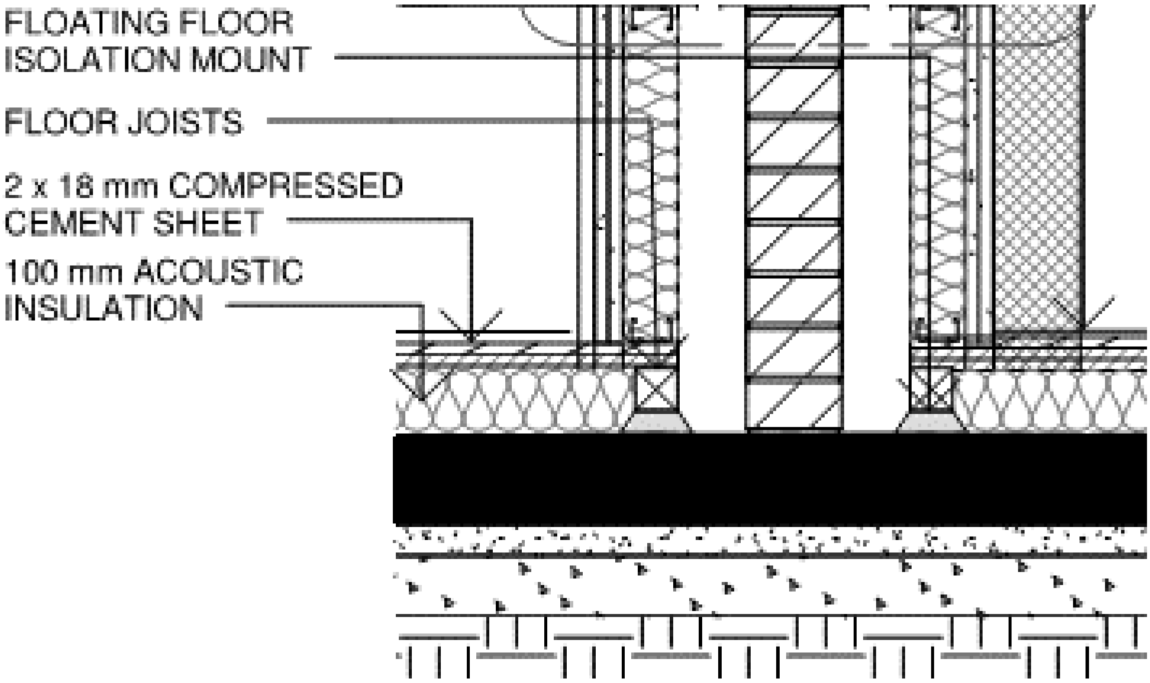
Once room shapes and dimensions were locked in the critical spaces were modelled in Odeon (3D room acoustics modelling software) to examine both the overall reverberation times as well as the reflection sequences. In most cases, to minimise costs, construction time and risk, materials for the room finishes were generally selected from off the shelf systems. The use of commercially available finish systems meant that achievable acoustic performance was known and guaranteed by the suppliers.

There were however instances that made use of non-proprietary products in order to achieve acoustic outcomes. In those instances the design utilised materials that would normally be not used as absorbent finishes, such as plasterboard and plain plywood, in framed panels. These were incorporated into the room in order to provide the specifically required low frequency absorption. In order to achieve a cohesive aesthetic and minimise the number of suppliers, a small finishes pallet was selected and reused across the project

3.3 Sound isolation

It was identified early in the design process that the low frequency isolation required between adjacent spaces would only be achievable within the required wall thickness allowances with wall construction incorporating a masonry element. Brick masonry was also preferred due to the existing brickwork in the building. Acoustic rated walls to all critical areas therefore all incorporated brickwork in combination with plasterboard linings.

Cost, space and structural limitations of the existing slabs prevented the incorporation of traditional heavy-weight concrete and masonry floating construction systems. Instead, the isolation of the core rooms was designed around lightweight floating floors, comprising 2 layers of 18mm Compressed Fibre Cement (CFC) sheeting on Embelton NRD isolators. A lightweight plasterboard wall leaf on steel studs was constructed on top of the floating floor in each room, while a non-floating masonry wall leaf was constructed off the slab between the two floating floors.



Source (Brewster Hjorth Architects, 2016)
Figure 3: Wall detail with isolated floors

The detailing of this type of system is obviously complex by nature but within an adaptive reuse context even more so. Continual close supervision on site and ongoing co-ordination with the builder, architect and structural engineer were required in order to execute the design effectively.

4 PROJECT OUTCOMES

4.1 Room acoustic outcomes

All critical spaces were tested on completion and reverberation times were within 0.1 seconds of the design targets in all cases. Ambient noise levels were also compliant in all critical spaces. A summary is set out in Table 3.

Table 3: Measured mechanical noise levels and Reverberation Time results compared to targets

Room	Ambient level result (NR)	Ambient level target (NR)	RT result, ($RT_{60,\ s}$)	RT target, ($RT_{60,\ s}$)
Live Room	20	20	0.6	0.7-0.8
Isolation Room 4	20	20	0.2	0.3
Isolation Room 3	19	20	0.3	0.4
Control Room 2	19	20	0.3	0.2-0.3
Control Room 1	20	20	0.2	0.2-0.3
Teaching Control	19	30	0.3	0.4
Isolation Room 1	19	20	0.3	0.4
Postgrad Room	23	30	0.3	0.3
Practice Room 5	20	30	0.3	0.3
Ensemble Room 3	19	30	0.4	0.3

In addition to the time based measurements the directional performance of Control Room 1 was also investigated with the use of the IRIS 3D impulse response system. Figure 4 below shows the reflections at the listener position in Control Room 1 due to a source at the Right hand side monitor speaker position.

For Control Room 1 the surface treatments to the walls were made up of 100mm deep semi-rigid fabric faced acoustic panel (Autex Quietspace Panel 100mm) to the front wall (with window) and 200mm deep Quadratic diffusers to the main section of the rear wall (Ultrafonic QRD type). The small sections of side walls (with door on one side) were used for low frequency absorption, comprising lightly (1.8% open area) perforated 6mm plywood with a 100mm air cavity and insulation behind. The front section of the ceiling was finished with 25mm deep semi-rigid fabric faced acoustic panel (Autex Quietspace Panel 25mm). The rear section of the ceiling was not absorptive, with timber battens applied for a small amount of diffusion.

At the time of commission testing the monitor speakers were not installed and a dodecahedral speaker was used for testing. These will distort the reflection sequence relative to the actual studio monitors due to strong source levels being driven away from the receiver towards the window.

Nevertheless the plot shows the small number of reflections arriving from the front of the room (right hand side of the graphic) relative to the large number of reflections arriving from the diffuse rear of the room (left hand side of the graphic).

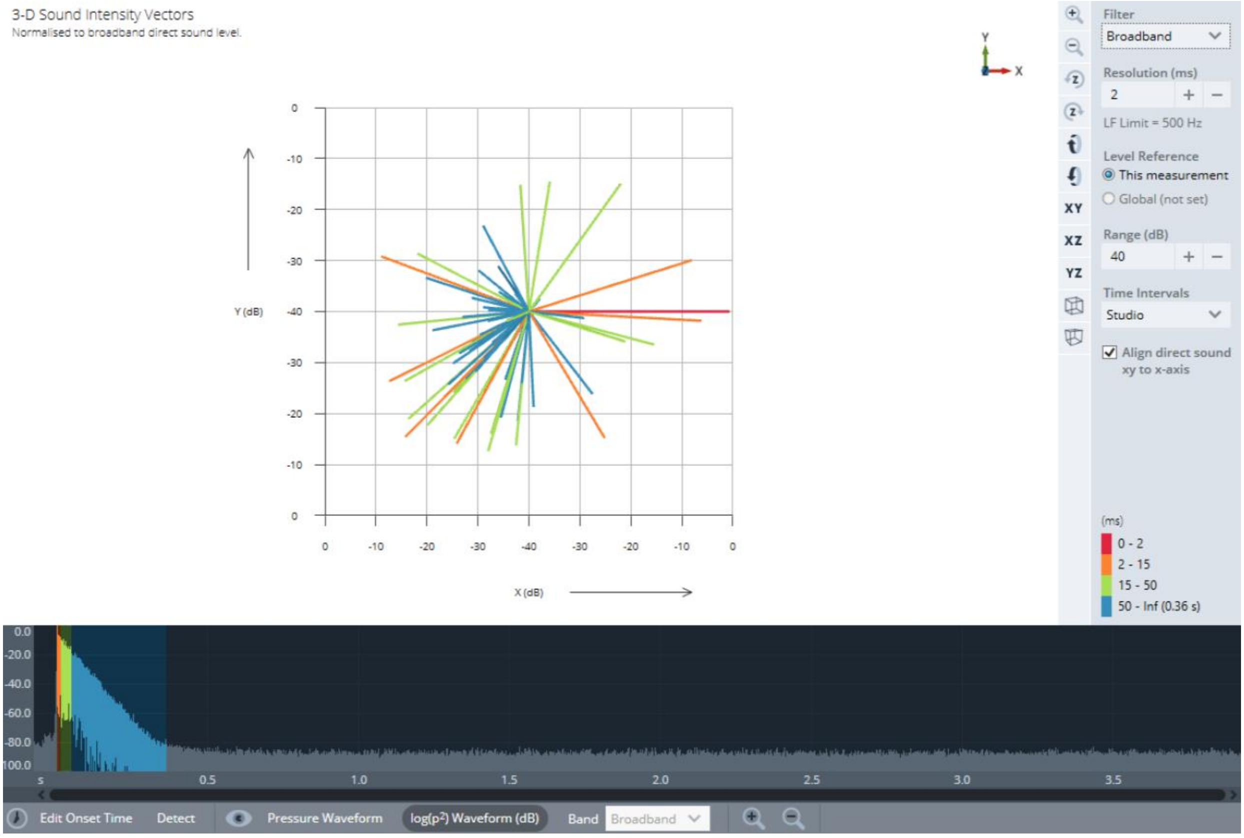


Figure 4: IRIS 3D impulse response (XY plane) in Control Room 1 from RHS monitor location

4.2 Sound isolation outcomes

The tested acoustic performance on site between two adjacent spaces is shown in Figure 5.

The partition between the Live Room and the Control Room has floating floors on both sides but does include a window and sound lock doors. The window comprised two separate frames at 150mm (minimum) spacing with 10.38mm laminate and 12.38mm laminated glass. Each of the doors to the sound lock were rated R_w 35.

The partition between Isolation Rooms 2 & 3 has a floating floor only on one side but does not include any windows or doors.

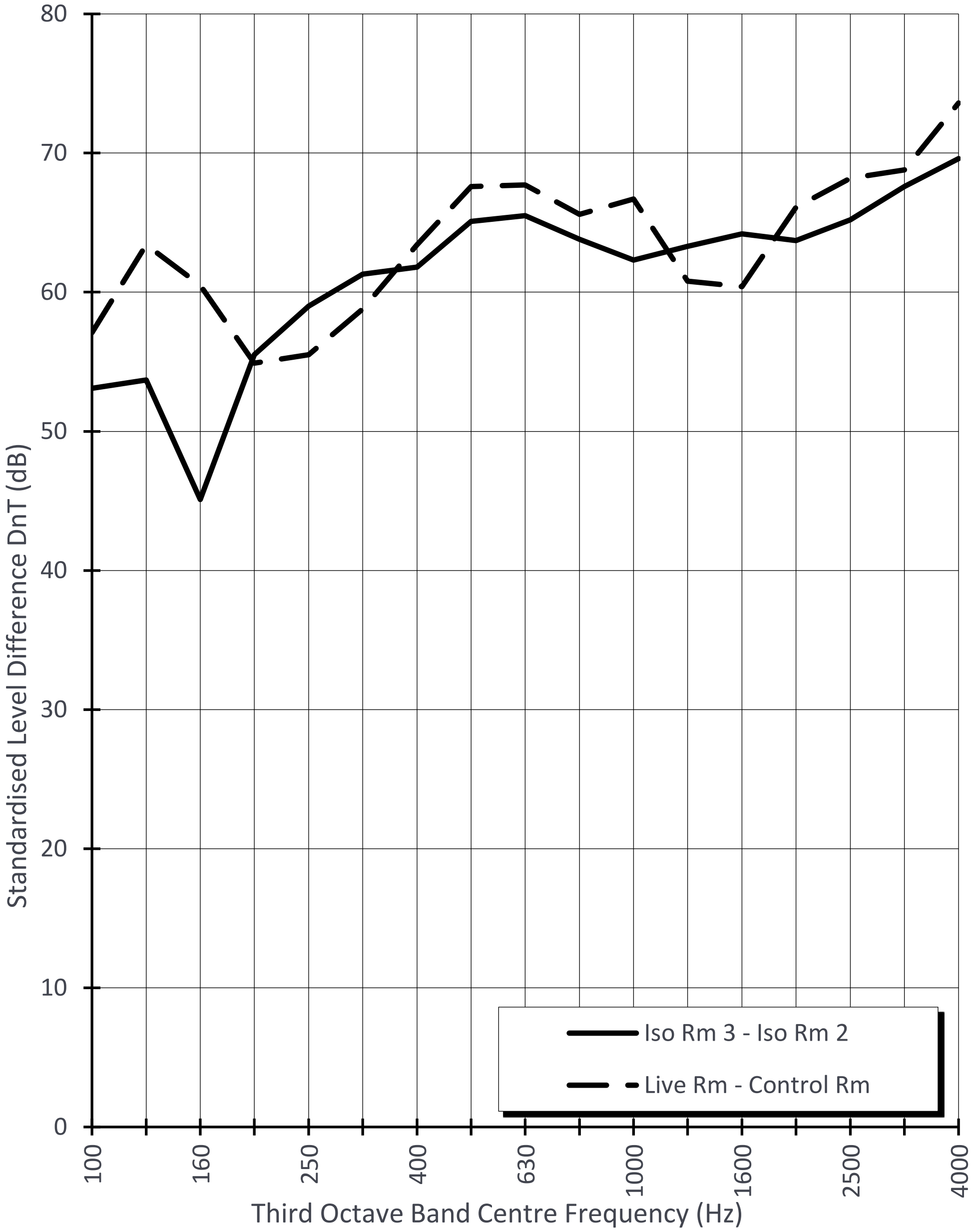


Figure 5: Transmission Loss tested on completion

Table 4 shows the range of typical isolation achieved on completion. All adjacent rooms in Building F achieved the design targets with the exception of one partition. In that instance the isolation between two adjacent practice rooms was limited due to the existing building envelope. The limitation was noted during construction however it was not able to be rectified without demolishing a section of existing wall that was not proposed to be removed. A decision was made by the project team to proceed, accepting the acoustic compromise.

Table 4: Room to room sound isolation criteria

Source Room	Receive Room	Result Dw	Target Dw
Practice or Ensemble	Practice or Ensemble	52-65	55
Control	Live (associated space)	61-63	55
Control	Ensemble (non-associated space)	>65	60
Live	Isolation (associated space)	45-46	45

5 SUMMARY

The new music precinct has provided staff and students with a world class facility, delivered within a difficult set of project constraints. The acoustic testing on completion of the project indicated that the agreed project goals had been met. Even more importantly, feedback from the end users has been positive, with Associate Professor Dr Bruce Crossman saying:

> *The new facilities are amazing! It is a powerful student recruitment and retention tool for us to use, as well as being a brilliant facility for conducting research, including organizing music festivals and having a great place to show national and international guests.*

The outcomes for the facility could only be achieved by engaging with stakeholders early to identify the true needs of the space, making key design decisions early in the design process and then working collaboratively with the design and build teams throughout the entire project.

REFERENCES

Davis, D Davis, C. 1980. '*The LEDE Concept for the Control of Acoustic and Psychoacoustic Parameters in Recording Control Rooms*'. Journal of the Audio Engineering Society, 1980 September, Volume 28, Number 9.