

Manchester City Council

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Subject: Factory_Acoustic commissioning test program (**DRAFT**)

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This document describes the acoustic commissioning test program for the Factory project in Manchester. The acoustic commissioning testing will be done by Level Acoustics & Vibration (Level) as soon as construction works are finished, so just before or after delivery of the project (expected 2022 Q1).

In-between-testing of fragments of the building (short tests of 2-4 hours planned during site visits) might be an option earlier in the process; however are not part of this document. Currently these types of testing are not planned.

Aim of the testing

The testing is aimed to proof whether all relevant acoustic aspects meet the requirements as described in the technical brief.

In detail measurements and further investigations such as calculations, which for example are necessary when requirements are not met, are no part of the testing program and Level's current acoustic scope. They can only be planned when any shortcomings are known.

What is tested

All acoustically relevant aspects as described in the technical brief are tested and compared with the set requirements. During the design and construction process some of the requirements have been adjusted. Where relevant, the last version is applied as basis for the testing.

A special item is the noise egress by Factory towards surrounding apartment buildings. There the Planning Conditions are leading for comparison of test results.

The following aspects are tested:

- Room acoustics, reverberation time and speech intelligibility parameters where relevant
- Noise egress by Factory towards surrounding apartment towers or (measurement) locations representing future locations of these towers
- Airborne sound insulation between spaces in Factory
- Sound levels by MEP
- Sound and vibration levels by traffic towards vibration sensitive locations in Factory, most relevant the orchestra pit floor and TH floor

In principle, the test program is designed to be able to test all requirements in the brief for representative spaces/locations assuming everything runs smoothly. If this is the case and the results seem promising (set requirements are met), in other words start-up of in detail measurements/investigations is not needed, the test program might offer options to also test acoustic aspects that are not in the technical brief, nevertheless are very interesting to test, for example for additional implementation in Factory's Acoustic Manual (currently not in Level's scope; however optionally to be developed).

Examples of this are: testing with inner box doors of Warehouse and Theatre open to determine impact on noise egress and sound transmission within the building; impact sound measurements to represent jumping, dancing and walking of large numbers of people (audience), works in the loading docks and stage set-up.

How does the testing take place

Level brings and uses their own measurement equipment (data acquisition systems, microphones, vibration sensors et cetera), including some of the sound/vibration excitation sources (tapping machine, hammers, potentially shakers, smaller airborne sound sources).

What Level does not bring are airborne sound sources i.e. sound systems (generation, speakers, filtering et cetera) that are directly representative / used in the Warehouse and the Theatre in the future. Level proposes to use MIF (sourced) sound systems in both the Warehouse and the Theatre (for explanation see further in this document).

What is expected from MIF/MCC and LoR

- Level staff gets open access to all spaces in the building, for the agreed testing days
- MIF staff available and on site (as agreed, see later in this document)
- No other persons in/around the building
- No construction or cleaning activities
- All construction and MEP elements are in and fully operating/operable, as if the building is delivered and in full operation
- Electricity in all spaces
- Mobile construction platforms or drones including staff arranged and available (costs not in Level scope)
- Operators to handle MEP systems and door opening system (proscenium) during test days
- Before the first test weekend, the Warehouse moveable doors must be opened and theatre seats stored in the Theatre Foyer space (not in the Warehouse)
- In between test weekend 2 and 3 Warehouse moveable doors must be closed and theatre seats installed
- Sound systems MIF installed and operating with sound production at least 125 dB(C), see appendix C

Items for discussion and final planning of the testing with MCC, MIF and LoR

This document is the first draft version of the test program, and will be updated after discussions with MCC, MIF and LoR (in their role as construction process manager).

Items to be discussed are:

- The contents of the test program. Level will present the draft test program in a meeting to MCC and MIF representatives. Based on discussion the test program will be updated.
- The planning of the testing in line with the construction schedule of the Factory project. Currently Level plans testing in three weekends in a row, with some checks during the week between these weekends. For details, see further in this document. Reason why Level currently proposes testing in weekends is to avoid conflicts with construction works as much as possible. Testing is to be done while the building basically is finished, with all wall, floor, façade, roof, ceiling, doors and windows, including all sealants et cetera in place; besides, all MEP components need to be in place and fully functioning. This implies that testing ideally should be done just before or after finishing construction. Together with all parties involved, Level will plan the exact testing days, based on the construction programming.
- Also relevant for planning the exact testing days are the availabilities of staff for operation of the moveable doors, MEP installations, sound systems et cetera, of the sound systems themselves and optionally mobile construction platforms and/or drones. Testing with MIF sound systems installed in line with future use of the Warehouse and Theatre is strongly preferred (provided they are powerful enough for the testing), since this is the best representation of the future use of the building, its noise egress towards surrounding apartment towers, and sound transmission between the Warehouse and Theatre. Besides, by using these systems additional costs for renting equipment and staff for operation of different sound systems is avoided (not in Level scope).

Appendix A

Test program (DRAFT)

WH = Warehouse

TH = Theatre

Weekend = Friday 4 pm till Sunday 11 pm

Weekend1

Provide before weekend: all moveable doors TH and WH closed (with operator available), Seats in TH.

Check for audible gaps, visual checks and perform initial measurements

Measurements of background noise without and with Building Services (with operator available), MEP and Toilets

Emission of MEP noise (checks close to equipment)

During week (in between Weekend1 and Weekend2)

Fix mayor issues found during inspection weekend1

Weekend2: WH moveable doors open, no TH seats

Provide before weekend: WH moveable doors open, Proscenium doors closed (with operator available), PA in WH (moveable on platform), PA in TH, no seats in stalls TH and pit covered (seats stored in TH foyer). All building services off. Truck with driver to pass under theatre for noise ingress test (Day 2). Optionally/tbd: mobile construction platform / drones outside building (with operator), for noise egress measurements

Parallel Day 1:

Emission testing: from Full WH and TH

Sound insulation internally: Full WH to Towers, WH to TH (and vice versa)

End of day, Install measurement set background noise (vibrations/microphones), when done in TH. Remove PA.

Parallel Day 2:

Measure background noise/vibrations from Truck (and Trains)

Room Acoustics: TH without stalls seats (proscenium door closed and possibly open), WH N+S

Sound insulation internally: Tower spaces (including RT measurements)

During week (in between Weekend2 and Weekend3)

Close the WH moveable doors. Install Theatre seats

Weekend3: WH moveable doors closed, TH seats installed

Provide before weekend: WH moveable doors closed, Proscenium doors closed (with operator available), PA in WH-N (moveable on platform), PA in TH, seats in stalls TH and orchestra pit open. All building services off.

Parallel Day 1:

Sound insulation internally: WH-N to WH-S and TH, WH-S to WH-N, TH and GF foyer

Room Acoustics: TH Foyer, GF Foyer, Control Rooms

End of Day 1:

Room Acoustics: TH with stalls seats and pit open, proscenium door open

Start of Day 2:

Sound insulation: TH+WHS (proscenium doors open) to WHN

Parallel Day 2:

Sound insulation internally: TH to TH foyer, TH to WH S/N, Impact sound WH floor to Orchestra pit,

Room Acoustics: WH S, WH N, (Control Rooms)

Time left?

Emission from WH-S

Effect of opening doors on sound insulation internally/externally

Impact sound various locations

Appendix B

Total test program (**DRAFT**)

XLS file

THE FACTORY MANCHESTER
Acoustic commission testing - PRELIMINARY TEST PROGRAM
dd 2021 July 2 (DRAFT)
Level Acoustics & Vibration

ROOM ACOUSTICS	page 1	
SOUND INSULATION (AIRBORNE) WITHIN FACTORY	page 2	
SOUND INSULATION (IMPACT) WITHIN FACTORY	page 3	
BACKGROUND NOISE LEVELS	page 4	80,3 total number of hours
BACKGROUND VIBRATION LEVELS	page 6	10,0 total number of days
NOISE EGRESS / FAÇADE SOUND INSULATION	page 7	

1 ROOM ACOUSTICS

What	Further specifications	Where	Further specifications	Further specifications	Time slot
Reverberation time		WH complete			4
Reverberation time		WHN			4
Reverberation time		WHS			4
Reverberation time		TH with prosc door open, stalls with seats	stage areas		1
Reverberation time			audience areas incl balcony		2
Reverberation time			orchestra pit		1
Reverberation time		TH with prosc door closed, stalls with seats	stage areas		1
Reverberation time			audience areas incl balcony		2
Reverberation time			orchestra pit		1
Reverberation time		TH with prosc door open, stalls without seats	stage areas		1
Reverberation time			audience areas incl balcony		2
Reverberation time			orchestra pit		1
Reverberation time		TH with prosc door closed, stalls without seats	stage areas		1
Reverberation time			audience areas incl balcony		2
Reverberation time			orchestra pit		1
Reverberation time		Main foyer			2
Reverberation time		TH foyer			2
Reverberation time		control rooms 2x	1x		0,5
Reverberation time			1x		0,5
Reverberation time		3 spaces in Towers tbd	1x		0,1
Reverberation time			1x		0,1
Reverberation time			1x		0,1
Reverberation time		all tower spaces relevant for sound insulation measurements	1x		0,1
Reverberation time			1x		0,1
Reverberation time			1x		0,1
Reverberation time			1x		0,1
Reverberation time			1x		0,1
Reverberation time			1x		0,1
Reverberation time			1x		0,1
Reverberation time			1x		0,1
Reverberation time			1x		0,1
Reverberation time			1x		0,1
Reverberation time			1x		0,1
Reverberation time			1x		0,1
Reverberation time		loading dock/xxl	1x		0,5
Reverberation time		loading dock	1x		0,5
Reverberation time		corridor between loading dock and TH	1x		0,1
Speech Intelligibility	without speech amplification	WHN	stage set-up 1		1
Speech Intelligibility	without speech amplification	TH different stage areas	prosc door open		1
Speech Intelligibility	without speech amplification		prosc door closed		1
Speech Intelligibility	without speech amplification	TH different audience areas incl balcony	prosc door open		1
Speech Intelligibility	without speech amplification		prosc door closed		1
Other room acoustical parameters incl in detail sta: impulse responses are recorded to determine			included in the above		incl in above

40,7 total number of hours

2 SOUND INSULATION (AIRBORNE) WITHIN FACTORY

Source room/space	Receiving space	Further specifications	Further specifications	Further specifications	Time slot
WH complete	TH (with closed prosc door)	closed prosc door	open flex wall	WH inner box doors closed	1
WH complete	Tower South - level 2/3	closed prosc door	open flex wall	WH inner box doors closed	0,1
WH complete	Tower South - level 4	closed prosc door	open flex wall	WH inner box doors closed	0,1
WH complete	Tower South - level 5	closed prosc door	open flex wall	WH inner box doors closed	0,1
WH complete	Tower South - level 6	closed prosc door	open flex wall	WH inner box doors closed	0,1
WH complete	Tower South - level 7	closed prosc door	open flex wall	WH inner box doors closed	0,1
WH complete	Tower South - level 8	closed prosc door	open flex wall	WH inner box doors closed	0,1
WH complete	Tower North - level 2	closed prosc door	open flex wall	WH inner box doors closed	0,1
WH complete	Tower North - level 3	closed prosc door	open flex wall	WH inner box doors closed	0,1
WH complete	Tower North - level 4	closed prosc door	open flex wall	WH inner box doors closed	0,1
WH complete	Tower North - level 5	closed prosc door	open flex wall	WH inner box doors closed	0,1
WH complete	Tower North - level 6	closed prosc door	open flex wall	WH inner box doors closed	0,1
WH complete	Tower North - level 7	closed prosc door	open flex wall	WH inner box doors closed	0,1
WH complete	Tower North - level 8	closed prosc door	open flex wall	WH inner box doors closed	0,1
WH complete	Main foyer	closed prosc door	open flex wall	WH inner box doors closed	0,1
WHN	TH stage	closed prosc door	closed flex wall	WH inner box doors closed	0,5
WHN	TH audience areas incl balcony	closed prosc door	closed flex wall	WH inner box doors closed	0,5
WHN	TH stage cq WHS	open prosc door	closed flex wall	WH inner box doors closed	0,5
WHN	TH orchestra pit	open prosc door	closed flex wall	WH inner box doors closed	0,1
WHN	TH audience areas	open prosc door	closed flex wall	WH inner box doors closed	0,5
WHN	WHS	closed prosc door	closed flex wall	WH inner box doors closed	0,5
TH	WHN	closed prosc door	closed flex wall	all doors in between closed	0,5
TH	WHS	closed prosc door	closed flex wall	all doors in between closed	0,5
TH	TH foyer	closed prosc door	closed flex wall	all doors in between closed	0,1
From TH stage cq WHS	WHN	open prosc door	closed flex wall	all doors in between closed	0,5
From TH stage cq WHS	WHN	open prosc door	closed flex wall	doors in between open	0,5
From full TH	TH foyer	open prosc door	closed flex wall	all doors in between closed	0,1
From full TH	control room 1	open prosc door	closed flex wall	all doors in between closed	0,1
From full TH	control room 2	open prosc door	closed flex wall	all doors in between closed	0,1
Loading dock/XXL	WHS	closed prosc door	closed flex wall	all doors in between closed	0,1
Loading dock/XXL	Tower South - level 4	closed prosc door	closed flex wall	all doors in between closed	0,1
Tower north - workspace level 2	WNH				
Tower north - rehearsal space	Tower north - rehearsal space same level			all doors closed	0,1
Tower north - rehearsal space	Tower north - rehearsal space lower level			all doors closed	0,1
Tower north - rehearsal space	WHN			all doors closed	0,1
Main foyer	orchestra pit			all doors closed	0,1

8 total number of hours

3 SOUND INSULATION (IMPACT) WITHIN FACTORY

incl conversion to (jumping/dancing/walking) large audience numbers
working with at least 4 tapping machines or different heavy source to obtain sufficient floor excitation

Source room/space	Receiving space	Further specifications	Further specifications	Further specifications	Time slot
WHN	TH stage cq WHS	open prosc door	closed flex wall	WH inner box doors closed	0,5
					0,5 total number of hours

4 BACKGROUND NOISE LEVELS

[illegible]

[illegible]

20,6 total number of hours

5 BACKGROUND VIBRATION LEVELS

tactile vibrations measured with high sensitive accelerometers

What	Further specifications	Where	Further specifications	Time slot
Vibration levels without MEP	traffic, all other	WH complete	long term measurements / recording	1
Vibration levels without MEP	traffic, all other	TH	stage areas	1
Vibration levels without MEP	traffic, all other		audience areas incl balcony	1
Vibration levels without MEP	traffic, all other		orchestra pit	0,5
Vibration levels without MEP	traffic, all other	Main foyer	long term measurements / recording	0,5
Vibration levels without MEP	traffic, all other	TH foyer	long term measurements / recording	0,5
				4,5 total number of hours

6 NOISE EGRESS CQ SOUND INSULATION FAÇADE CQ MAX ALLOWABLE SOUND PRODUCTION WITHIN FACTORY

What	Further specifications	Where	Further specifications	Time slot
Strategy 1 direct estimation of max allowable sound production levels proof of planning conditions	Sound level measurements at various locations in/representative for	Tower 1 - height 1		1
	(future) apartment buildings	Tower 1 - height 2		0,5
		Tower 1 - height 3		0,5
		Tower 2 - height 1		1
		Tower 2 - height 2		0,5
		Tower 2 - height 3		0,5
		Tower 3 - height 1		1
		Tower 3 - height 2		0,5
		Tower 3 - height 3		0,5
				6 total number of hours

Appendix C

For sound production in Warehouse: examples of sound system set-ups, indicative for sound production during testing sound insulation between Warehouse and other spaces

For sound production in Theatre: use of future/actual sound systems installed (as expected during future operation of Factory)



Sound production in hall for pop/rock concerts



Sound production in chamber music hall



Sound production in symphony hall

Example of PA system (for testing sound insulation) in 3550 m³ hall to create 125 dB(C)



Amount	Description
12	Synco E118 SUB Speaker cabinet
12	Synco STS LO 215 Speaker cabinet
4	Synco STS MH Speaker cabinet (black label)
4	Synco STS SINGLE + LOW + SUB MASTER amprack
4	PA speaker cable SET L : STS-NL-XLR
1	Digico SD11i console 16/8 analog + 1/1 AES/EBU (S12)
2	Denon DN-500R SD/USB recorder
1	Mixing position accessories SET : XLR3
1	CEE 32A/400V power distribution SET Controls
1	CEE 32A/400V power distribution SET Amps
1	Motorola Portofoon SET : 5x GP340