Noise Impact Assessment

BS4142:1997

Refrigeration and Air Conditioning Equipment

Tempest Rd Wtrloo Exp ("Site")

18 The Westbrook Centre, Grassmere Way,

Cowplain, Waterlooville, PO7 8SE.

Tesco Stores Ltd ("Customer")

Tesco House, Delamere Road,

Cheshunt, Hertfordshire, EN8 9SL.

Testing Laboratory:	KR Associates (UK) Ltd
Laboratory Address:	Unit 22 Basepoint Centre Anderson's Road Southampton SO14 5FE
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Consultant:	Rhys Scrivener

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1 EXECUTIVE SUMMARY

1.1 Introduction

KR Associates (UK) Ltd ("KRA") have been instructed by Tesco Stores Ltd to undertake an environmental assessment at 18 The Westbrook Centre, Grassmere Way, Cowplain, Waterlooville to determine if the refrigeration and air conditioning units will adversely affect the nearest noise sensitive properties in terms of noise and to establish if planning permission should be granted.

1.2 External Plant

It has been proposed to install 1 No Searle MGB124 refrigeration condenser, 2 No Mitsubishi Heavy FDCA 501 HESR sales floor AC units and 1 No Mitsubishi Heavy SRC 28 CD-5 Cash Office AC ("plant") which have combined rating levels at the nearest noise sensitive facade of $L_{Aeq,1hr}$ 36 dB during the day time (07:00 to 23:00) and $L_{Aeq,5\ min}$ 19 dB during the night time (23:00 to 07:00).

1.3 Assessment Position

For the purposes of this assessment, the assessment position was established as the nearest noise sensitive facade located at 1m from the residential facade of the property within Damask Gardens. This position being 30.0 m from the various proposed units of plant equipment.

1.4 Background Noise Levels

Background noise levels were measured between 16:32 on 24th August 2010 and 16:58 on 25th August 2010 within Grassmere Way to the rear of the store. The minimum night time background levels were found to be $L_{A90,5min}$ 44 dB and the minimum day time background noise levels were found to be $L_{A90,1\ hr}$ 60 dB.

1.5 BS4142:1997 Assessment

The noise emissions from the plant will result in a conclusion under BS4142:1997 of -25 dB during the night time period and -24 dB during the daytime period both of which fall below the -10 dB assessment level which indicates that complaints are unlikely.

1.6 Conclusion

The noise emissions from the plant will not have an adverse effect on the nearby residential properties and therefore KRA would recommend that planning permission is granted.

2 SITE DETAILS

2.1 Proposal

To support a planning application for refrigeration and air conditioning equipment.

2.2 Site Description

The site is the location of a previous Tesco Express store which was destroyed by fire. The proposed new store is a single storey building on the corner of Tempest Avenue and Grassmere Way. The proposed plant is to be located within the roof void.

2.3 Area Description

The local area is a mix of commercial and residential property with a public house and small parade of shops (with residential flats over) to the rear of the site. There are further residential properties across both Grassmere Way and Tempest Avenue. There is a car park and recycling area next to the store.

2.4 Source Location

2.4.1 Refrigeration Condenser

It is proposed to locate the external Searle MGB124 refrigeration condenser within a dedicated plant area on the roof of the store.

2.4.2 Sales Floor AC Unit

It is proposed to locate the 2 No external Mitsubishi Heavy FDCA 501 HESR sales floor combined air conditioning and heat pump units within a dedicated plant area on the roof of the store.

2.4.3 Cash Office AC Unit

It is proposed to locate the single external Mitsubishi Heavy SRC 28 CD-5 cash office air conditioning unit within a dedicated plant area on the roof of the store.

2.5 Nearest Noise Sensitive Facade

The nearest noise sensitive facade is located at 1m from the residential facade of the property within Damask Gardens.

3 ASSESSMENT METHODOLOGY AND CRITERIA

3.1 International Standard 9613-Part 2: 1996

3.1.1 Scope

BS 4142[2] in section 6.3.6 recommends the following:

> *"Determine the specific noise level by calculation alone...if the source is not yet in operation. In such cases, report the method of calculation in detail and give the reason for using it"*

3.1.2 Integrated Pollution Prevention and Control (IPPC) – H3 Part 2[6]

Section 2.5.1 Methodology states that

> *"For industrial noise it is preferable to use those principles of ISO 9613 -2 1996...."*

3.1.3 Relevance of Guidance

It is therefore considered appropriate to calculate the resultant noise levels from the installation of the plant using the method defined in ISO 9613:Part 2[3] which states in the scope.

> *"This part of ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources."*

The standard uses well defined calculations to take account of a variety of influences including source location, distance from the source to the receiver, atmospheric absorption and the effect of the ground and barriers.

3.2 Planning and Policy Guidance 24 ("PPG24")[1]

3.2.1 Summary

> *"PPG24 guides local authorities in England on the use of their planning powers to minimise the adverse impact of noise."*

3.2.1.1 Application of Guidance

Paragraph 3 of Annex 1 of PPG 24[1] explains that:

> *"The Noise Exposure Levels should not be used for assessing the impact of industrial noise on residential developments because the nature of this type of noise...because there is insufficient information on people's response to industrial noise to allow detailed guidance to be given"*

3.2.1.2 Use of BS4142[2]

Paragraph 19 of Annex 3 of PPG 24[1] states that:

> *"The likelihood of complaints about noise from industrial development can be assessed, where the standard is appropriate, using guidance in BS4142:1997".*

3.2.1.3 Glossary

The glossary of PPG 24[1] provides some useful guidance.

> *"A change of 3 dB(A) is the minimum perceptible under normal conditions, and a change of 10 dB(A) corresponds roughly to halving or doubling the loudness of the sound."*

It is therefore considered that the level at which noise levels have an adverse impact is above the +3 dB(A) difference in levels which are considered to be the minimal level at which a change is perceptible.

3.2.1.4 Introduction

The introduction of PPG 24[1] states that:

> *"The aim of this guidance is to provide advice....without unreasonable restrictions on development or adding unduly to the costs and administration burdens of business."*

3.2.2 British Standard 4142[2]

This standard compares the proposed source levels against the underlying background noise levels and gives an indication on the likelihood of complaints.

3.2.2.1 Background Noise Levels

These are established as the underlying noise levels against which the assessment of the specific source can be made and are measured at the assessment position or an equivalent position where it is not appropriate to measure the noise levels at the assessment position.

3.2.2.2 Assessment Position

This is located externally at the nearest noise sensitive facade.

3.2.3 Rating Noise Level

The Rating Noise Level is calculated at the assessment position using the source sound power levels and includes where necessary a character correction.

3.2.4 British Standard 7445 – Part 2[5]

Section 4.1.3 entitled Tonal Adjustment provides some useful guidance of when to apply a tonal / character correction in note 1.

> *"..a prominent tonal component may be detected in one third octave spectra if the level of a one-third octave band exceeds the level of the adjacent bands by more than 5 dB...*

3.2.5 BS4142[2] Conclusion

This establishes the difference between the specific noise level and the background noise level and gives an indication if the proposed plant is likely to give rise to complaints within three distinct categories.

> *"Assess the likelihood of complaints by subtracting the measured background noise level from the rating level. The greater this difference the greater the likelihood of complaints.*
>
> - *A difference of around +10 dB or more indicates that complaints are likely.*
> - *A difference of around +5dB is of marginal significance.*
> - *If the rating level is more than 10 dB below the measured background level then there is a positive indication that complaints are unlikely."*

3.2.6 BS4142[2] – Complaints Unlikely

Though a -10 dB criterion under BS4142[2] gives a conclusion of 'complaints unlikely', care needs to be taken when setting this criteria when the background noise level is very low as detailed in the scope of this standard.

> *"The method is not suitable for assessing the noise....when the background and rating noise are both very low.*
>
> *Note. For the purposes of this standard, background noise levels below 30dB and rating levels below 35 dB are considered to be very low."*

3.3 Criteria

Having regard to the guidance within PPG24[1] and BS4142[2] it is considered the following are the appropriate criteria against which the plant noise emissions should be assessed to ensure they do not have an adverse effect on local amenity. The criteria level is set at the level defined as *'Complaints Marginal'* within BS4142[2] and having regard to the general guidance within PPG24[1]. The criteria level has been set at above the minimum level where a change is perceptible and well below the level which will have an adverse impact on amenity.

Assessment Period	BS4142[2] Assessment
Day Time – 07:00 to 23:00 hours	+5 dB
Night Time – 23:00 to 07:00 hours	+5 dB

3.4 WHO Guidelines for Community Noise

3.4.1 World Health Organisation

At the beginning of the document published by the World Health Organisation entitled "Criteria for Community Noise" ("WHO")[16] there is the following statement.

> *"This document is not a formal publication of the World Health Organisation and all rights are reserved by the Organisation. This document may, however, be freely reviewed, abstracted, reproduced or translated in part, but not for sale or for use in conjunction with commercial purposes."*

The document goes onto state.

> *"The authors alone are responsible for the views expressed in this document."*

4 CALCULATION OF NOISE LEVELS

4.1 Scope of Calculations

The noise levels at the assessment position located 1m from the nearest noise sensitive property located at 1m from the residential facade of the property within Damask Gardens are calculated using the sound power levels of the plant and the calculations contained within ISO 9613 Part 2: 1996.

4.2 Source Sound Power Levels (L_w)

The noise emissions of the proposed plant are summarised below.

Equipment	Sound Power Level (L_w) (Free field - Full Load)	Location
Refrigeration Condenser Searle / MGB124	Day Time: 60.0 dB(A)	Within a dedicated plant area on the roof of the store
	Night Time : 50.5 dB(A)	
Sales Floor AC Units Mitsubishi Heavy / FDCA 501 HESR	65.1 dB(A)	
Cash Office AC Units Mitsubishi Heavy / SRC 28 CD-5	59.5 dB(A)	
Sound Power Levels – $L_{eq,1hour}$, dB, reference level 1 x 10^{-12} watts.		

4.3 ISO 9613 Part 2 Calculations

4.3.1 Directivity Correction (D_c)

A correction is made for the directivity of the source based on the number of reflective surfaces near the source.

Unit Description	Correction in dB (D_c)
Refrigeration Condenser (Searle MGB124)	+6 dB (2 surfaces)
Sales Floor AC Units (Mitsubishi Heavy FDCA 501 HESR)	+6 dB (2 surfaces)
Cash Office AC Units (Mitsubishi Heavy SRC 28 CD-5)	+6 dB (2surfaces)

4.3.2 Geometric Divergence (A_{div})

A correction is made for the spreading of the noise from the source and accounts for the increase in distance from the source.

Unit Description	Correction in dB (A_{div})
Refrigeration Condenser (Searle MGB124)	-40.5 dB (30.0 m)
Sales Floor AC Units (Mitsubishi Heavy FDCA 501 HESR)	-40.5 dB (30.0 m)
Cash Office AC Units (Mitsubishi Heavy SRC 28 CD-5)	-40.5 dB (30.0 m)

4.3.3 Other Corrections

Corrections are made to account for Atmospheric Absorption (A_{atm}), Ground Absorption (A_{gr}) and Barrier Attenuation. These corrections are dependent on frequency but the overall broad band correction of all three corrections is detailed below.

Unit Description	Additional Corrections $A_{atm} + A_{gr} + A_{bar}$
Refrigeration Condenser (Searle MGB124)	--3.9 dB
Sales Floor AC Units (Mitsubishi Heavy FDCA 501 HESR)	--2.8 dB
Cash Office AC Units (Mitsubishi Heavy SRC 28 CD-5)	--2.9 dB

4.4 Summary of Calculations

Calculation Element	Summary of Correction			
	Refrigeration Condenser		Sales Floor AC	Cash Office AC
	Day Time (23:00 to 07:00)	Night Time (23:00 to 07:00)	Day Time 07:00 to 23:00)	Day Time (07:00 to 23:00)
Source Sound Power Level	60.0 dB	50.5 dB	65.1 dB	59.5 dB
Source Directivity (D_c)	+6 dB (2 Surfaces)		+6 dB (2 Surfaces)	+6 dB (2 Surfaces)
Geometric Divergence (A_{div})	- 40.5 dB (30.0) m		- 40.5 dB (30.0) m	- 40.5 dB (30.0) m
Atmospheric Absorption (A_{atm})	Atmospheric Absorption, Ground Absorption and Barrier Correction are dependent on Frequency but the overall broad band reduction is given below.			
Ground Absorption (A_{gr})				
Other Correction (A_{bar})	$A_{atm} + A_{gr} + A_{bar}$ --3.9 dB		$A_{atm} + A_{gr} + A_{bar}$ --2.8 dB	$A_{atm} + A_{gr} + A_{bar}$ --2.9 dB
Resultant Level at the assessment Position	29.4 dB(A)	19.9 dB (A)	33.4 dB(A)	27.8 dB(A)

4.5 Specific Noise Levels (BS4142:1997)

4.5.1 Operating Times

Equipment	Operating Times
Refrigeration Condenser: Searle / MGB124	24 Hours per day
Sales Floor AC Units Mitsubishi Heavy / FDCA 501 HESR	07:00 to 23:00 hours 7 Days per week
Cash Office AC Units Mitsubishi Heavy / SRC 28 CD-5	

4.5.2 Specific Noise Levels

Time Period	Specific Noise Levels – Assessment Position
Day Time (07:00 – 23:00)	36 dB
Night Time (23:00 – 07:00)	19 dB
Sound Pressure Levels – $L_{Aeq,t}$ dB reference level (2×10^{-5} Nm^{-2}). 23:00 to 07:00 t = 5 minutes , 07:00 to 23:00 t = 1 hour.	

4.6 Minimum Background Noise Levels

4.6.1 Table of Levels

Time Period	Background Noise Levels (Minimum 5 minutes Periods)
Day Time (07:00 – 23:00)	60 dB
Night Time (23:00 – 07:00)	44 dB
Sound Pressure Levels – $L_{A90,t}$ dB reference level (2×10^{-5} Nm^{-2}). 23:00 to 07:00 t = 5 minutes , 07:00 to 23:00 t = 1 hour.	

5 ASSESSMENTS

5.1 07:00 to 23:00 – Day Time

Refrigeration Sales Floor AC Cash Office AC Assessment Position Background Position	Searle - MGB124 (Operating) Mitsubishi Heavy - FDCA 501 HESR (Operating) Mitsubishi Heavy - SRC 28 CD-5 (Operating) 1m from the residential facade of the property within Damask Gardens Background noise levels were recorded at Grassmere Way to the rear of the store		
Item	Calculation	Clause	Commentary
Specific Noise Level	36 dB	6.3	Specific noise level was calculate. See section 8 for calculations
Acoustic feature correction	+0 dB	8.2.	Neither the refrigeration nor air conditioning equipment had a distinct tone or character.
Rating Level	36 dB	8.3.	The acoustic feature correction is added to the specific noise level.
Background Noise Level	60 dB	7.1.	The background noise level was measured at an appropriate position.
Excess of Rating over Background Level	-24 dB	9	The background levels is subtracted from the rating level. (Numerical values)
Assessment indicated complaint are Complaints Unlikely		9	The excess of rating over the background is compared against BS4142:1997.
Conclusion		**-24 dB**	

5.2 23:00 to 07:00 – Night Time

Refrigeration Sales Floor AC Cash Office AC Assessment Position Background Position	Searle - MGB124 (Operating) Mitsubishi Heavy - FDCA 501 HESR (Not Operating – Turned Off) Mitsubishi Heavy - SRC 28 CD-5 (Not Operating – Turned Off) 1m from the residential facade of the property within Damask Gardens Background noise levels were recorded at Grassmere Way to the rear of the store		
Item	Calculation	Clause	Commentary
Specific Noise Level	19 dB	6.3	Specific noise level was calculated. See section 8 for calculations
Acoustic feature correction	+0 dB	8.2.	Neither the refrigeration nor air conditioning equipment had a distinct tone or character.
Rating Level	19 dB	8.3.	The acoustic feature correction is added to the specific noise level.
Background Noise Level	44 dB	7.1.	The background noise level was measured at an appropriate position.
Excess of Rating over Background Level	-25 dB	9	The background levels is subtracted from the rating level. (Numerical values)
Assessment indicated complaint are Complaints Unlikely		9	The excess of rating over the background is compared against BS4142:1997.
Conclusion		**-25 dB**	

5.2.1 Character Correction

With reference to the guidance contained within section 4.1.3. of BS 7445 the third octave specific sound pressure levels were analysed and it was found that no single third octave sound pressure level was more than 5 dB above the two adjacent bands.

5.2.2 Summary of Assessments

The following table shows a summary of assessments made under BS4142:1997 from the operation of the plant during a 24 hour period.

Time Period	BS4142:1997 Assessment
Day Time (07:00 – 23:00)	-24 dB
Night Time (23:00 – 07:00)	-25 dB
Sound Pressure Levels – $L_{A90,t}$ dB reference level (2×10^{-5} Nm^{-2}). 23:00 to 07:00 t = 5 minutes , 07:00 to 23:00 t = 1 hour.	

6 CONCLUSIONS

6.1 Local Amenity

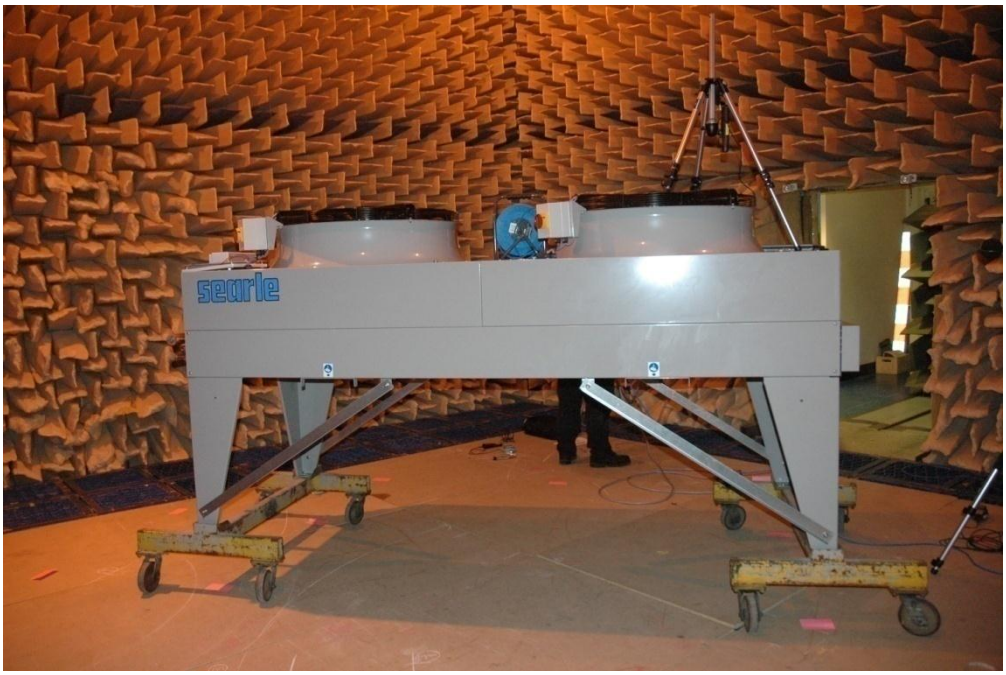
The noise emissions from the proposed plant have been assessed using the guidance in PPG24 and are unlikely to have an adverse impact on the local amenity.

7 APPENDIX A – SOURCE SOUND POWER LEVELS

7.1 Refrigeration Units – Day Time Test Certificate

Manufacturer:	Searle
Model:	MGB124
Conditions:	Day Time (35oC Ambient) 3V Supply 328 rpm
Location of Tests:	Southampton University – Anechoic Chamber
Date of Tests:	19th November 2008
K1 Correction	0 dB (Broadband Level)
K2 Correction	0 dB (Broadband Level)

Photograph of Unit Under Test



1/3rd Octave Band Centre Frequency (Hz)

50	**63**	80	100	**125**	160	200	**250**	315	400	**500**	630	800	**1000**	1250	1650	**2000**	2500	3150	**4000**	5000
72	67	65	62	62	58	56	56	56	56	54	53	53	50	47	44	41	40	38	38	36
73.9			66.3			61.3			59.8			55.6			55.6			42.5		

Sound Power Level: Grade 2 Engineering Grade	**$L_{W(A)}$ 60.0 dB** t = 10 minutes Reference 1 x 10^{-12} watts	Sound Pressure Level at 10m: (Annex C)	**$L_{P(A)}$ 29.2 dB** t = 10 minutes Reference 2 x 10^{-5} Nm^{-2}
Test Laboratory:	KR Associates (UK) Ltd	Approved:	Rhys Scrivener, MSc, MIOA
Report Reference:	KR01557 / 1	Signed:	NOT A UKAS TEST
Test Date:	19th November 2008		
Approval Date:	19th November 2008		

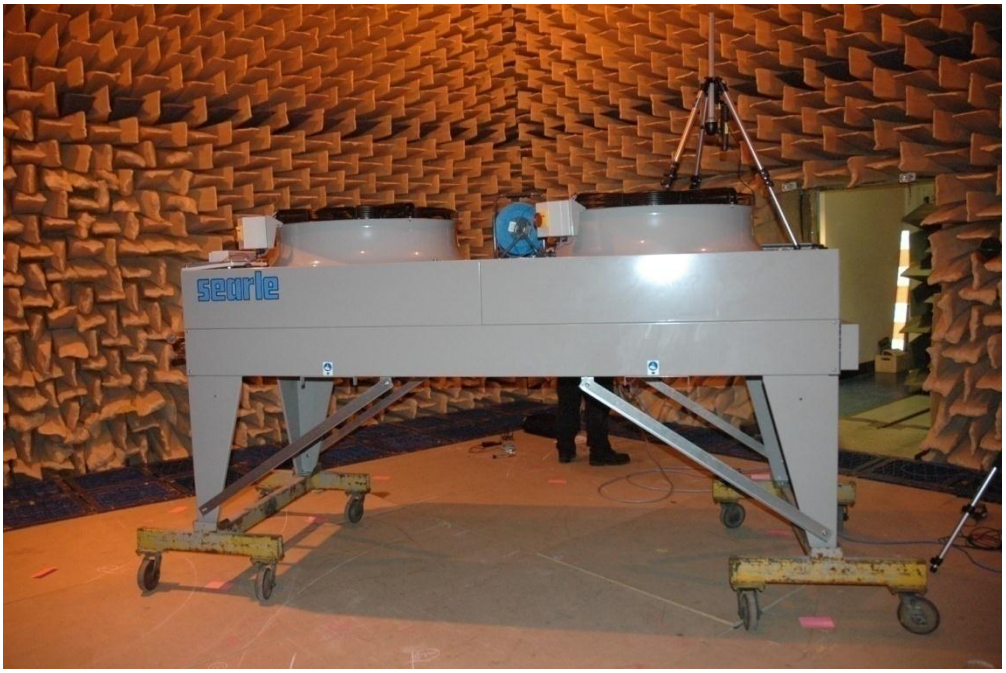
<+- 1.31 dB. The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor of k=2

Note: BS ISO 13487[14] does not clarify sound power levels quoted in third octaves.
These are contained only for reference purposes.

7.2 Refrigeration Units – Night Time Test Certificate

Manufacturer: Model:	Searle MGB124
Conditions:	Night Time (27oC Ambient) 2V Supply 216 rpm
Location of Tests: Date of Tests:	Southampton University – Anechoic Chamber 19th November 2008
K1 Correction	1.1 dB (Broadband Level)
K2 Correction	0 dB (Broadband Level)

Photograph of Unit Under Test



1/3rd Octave Band Centre Frequency (Hz)

50	**63**	80	100	**125**	160	200	**250**	315	400	**500**	630	800	**1000**	1250	1650	**2000**	2500	3150	**4000**	5000
56	54	56	55	50	48	47	47	47	45	46	44	42	38	36	33	31	29	26	28	24
60.3			56.7			51.8			49.7			44.2			36.0			31.0		

Sound Power Level: Grade 2 Engineering Grade	**$L_{W(A)}$ 50.5 dB** t = 10 minutes Reference 1 x 10^{-12} watts	Sound Pressure Level at 10m: (Annex C)	**$L_{P(A)}$ 18.7 dB** t = 10 minutes Reference 2 x 10^{-5} Nm^{-2}
Test Laboratory:	KR Associates (UK) Ltd	Approved:	Rhys Scrivener, MSc, MIOA
Report Reference:	KR01557 / 2	Signed:	NOT A UKAS TEST
Test Date:	19th November 2008		
Approval Date:	19th November 2008		

<+- 1.31 dB. The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor of k=2

Note: BS ISO 13487[14] does not clarify sound power levels quoted in third octaves.

These are contained only for reference purposes.

7.3 Sales Floor AC Units – Day Time Test Certificate

Manufacturer:	Mitsubishi Heavy
Model:	FDCA 501 HESR
Conditions:	Day Time – Full Load Cooling – 2 UNITS OPERATING
Location of Tests:	Shefford Express Site
Date of Tests:	14th July 2007
K1 Correction	0.5 dB (Broadband Level)
K2 Correction	0 dB (Broadband Level)

Photograph of Unit Under Test (Noise Levels for 2 Units)



1/3rd Octave Band Centre Frequency (Hz)

50	**63**	80	100	**125**	160	200	**250**	315	400	**500**	630	800	**1000**	1250	1650	**2000**	2500	3150	**4000**	5000
78	76	73	75	67	62	63	56	57	55	52	52	57	56	54	53	57	55	50	50	49
79.0			75.0			64.0			57.0			59.0			57.0			52.0		

Sound Power Level: Grade 2 Engineering Grade	**$L_{W(A)}$ 65.1 dB** t = 10 minutes Reference 1 x 10^{-12} watts	Sound Pressure Level at 10m: (Annex C)	**$L_{P(A)}$ 34.7 dB** t = 10 minutes Reference 2 x 10^{-5} Nm^{-2}
Test Laboratory:	KR Associates (UK) Ltd	Approved:	Rhys Scrivener, MSc, MIOA
Report Reference:	KR01557 / 2	Signed:	NOT A UKAS TEST
Test Date:	14th July 2007		
Approval Date:	19th November 2008		

<+- 1.31 dB. The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor of k=2

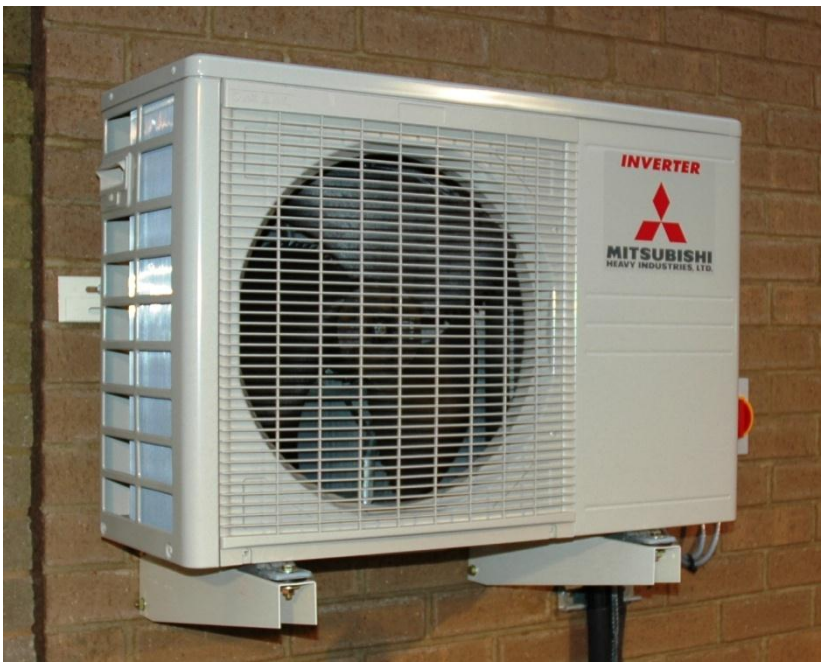
Note: BS ISO 13487[14] does not clarify sound power levels quoted in third octaves.

These are contained only for reference purposes.

7.4 Cash Office AC Unit – Day Time Test Certificate

Manufacturer: Model:	Mitsubishi Heavy SRC 28 CD-5
Conditions:	Day Time – Full Load Cooling
Location of Tests: Date of Tests:	Shefford Express Site 14th July 2007
K1 Correction	1.1 dB (Broadband Level)
K2 Correction	0 dB (Broadband Level)

Photograph of Unit Under Test



1/3rd Octave Band Centre Frequency (Hz)

50	**63**	80	100	**125**	160	200	**250**	315	400	**500**	630	800	**1000**	1250	1650	**2000**	2500	3150	**4000**	5000
74	76	70	69	68	65	59	54	53	51	47	47	50	51	48	47	48	46	45	44	42
75.0			70.0			60.0			52.0			52.0			50.0			52.0		

Sound Power Level: Grade 2 Engineering Grade	**$L_{W(A)}$ 59.5 dB** t = 10 minutes Reference 1 x 10^{-12} watts	Sound Pressure Level at 10m: (Annex C)	**$L_{P(A)}$ 28.9 dB** t = 10 minutes Reference 2 x 10^{-5} Nm^{-2}
Test Laboratory:	KR Associates (UK) Ltd	Approved:	Rhys Scrivener, MSc, MIOA
Report Reference:	KR01557 / 2	Signed:	NOT A UKAS TEST
Test Date:	19th November 2008		
Approval Date:	19th November 2008		

<+- 1.31 dB. The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor of k=2

Note: BS ISO 13487[14] does not clarify sound power levels quoted in third octaves.

These are contained only for reference purposes.

8 APPENDIX B – DETAILED ISO 9613 CALCULATIONS

8.1 Source Directivity (D_c)

8.1.1 Formula

A correction is made to account for the location of the source and the effect of additional reflective surfaces excluding the ground and is contained within section 6 of ISO 9613-Part 2:1996.

Number of Surfaces	Correction in dB (D_c)
1 Reflective Surface	+3 dB
2 Reflective Surfaces	+6 dB
3 Reflective Surfaces	+9 dB

8.1.2 Corrections

Unit Description	Correction in dB (D_c)
Refrigeration Condenser (Searle MGB124)	+6 dB
Sales Floor AC Units (Mitsubishi Heavy FDCA 501 HESR)	+6 dB
Cash Office AC Units (Mitsubishi Heavy SRC 28 CD-5)	+6 dB

8.2 Geometric Divergence (A_{div})

8.2.1 Formula

A correction for the distance between the source and assessment position using the following formula defined in section 7.1 of ISO 9613-Part 2:1996.

Formula	Symbols
$A_{div} = 20 . Log_{10} (d/d_0) +11$	A_{div} = Reduction due to Geometric Divergence (dB) d = Distance from source to receiver (m) d_0 = reference distance (1m)

8.2.2 Corrections

Unit Description	Correction in dB (A_{div})
Refrigeration Condenser (Searle MGB124)	-40.5 dB (30.0 m)
Sales Floor AC Units (Mitsubishi Heavy FDCA 501 HESR)	-40.5 dB (30.0 m)
Cash Office AC Units (Mitsubishi Heavy SRC 28 CD-5)	-40.5 dB (30.0 m)

8.3 Atmospheric Absorption (A_{atm})

8.3.1 Formula

A correction is made to account for the atmospheric absorption which is contained within section 7.2 of ISO 9613 – Part 2:1996 and ISO 9613-Part 1 : 1993.

Formula	Symbols
$A_{atm} = \alpha d / 1000$ Where $\alpha = 8.686\ f^2([1.84x10^{-11} . (p_a/p_r)^{-1} . (T/T_0)^{0.5}] +$ $(T/T_0)^{-2.5} . \{0.01275[e^{(-2239.1/T)}] . [f_{r0} + (f^2/f_{r0})]^{-1} +$ $0.1068\ [\ e^{(-3352.0/T)}] . [f_{rN} + (f^2/f_{rN})]^{-1}\ \})$ $f_{r0} = (p_a/p_r)\ (\ 24 + 4.04 . 10^4 . h . [(0.02 + h)/(0.391+h)]$ $f_{rN} = (p_a/p_r) . (T/T_0)^{-0.5} . (9 + 280 . h . e^{(-4.170\ [(T/T0)(-1/3) - 1]}\})$ $h = h_r\ (p_{sat} / p_r) / (p_a / p_r)$ $s_{at} / p_r = 10^c$ $c = -6.8346\ (T_{01}/T)^{1.261} + 4.6151$	A_{atm} = Reduction due to atmospheric Absorption (dB) α = Atmospheric absorption coefficient d = Distance from source to receiver (m) f = Frequency (Hz) p_a = Ambient atmospheric pressure (KPa) p_r = Reference ambient atmospheric pressure (101.325 KPa) T = Ambient temperature (Kelvin) T_0 = Reference air temperature (293.15 Kelvin) f_{r0} = Relaxation frequency of Oxygen (Hz) f_{rN} = Relaxation frequency of Nitrogen (Hz) h = Molar concentration of water vapour (%) h_r = Relative Humidity (%RH) c = exponent value T_{01} = Triple-point isotherm temperature (273.16 Kelvin)

8.3.2 Corrections

8.3.2.1 Refrigeration Condenser

Distance from source to receiver, d (m):			30.0	Atmospheric Temperature, T (Kelvin)		291
Atmospheric Pressure, p_r (KPa):			101.325	Relative Humidity, h_r (%RH)		70
Octave Band Centre Frequency (Hz)						
63	125	250	500	1000	2000	4000
0.0 dB	0.0 dB	0.0 dB	0.1 dB	0.1 dB	0.3 dB	0.7 dB
Atmospheric Absorption A_{atm} (dB)						

8.3.2.2 Sales Floor AC Units

Distance from source to receiver, d (m):			30.0	Atmospheric Temperature, T (Kelvin)		291
Atmospheric Pressure, p_r (KPa):			101.325	Relative Humidity, h_r (%RH)		70
Octave Band Centre Frequency (Hz)						
63	125	250	500	1000	2000	4000
0.0 dB	0.0 dB	0.0 dB	0.1 dB	0.1 dB	0.3 dB	0.7 dB
Atmospheric Absorption A_{atm} (dB)						

8.3.2.3 Cash Office AC Units

Distance from source to receiver, d (m):			30.0	Atmospheric Temperature, T (Kelvin)		291
Atmospheric Pressure, p_r (KPa):			101.325	Relative Humidity, h_r (%RH)		70
Octave Band Centre Frequency (Hz)						
63	125	250	500	1000	2000	4000
0.0 dB	0.0 dB	0.0 dB	0.1 dB	0.1 dB	0.3 dB	0.7 dB
Atmospheric Absorption A_{atm} (dB)						

8.4 Ground Absorption (A_{gr})

8.4.1 Formula

A correction is made for the effect of the ground between the source and receiver and is detailed in section 7.3.1 of ISO 9613-Part 2:1996.

Formula	Symbols
$A_{gr} = A_s + A_r + A_m$ At 63 Hz As, Ar = -1.5 At 125 Hz As, Ar = $-1.5 + G \cdot 1.5 + 3.e^{-1.29h-5)2} \cdot (1 - e^{-dp/50}) +$ $5.7 \cdot (1 - e^{-2.8x10-6 \cdot dp2})$ At 250 Hz As, Ar = $-1.5 + G \cdot 1.5 + 8.6 \cdot e^{-0.09h2} \cdot (1 - e^{-dp/50})$ At 500 Hz As, Ar = $-1.5 + G \cdot 1.5 + 14 \cdot e^{-0.46h2} \cdot (1 - e^{-dp/50})$ At 1000 Hz As, Ar = $-1.5 + G \cdot 1.5 + 5 \cdot e^{-0.9h2} \cdot (1 - e^{-dp/50})$ At 2000 & 4000 Hz As, Ar = $-1.5 \cdot (1 - G)$ At 63 Hz $A_M = -3q$ At 125 – 4000 Hz $A_M = -3 \cdot q \cdot (1 - G_m)$ q = 0 as $d_p < 30 (h_s + h_r)$	A_{gr} = Total Ground Absorption (dB) h_s = height of the source (m) h_r = Height of receiver (m) A_s = Ground absorption at the source upto 30.h_s m (dB) A_r = Ground absorption at the receiver upto 30 h_r m (dB) Am = Ground absorption not in A_s or A_r (dB)

8.4.2 Corrections

8.4.2.1 Refrigeration Condenser

Plan distance from source to receiver, d_p (m):			30.0	Ground Type, G (0 = hard to 1 = Soft)		0.0
Height of Source h_s (m):			5.0	Height of Receiver, h_r (m)		4.2
Octave Band Centre Frequency (Hz)						
63	125	250	500	1000	2000	4000
-3 dB	-3 dB	-3 dB	-3 dB	-3 dB	-3 dB	-3 dB
Ground Absorption A_{gr} (dB)						

8.4.2.2 Sales Floor AC Units

Plan distance from source to receiver, d_p (m):			30.0	Ground Type, G (0 = hard to 1 = Soft)		0.0
Height of Source h_s (m):			5.0	Height of Receiver, h_r (m)		4.2
Octave Band Centre Frequency (Hz)						
63	125	250	500	1000	2000	4000
-3 dB	-3 dB	-3 dB	-3 dB	-3 dB	-3 dB	-3 dB
Ground Absorption A_{gr} (dB)						

8.4.2.3 Cash Office AC Unit

Plan distance from source to receiver, d_p (m):			30.0		Ground Type, G (0 = hard to 1 = Soft)		0.0
Height of Source h_s (m):			5.0		Height of Receiver, h_r (m)		4.2
Octave Band Centre Frequency (Hz)							
63	125	250	500		1000	2000	4000
-3 dB	-3 dB	-3 dB	-3 dB		-3 dB	-3 dB	-3 dB
Ground Absorption A_{gr} (dB)							

8.5 Barrier Effect (A_{bar})

8.5.1 Formula

A correction is made for any barrier in the direct line of site between the source and the assessment position and is detailed in section 7.4 of ISO 9613-Part 2:1996. For clarity the K_{met} meteorological correction has been ignored and C_2 equals 40 and C_3 equals 1.

Formula	Symbols
$A_{bar} = 10 . Log_{10} [3 + (40 . \delta / \lambda) - A_g$ *Note1 where $\delta = a + b - r$ and $\lambda = c / f$	A_{bar} = Effective barrier attenuation (dB) A_{gr} = Total Ground Absorption (dB) *Note 1: Only apply the Agr correction if Agr > 0 δ = Path difference (m) a = Distance from source to barrier head (m) b = Distance from barrier head to assessment position (m) r = Distance from source to assessment position (m) λ = Wavelength of sound (m) c = Speed of sound – Assumed to be 342 ms^{-1} f = Octave band centre frequency (Hz)

No corrections were added.

8.6 Calculation of Specific Noise Levels - 23:00 to 07:00 (Night Time)

Octave Band Centre Frequency (Hz)	63	125	250	500	1000	2000	4000
Refrigeration Condenser	Searle - MGB124						
Sound Power Levels	60 dB	57 dB	52 dB	50 dB	44 dB	36 dB	31 dB
Source Directivity (D_c)	6 dB	6 dB	6 dB	6 dB	6 dB	6 dB	6 dB
Geometric Divergence (A_{div})	41 dB	41 dB	41 dB	41 dB	41 dB	41 dB	41 dB
Atmospheric Absorption (A_{atm})	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	1 dB
Ground Absorption (A_{gr})	-3 dB	-3 dB	-3 dB	-3 dB	-3 dB	-3 dB	-3 dB
Barrier Correction (A_{bar})	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB
Resultant Specific Noise Level	29 dB	25 dB	20 dB	18 dB	13 dB	4 dB	-1 dB
A – Weighting	-26 dB	-16 dB	-9 dB	-3 dB	0 dB	+1 dB	+1 dB
A-Weighted Specific Noise Levels	3 dB	9 dB	12 dB	15 dB	13 dB	5 dB	0 dB
	19 dB						
Sound Power Levels – dB, 5 minute L_{eq}'s with a reference level of 1×10^{-12} watts Sound Pressure Levels – dB, 5 minute L_{eq}'s with a reference level of 2×10^{-5} Nm^{-2}							

8.7 Calculation Specific Noise Levels - 07:00 to 23:00 (Day Time)

Octave Band Centre Frequency (Hz)	63	125	250	500	1000	2000	4000
Refrigeration Condenser	Searle - MGB124						
Sound Power Levels	73.9 dB	66.3 dB	61.3 dB	59.8 dB	55.6 dB	47.1 dB	42.5 dB
Source Directivity (D_c)	6 dB	6 dB	6 dB	6 dB	6 dB	6 dB	6 dB
Geometric Divergence (A_{div})	40.5 dB	40.5 dB	40.5 dB	40.5 dB	40.5 dB	40.5 dB	40.5 dB
Atmospheric Absorption (A_{atm})	0.0 dB	0.0 dB	0.0 dB	0.1 dB	0.1 dB	0.3 dB	0.7 dB
Ground Absorption (A_{gr})	-3.0 dB	-3.0 dB	-3.0 dB	-3.0 dB	-3.0 dB	-3.0 dB	-3.0 dB
Barrier Correction (A_{bar})	0.0 dB	0.0 dB	0.0 dB	0.0 dB	0.0 dB	0.0 dB	0.0 dB
Resultant Level (Condenser)	42.4 dB	34.7 dB	29.7 dB	28.2 dB	23.9 dB	15.3 dB	10.2 dB
A – Weighting	-26 dB	-16 dB	-9 dB	-3 dB	0 dB	+1 dB	+1 dB
A-Weighted Specific Noise Levels	16.2 dB	18.6 dB	21.1 dB	25.0 dB	23.9 dB	16.5 dB	11.2 dB
Specific Level (Condenser)	29.4 dB						
Sales Floor AC External Unit	Mitsubishi Heavy - FDCA 501 HESR						
Sound Power Levels	79.0 dB	75.0 dB	64.0 dB	57.0 dB	59.0 dB	57.0 dB	52.0 dB
Source Directivity (D_c)	6 dB	6 dB	6 dB	6 dB	6 dB	6 dB	6 dB
Geometric Divergence (A_{div})	40.5 dB	40.5 dB	40.5 dB	40.5 dB	40.5 dB	40.5 dB	40.5 dB
Atmospheric Absorption (A_{atm})	0.0 dB	0.0 dB	0.0 dB	0.1 dB	0.1 dB	0.3 dB	0.7 dB
Ground Absorption (A_{gr})	-3.0 dB	-3.0 dB	-3.0 dB	-3.0 dB	-3.0 dB	-3.0 dB	-3.0 dB
Barrier Correction (A_{bar})	0.0 dB	0.0 dB	0.0 dB	0.0 dB	0.0 dB	0.0 dB	0.0 dB
Resultant Level (Sales Floor AC)	47.5 dB	43.4 dB	32.4 dB	25.4 dB	27.3 dB	25.2 dB	19.7 dB
A – Weighting	-26 dB	-16 dB	-9 dB	-3 dB	0 dB	+1 dB	+1 dB
A-Weighted Specific Noise Levels	21.3 dB	27.3 dB	23.8 dB	22.2 dB	27.3 dB	26.4 dB	20.7 dB
Specific Level (Sales Floor AC)	33.4 dB						
Cash Office Unit	Mitsubishi Heavy - SRC 28 CD-5						
Sound Power Levels	75.0 dB	70.0 dB	60.0 dB	52.0 dB	52.0 dB	50.0 dB	47.0 dB
Source Directivity (D_c)	6 dB	6 dB	6 dB	6 dB	6 dB	6 dB	6 dB
Geometric Divergence (A_{div})	40.5 dB	40.5 dB	40.5 dB	40.5 dB	40.5 dB	40.5 dB	40.5 dB
Atmospheric Absorption (A_{atm})	0.0 dB	0.0 dB	0.0 dB	0.1 dB	0.1 dB	0.3 dB	0.7 dB
Ground Absorption (A_{gr})	-3.0 dB	-3.0 dB	-3.0 dB	-3.0 dB	-3.0 dB	-3.0 dB	-3.0 dB
Barrier Correction (A_{bar})	0.0 dB	0.0 dB	0.0 dB	0.0 dB	0.0 dB	0.0 dB	0.0 dB
Resultant Level (Cash Office AC)	43.5 dB	38.4 dB	28.4 dB	20.4 dB	20.3 dB	18.2 dB	14.7 dB
A – Weighting	-26 dB	-16 dB	-9 dB	-3 dB	0 dB	+1 dB	+1 dB
A-Weighted Specific Noise Levels	17.3 dB	22.3 dB	19.8 dB	17.2 dB	20.3 dB	19.4 dB	15.7 dB
Specific Level (Cash Office AC)	27.8 dB						
Combined Levels							
Resultant Specific Noise Level	49.8 dB	45.1 dB	35.3 dB	30.5 dB	29.5 dB	26.3 dB	21.3 dB
A – Weighting	-26 dB	-16 dB	-9 dB	-3 dB	0 dB	+1 dB	+1 dB
A-Weighted Specific Noise Levels	23.6 dB	29.0 dB	26.7 dB	27.3 dB	29.5 dB	27.5 dB	22.3 dB
	35.6 dB						
Sound Power Levels – dB, 5 minute L_{eq}'s with a reference level of 1×10^{-12} watts Sound Pressure Levels – dB, 5 minute L_{eq}'s with a reference level of 2×10^{-5} Nm^{-2}							

9 APPENDIX C - BACKGROUND NOISE LEVELS

9.1 Recorded Background Noise Levels

9.1.1 24/8/2010 17:00 - 25/8/2010 07:00

Time	L_{Max}	Minimum 5 minute			1 Hour			Day and Night		
		$L_{Aeq,t}$	$L_{A10,t}$	$L_{A90,t}$	$L_{Aeq,t}$	$L_{A10,t}$	$L_{A90,t}$	$L_{Aeq,t}$	$L_{A10,t}$	$L_{A90,t}$
07:00 – 08:00										
08:00 – 09:00										
09:00 – 10:00										
10:00 – 11:00										
11:00 – 12:00										
12:00 – 13:00										
13:00 – 14:00										
14:00 – 15:00										
15:00 – 16:00										
16:00 – 17:00										
17:00 – 18:00	72.8	58.5	60.1	54.7	59.3					
18:00 – 19:00	77.1	58.1	60.0	54.8	59.0					
19:00 – 20:00	73.0	55.3	58.8	50.4	56.3					
20:00 – 21:00	72.9	52.4	54.5	43.3	54.3					
21:00 – 22:00	80.1	51.6	53.9	42.7	55.9					
22:00 – 23:00	66.1	47.2	50.1	42.0	50.1					
23:00 – 00:00	69.8	45.4	48.3	41.4	49.9					
00:00 – 01:00	66.8	40.5	42.6	34.3	44.9					
01:00 – 02:00	68.1	36.7	39.8	30.5	43.5					
02:00 – 03:00	60.2	34.0	36.0	28.6	39.5					
03:00 – 04:00	55.8	35.5	37.9	28.1	38.1					
04:00 – 05:00	62.7	34.5	37.8	28.1	42.7					
05:00 – 06:00	74.7	41.5	43.2	36.3	50.9					
06:00 – 07:00	70.0	48.9	51.0	45.4	53.4					
	dB t = 1 hr	dB, t = 5 minutes			dB, t = 1 hour			dB, 07:00 – 23:00 t = 16 hours 23:00 – 07:00 t = 8 hours		
Sound Pressure Levels, dB. Reference level of 2×10^{-5} Nm^{-2}										

9.1.2 25/8/2010 07:00 – 17:00

Time	L_{Max}	Minimum 5 minute			1 Hour			Day and Night		
		$L_{Aeq,t}$	$L_{A10,t}$	$L_{A90,t}$	$L_{Aeq,t}$	$L_{A10,t}$	$L_{A90,t}$	$L_{Aeq,t}$	$L_{A10,t}$	$L_{A90,t}$
07:00 – 08:00	73.9	55.5	57.8	50.5	56.3					
08:00 – 09:00	84.1	54.6	57.8	47.8	63.3					
09:00 – 10:00	86.5	60.9	63.4	56.3	70.3					
10:00 – 11:00	82.2	58.3	61.2	52.9	67.2					
11:00 – 12:00	87.1	56.9	59.7	52.0	71.2					
12:00 – 13:00	87.0	57.2	60.4	53.1	63.8					
13:00 – 14:00	93.0	60.8	63.2	56.8	66.1					
14:00 – 15:00	85.0	60.1	62.2	57.2	64.2					
15:00 – 16:00	79.8	59.8	61.0	57.5	62.5					
16:00 – 17:00	73.9	55.5	57.8	50.5	56.3					
17:00 – 18:00										
18:00 – 19:00										
19:00 – 20:00										
20:00 – 21:00										
21:00 – 22:00										
22:00 – 23:00										
23:00 – 00:00										
00:00 – 01:00										
01:00 – 02:00										
02:00 – 03:00										
03:00 – 04:00										
04:00 – 05:00										
05:00 – 06:00										
06:00 – 07:00										
	dB t = 1 hr	dB, t = 5 minutes			dB, t = 1 hour			dB, 07:00 – 23:00 t = 16 hours 23:00 – 07:00 t = 8 hours		
Sound Pressure Levels, dB. Reference level of 2×10^{-5} Nm^{-2}										

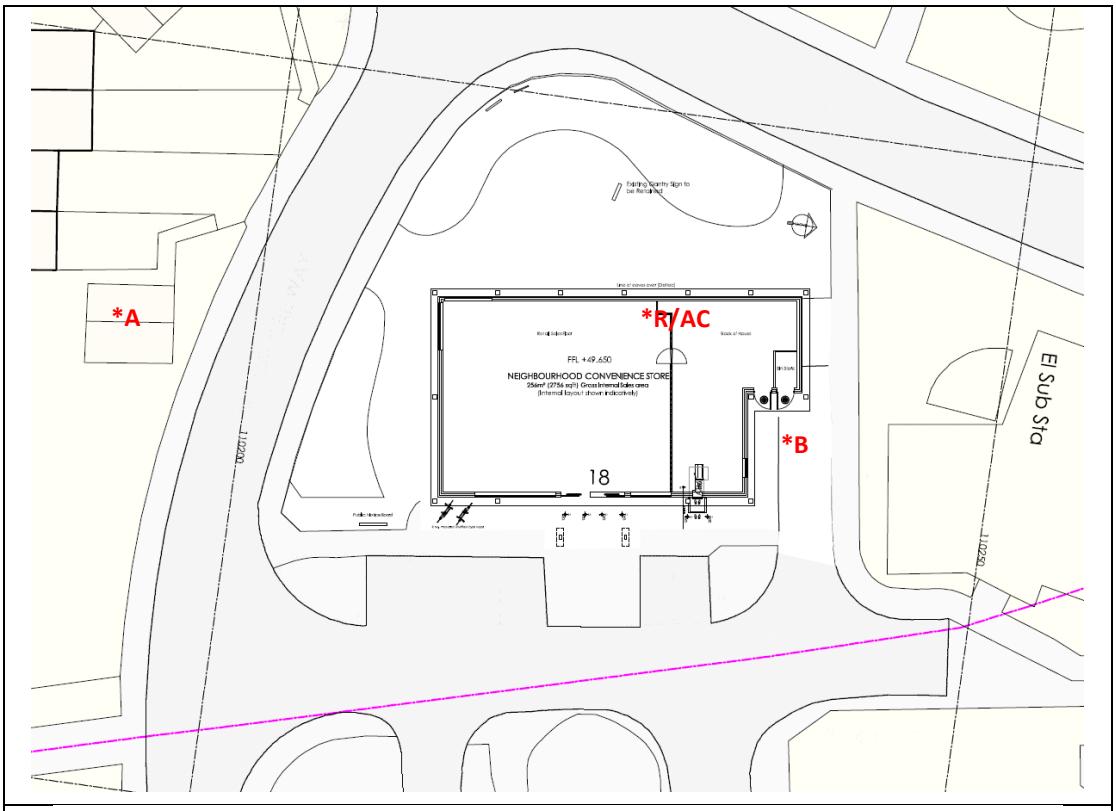
9.1.3 Minimum Levels Table

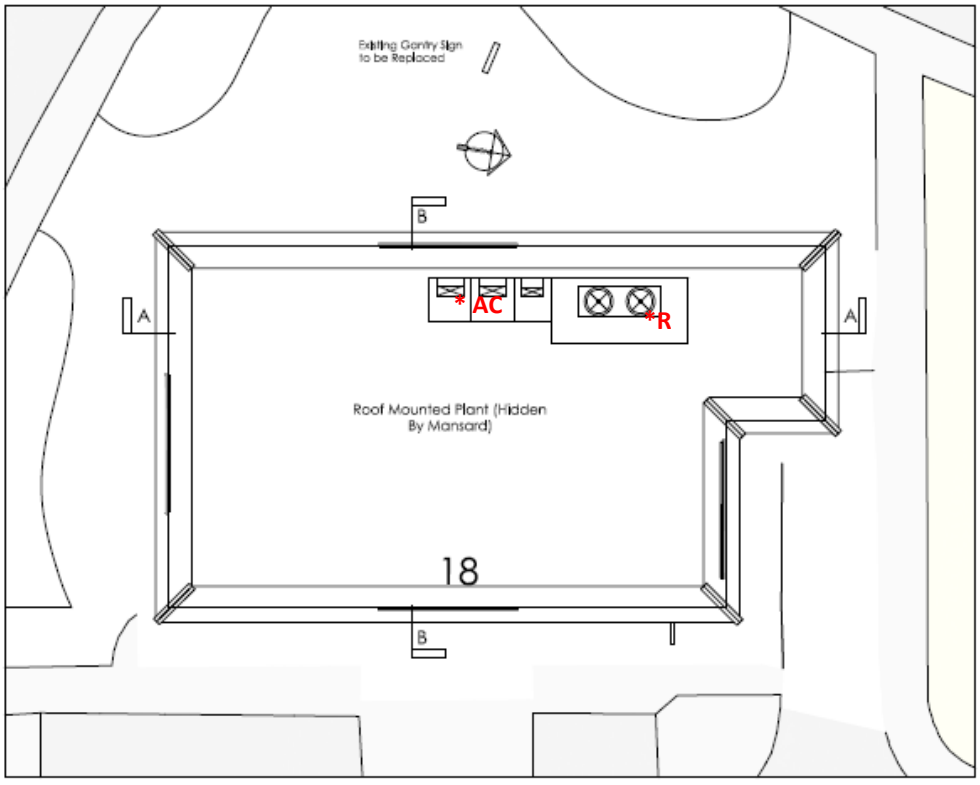
Time	L_{Max}	Minimum 5 minute			Minimum 1 hour			Minimum Day and Night		
		$L_{Aeq,t}$	$L_{A10,t}$	$L_{A90,t}$	$L_{Aeq,t}$	$L_{A10,t}$	$L_{A90,t}$	$L_{Aeq,t}$	$L_{A10,t}$	$L_{A90,t}$
07:00 – 23:00	82.9	64.9	68.6	52.5	66.9	70.8	**55.4**	70.6	73.6	60.5
23:00 – 07:00	81.2	53.4	57.9	**36.7**	62.0	63.5	38.7	65.8	68.4	44.5
	dB t = 1 hr	dB, t = 5 minutes			dB, t = 1 hour			dB, 07:00 – 23:00 t = 16 hours 23:00 – 07:00 t = 8 hours		
Sound Pressure Levels, dB. Reference level of 2×10^{-5} Nm^{-2}										

10 APPENDIX D – BS4142:19897 REQUIRED INFORMATION SUMMARY

Section 10 BS 4142	Item	Description		
a)	Source Under Investigation			
1)	Source – Refrigeration	Searle - MGB124		
	Source – Sales Floor Air Conditioning	SalesMan2 - SalesModel2		
	Source – Cash Office Air Conditioning	Mitsubishi Heavy - SRC 28 CD-5		
2)	Hours of Operation – Refrigeration	24 Hours per Day		
	Hours of Operation – Sales Floor AC	07:00 to 23:00 hours		
	Hours of Operation – Cash Office AC	07:00 to 23:00 hours		
3)	Mode of Operation – Refrigeration	Operates Continuously		
	Mode of Operation – Sales Floor AC	Operates Continuously		
4)	Mode of Operation – Cash Office AC	Operates Continuously		
	Location - Refrigeration	within a dedicated plant area on the roof of the store		
	Location – Sales Floor AC	within a dedicated plant area on the roof of the store		
	Location – Cash Office AC	within a dedicated plant area on the roof of the store		
b)	Dominance / Audibility – Refrigeration	The units will be inaudible		
	Dominance / Audibility – Sales Floor AC	The units will be inaudible		
	Dominance / Audibility – Cash Office (at the assessment position)	The units will be inaudible		
c)	Assessment Position	1m from the residential facade of the property within Damask Gardens		
	Background Noise Levels	The background noise levels were recorded at Grassmere Way to the rear of the store		
d)	Equipment	Sound Level Meter	Microphone	Calibrator
1)	Type	2250	4189	4231
2)	Manufacturer	Bruel & Kjaer	Bruel & Kjaer	Bruel & Kjaer
3)	Serial Number	2479672	2470299	2470299
4)	Calibration Date	12 October 2011	12 October 2011	12 October 2011
e)	Operational Tests			
1)	Calibrator	The associated calibrator was used.		
2)	Before Tests / After Tests	94.1dB / 94.1dB		
f)	Weather Conditions			
1)	Wind Speed and Direction	4ms-1, wind from the South West		
2)	Temperature Inversion Conditions	14°C (Temperature inversion not present)		
3)	Precipitation	Low Clouds and Rain		
4)	Fog	No Fog		
g)	Date and Time of Measurement	16:32 on 24th August 2010 to 16:58 on 25th August 2010		
i)	Measurement Time Intervals	Continuous Measurement Recorded as 5 minutes readings.		
j)	Reference Time Interval	23:00 to 07:00: 5 minutes 07:00 to 23:00: 1 hour.		
k)	Resultants Level (All Sources)	See Calculation		
l)	Background Noise Levels	See Section 4		
m)	Excess of Background	See Calculations		

11 APPENDIX E - LOCATION PLAN / SITE LAYOUT





*R	Location of Refrigeration Units
*AC	Location of Air Conditioning Units
*A	Assessment Position
*B	Background Noise Measurements

12 REFERENCES

12.1 Reference 1 - Planning and Policy Guidance 24

Planning and Noise.

12.1.1 Summary

"PPG 24 guides local authorities in England on the use of their planning powers to minimise the adverse impact of noise. It outlines the considerations to be taken into account in determining planning applications both for noise sensitive developments and for those activities which generate noise."

12.2 Reference 2 - British Standard 4142:1997

Method for Rating industrial noise affecting mixed residential and industrial areas.

12.2.1 Scope

"This British Standard described methods for determining at the outside of a building:

a) Noise levels from factories or industrial premises, or fixed installation, or sources of an industrial nature in commercial premises; and

b) Background noise levels

The standard also describes a method for assessing whether noise referred to in a) is likely to give rise to complaints from people residing within the building."

12.3 Reference 3 – International Standard 9613 – Part 2 :1996

Acoustics – Attenuation of sound during propagation outdoors

Part 2 – General Method of calculation

12.3.1 Scope

"This part of ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-Weighted sound pressure level under meteorological conditions favourable to propagation from sources of known sound emission."

12.4 Reference 4 – International Standard 9613 – Part 1: 1993

Acoustics – Attenuation of sound during propagation outdoors

Part 1 – Calculation of the absorption of sound by the atmosphere

12.4.1 Scope

"This part of ISO 9613 specifies an analytical method for calculating the attenuation of sound as a result of atmospheric absorption for a variety of meteorological conditions when the sound from any source propagates through the atmosphere outdoors."

12.5 Reference 5 – British Standard 7445 – Part 2:1991

Description and measurement of environmental noise

Part 2 – Guide to the acquisition of data pertinent to land use.

12.5.1 Scope

"This part of ISO 1996 (BS 7445) describes the methods to be used for measuring and describing environmental noise relevant to general land use."