Validity of acoustic test data & design risks associated with manufacturers test data

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ABSTRACT
The proliferation of highly conditioned or incomplete test data within manufacturer and supplier technical data sets creates substantial risk for all members of the acoustic community. This paper examines some of areas of concern to assist with mitigating the risks to acoustic professionals.

1. INTRODUCTION
Working in the acoustics field we are regularly provided with data upon which we must place our professional reputation. The use of such data can at times make or break the acoustic criteria from the perspective of overall project acceptance. Engineers working in noise control are regularly faced with issues associated with the misapplication of acoustic data by other non-acoustic professionals, mechanical contractors and construction companies.

Many of these issues stem from the method in which the acoustic data is presented or calculated by organisations.

2. ACOUSTIC TESTING STANDARDS
With the globalization that has occurred in since the 1990's there have been marked increases in the availability of products for purchase from international vendors. With the importation of products there are many situations where the test data available is tested in accordance with the relevant local standards from the country of manufacture rather than the relevant Australia Standard.

In such instances it is essential that either the products used are testing locally in accordance with the relevant Australian Standards or the subtle implications associated with the international standards are fully understood.

3. PRODUCT DEVELOPMENT IMPLICATIONS
In many instances there are reasons for product manufacture processes to be changed which may or may not incur changes to the products acoustic performance.

An example of this is the changes required after the amendment of the Building Code of Australia requiring increased thermal insulation for building elements. This has led to the manufacturers of products such as glass wool to adjust both the product compilation and thicknesses. Combining this with the relevant cost pressures felt by all organizations, there are many more differences in the products currently sold under the same model name as was the case years ago.

In most instances the relevant acoustic data for the raw material manufacturer has been updated to reflect the changes in product manufacture, however, it is not unusual for the downstream suppliers of products that use these "raw materials" to assume the product they tested acoustically many years ago would still be valid.

Tables 1 & 2 show examples of the acoustic absorption data for similar products tested in accordance with similar standards and published by the same manufacturer, a number of years apart.

Tables 3 and 4 show similar effects with nominally equivalent product data reported by another manufacturer, again, a number of years apart.

Table 1: Absorption Co-efficient Comparison 50mm thick Absorber – Manufacturer A

Product	125	250	500	1000	2000	4000	Hz
Semi Rigid Glass Wool – Unfaced AS 1045 (Data published in 1996)	0.27	0.75	1.12	1.12	1.07	1.04	
Semi Rigid Glass Wool – Unfaced AS/ISO 354 – 2006 (Data published in 2015)	0.20	0.6	1.00	1.00	1.00	1.00	

Table 2: Absorption Co-efficient Comparison 75mm thick Absorber – Manufacturer A

Product	125	250	500	1000	2000	4000	Hz
Semi Rigid Glass Wool – Unfaced AS 1045 (Data published in 1994)	0.52	0.95	1.24	1.13	1.06	1.09	
Semi Rigid Glass Wool – Unfaced AS/ISO 354 – 2006 (Data published in 2015)	0.35	1.00	1.00	1.00	1.00	1.00	

Table 3: Absorption Co-efficient Comparison 50mm thick Absorber – Manufacturer B

Product	125	250	500	1000	2000	4000	Hz
Semi Rigid Glass Wool – Unfaced AS 1045 (Data published in 2004)	0.26	0.64	1.04	1.12	1.09	0.95	
Semi Rigid Glass Wool – Unfaced AS ISO 354 – 2006 (Data published in 2012 & 2015)	0.19	0.68	1.09	1.16	1.02	1.00	

Table 4: Absorption Co-efficient Comparison 75mm thick Absorber – Manufacturer B

Product	125	250	500	1000	2000	4000	Hz
Semi Rigid Glass Wool – Unfaced AS 1045 (Data published in 2004)	0.60	1.13	1.22	1.08	1.09	-	
Semi Rigid Glass Wool – Unfaced AS ISO 354 – 2006 (Data published in 2012 & 2015)	0.29	1.08	1.23	1.06	0.99	-	

A major adjustment in the nominal “absorption” occurs where the absorption coefficient is limited to 1.00, in situations, where previous data, reported coefficients greater than 1.00.

Aside from such amendments in data presentation, the areas with substantial difference are in the 125Hz and 250Hz octave bands. Typically in building related noise control for mechanical ventilation plant or similar equipment, the lower frequencies drive the required noise control solution. Hence a 50% reduction in sound absorption at 125Hz will have effects for the selection of the noise control solution.

It is quite feasible that equipment specified to provide noise control for a mechanical ventilation system may fall short in lower frequency performance, simply due to the test data from the equipment supplier not being updated in line with the changes in the raw material. This can be seen in equipment such as duct silencers and acoustic louvers, where the performance of the acoustical absorber is critical to overall performance.

4. SECONDARY MANUFACTURER DATA

In many instances, manufacturers of fans or pump assemblies use the data provided by the impellor manufacturers as the basis for published product noise levels. A typical example is a company using a third party backward curved motor-rotor impellor as part of a in-house designed and manufactured roof mounted exhaust fan. The fan cowl, housing and support system all have effects for overall fan noise levels, however the published fan data sheets, quite often use motor-rotor noise data in unmodified form. This is further complicated by changes in directivity due to the cowl design. In consequence, it is not unusual for identical "test data" to be provided, for a vertical exhaust fan with a plastic cowl, for a downward discharge exhaust fan with a plastic cowl and for a vertical exhaust fan with metal cowl (see Figure 1).

Figure 1: Various Fan Types

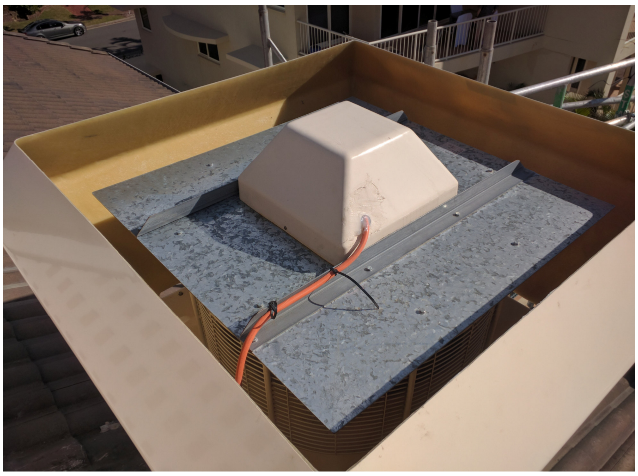

Figure 2: Roof Mounted Backward Curved Exhaust Fan

Figure 2 shows the mounting plate for a roof mounted backward curved fan. The shape and dimensions of the of the galvabond cover plate are designed to reduce the ingress of water when the fan is not operating. However, the reduced clearances and areas of increased velocity created by the plate have significant effects on the fan sound produced, modifying both its frequency content and the overall level emitted.

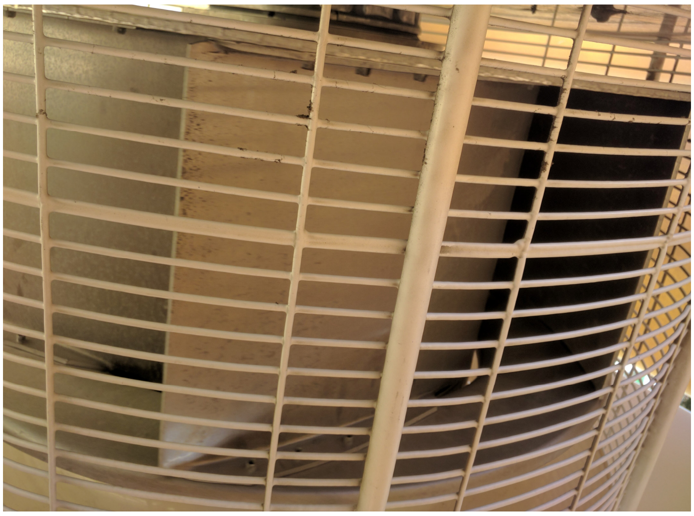

Figure 3: Roof Mounted Exhaust Fan

Figure 3 shows the mesh guarding of a fan. The guarding provides a mechanical obstruction to minimize risk of injury as well as reducing the ingress of birds and vermin when the fan is not operating. The location of the guarding, location of the vertical support ties and the location of the fan blades relative to the guarding all have effects on the overall noise level produced by the fan – not uncommonly increasing the emission.

While in many instances, increased noise levels may not be an issue, there are applications (such as the toilet and kitchen exhaust systems, associated with residential towers) where such increases will generate noise complaints. Thus, where noise levels are likely to be critical, it is very important to determine whether the noise data provided is for the entire "unit" or simply the rotating components contained within it.

5. SELECTIVE NOISE DATA

In some sections of industry, it is common practice to provide acoustic data for equipment in a selective manner. If the designer is not familiar with the assumptions forming the basis of the acoustic data, then the outcome of calculations using that data, can be quite "incorrect", with the designer getting it "wrong" and the equipment being "out of spec", as much noisier than expected.

5.1 Diesel & Gas Generators

Diesel & gas generator sets, ("gen sets") are prime example of selective acoustic data being provided. With much of the acoustic data provided by the manufacturers in standard "generator data sheets" the generator noise levels are reported as a single overall Sound Pressure Level (SPL) at a given distance. Typically this distance, is 7 m and the level presented, is a simple arithmetic average of noise measurements obtained at 6, 8 or 10 positions around the perimeter of the generator, at a height of 1 m above ground level.

In many situations, noise sensitive receivers, "the residents", will be located above the generator, with the generator housed in an OEM supplied enclosure. In many such cases, the radiator discharge air will exit the enclosure vertically. Due to the method used to obtain the average noise levels for the generator, noise levels at 1 m above ground level will be much less than the noise levels directly above the generator exhaust.

This can cause issues in locations such as regional hospitals where a stand-by generator is often located at ground level and adjacent to low-rise buildings with relatively low performing building fabric.

Additionally generator technical data will nearly always, have a notation confirming the noise levels are based upon "infinite exhaust" (see Figure 4) which means the data presented does not include any exhaust noise at all. This is done, because the exhaust will be provided with a muffler and muffler arrangements can be wide and varied, with very substantial variation in resultant noise level. Quite often the engine manufacturer does not supply the mufflers. Thus, any attempt to estimate the performance of the system with a muffler fitted would substantially complicate requirements for engine technical data published by the manufacturer.

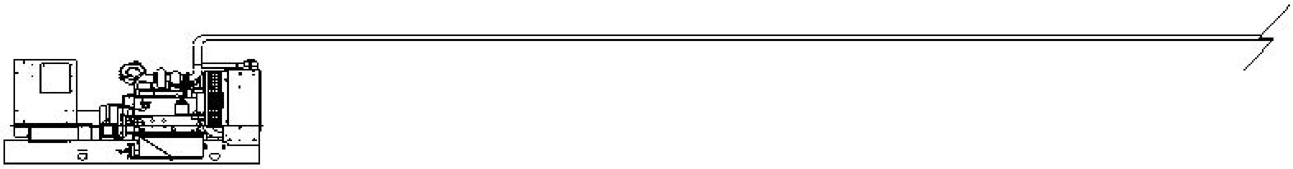

Figure 4: Infinite Exhaust

The noise data given in Tables 5 to 7 below, is for a small (30kW) gas engine. The data is based upon full load operation. As the tables show, the exhaust noise component is substantial and if not attenuated will dominate the overall emission. Hence, the location of the muffler and exhaust pipework, as well as the discharge location of the exhaust are critical to the overall system performance.

Table 5: Generator A-weighted Sound Pressure Level Data, L_p dB(A)

Standard Engine Unhoused, Infinite Exhaust	1	2	3	4	5	6	7	8	8 position arithmetic average
	70.7	70.3	73	72.7	72.1	72.8	72.6	74.2	72.7

Table 6: Generator A-weighted Sound Power Level, L_w dB(A)

Standard Engine Unhoused, Infinite Exhaust	63	125	250	500	1000	2000	4000	8000	Overall Sound Power Level
	64	78	89	92	95	93	90	90	100

* Sound data for generator set with infinite exhaust does not include exhaust noise.

Table 7: Generator Exhaust A-weighted Sound Pressure Levels, L_p @ 1 meter dB(A)

Open Exhaust (No Muffler) @ Rated Load	63	125	250	500	1000	2000	4000	8000	Overall Sound Pressure Level
	82	97	100	104	101	101	102	98	109

Typical data is also based upon a standard radiator package: in many instances, there is a requirement (or request) for oversized radiators to be supplied, to ensure that the equipment can be operated at higher ambient temperatures or for extended time periods at higher loads. Larger radiator packages invariably have larger radiator fans, which in turn provide increased noise levels as the radiator fan is usually a significant contributor to the overall emission from the unit. Indeed, it is not unusual for the radiator fan to provide the largest component of the (muffled) generator emission.

It should be noted that for a similar power output, a diesel engine would usually be substantially louder than the equivalent, natural gas engine.

5.2 Fans

Typically fan test data is provided using one of two methods: Method 1, involves the data being presented as a table of free field, Octave Band Sound Power Levels, with a single overall Sound Pressure figure at a nominated distance, such as, 3 m. Method 2, involves the data being presented as a table of “In-Duct Sound Power Levels” without an overall Sound Pressure level. A typical free field, fan, octave band sound power spectrum is given in Table 8.

Table 8: Typical Fan, Sound Power Spectrum L_w

63	125	250	500	1000	2000	4000	8000	Hz
87	84	82	75	73	71	65	61	dB

The fan will then be listed with an overall Sound Pressure Level, L_p of 58 dB(A) @ 3m. This figure is derived from the inverse square law where:

$$L_p = L_w - 20\log R - K \tag{1}$$

The overall Sound Pressure Level of 58dB(A) @3m is only achieved if K equals 11. This equates to spherical propagation, which for a fan, in most instances, is unrealistic. While in many cases, acousticians will undertake calculations from the octave band sound power spectra, it is important to understand that conclusions drawn from a cursory glance at the overall sound pressure can be problematic.

6. PERCENTAGE OPEN AREA CALCULATIONS

With the proliferation of naturally ventilated buildings there has been an increase in requests from mechanical consultants for openings in buildings to allow air entry where the openings are detailed as a percentage open area. In many instances this is due to the limitations on some of the modeling software used to determine how the buildings will operate under different ambient conditions.

Many acoustic products and especially acoustical louvres are susceptible to design issues when their selection is based upon percentage open area. It is not unusual for an acoustic louver to have open areas in the order of 15-25% while many mechanical consultants specify louvers with 50% open area.

The design of modern acoustic louvers is such that the lower percentage areas do not impact on the pressure drop through the louvres. Hence if the louvres are sized based upon an open area typically the louvres sizing is much too large. In such circumstances the area of the louvres is such that increased performance many well be specified unnecessarily simply due to the area of louvre.

Where a louvre open area is specified the correct approach is to determine from the louvre manufacturer the correct louvre size based upon the required airflow and the maximum pressure drop, not the open area.

7. CONCLUSIONS

While much of the acoustic test data available, may well have been valid at the time of publication, changes in product construction or manufacture tends to erode validity over time. It is important that the data used in our assessments are recent and incorporate any changes that naturally and regularly occur in industry. As professionals and as members of the acoustical community it is important that we not only try and minimize the proliferation of vague or technically incomplete data, but also, where possible, educate those who rely on our judgment, to better understand the risks associated with acoustical decisions made on the basis of such data.

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