Nuaire Testing Standards and Application Guidance Notes

Scope

It is necessary to ensure that designers of systems that use Nuaire products understand how the published performance data for products is derived.

It is also necessary for designers and other professionals that install and maintain those systems and products to understand the limiting factors that ensure their safe operation and to make appropriate provision for them.

This document is intended to provide a reference for the above information and defines generic, and where appropriate, product range or product code specific operating condition limits that apply to Nuaire products.

Some of the operational limits described may be considered to be simply "good practice" or "common sense", but as products become progressively more technically advanced, some features of operation may not be familiar to all parties, and assumptions should not be made.

It should be noted that this document is subject to continuous revision, and the most up-to date version will be that available on the company website (www.nuaire.co.uk/terms-and-conditions). Once downloaded or otherwise transferred, the document is no longer controlled and there is no provision for remote updating.

This document is not directed at the end user of the product, but it is available to them.

Nuaire produces products for various market sectors, and the information presented here refers to product types in the first market sector only (Building Services Products).

The (broad) market sectors are:

1. Building Services Products – i.e. those products that provide ventilation for the people in the building. The industry makes a notional distinction between the Residential and Non-Residential sectors, and this is mirrored in construction and product legislation.
2. “OEM" products - referring primarily to products designed to be integrated in other equipment.
3. "Process / Industrial" products, designed to provide air movement related to production processes and machinery.

Products in sectors (2) and (3) shall be supplied to conform to detailed specifications relating to the application and subject to additional technical guidance in Nuaire document ref: 671798 (Axus Short Cased Axial Flow Fans Installation and Maintenance).

In all cases, the relevant project and location specific operating conditions shall always take precedence over the general conditions described herein.

Operational Limits

Local Environment - Temperature

Ambient temperature (the temperature at the unit’s installed location) shall be within the range: -16 to + 40°C Air temperature (the temperature of the air passing through the unit) shall be within the range: -16 to + 40°C.

Local Environment- Humidity

Ambient humidity (the humidity at the unit’s installed location) shall be within the range: 10 to 95% (for controls, non- condensing).

Air humidity (the humidity of the air passing through the unit) shall be within the range: 10 to 95% (for controls, non-condensing).

Temperature and humidity levels within the product, and around the surfaces of the product may result in heat losses / gains, and may lead to the periodic formation of condensate on unit surfaces.

All units shall be capable of operating at the stated conditions, but the designer shall take the effects of the conditions shall be taken into consideration in the system design.

Heating / Cooling

Applicable ranges of units may incorporate water based heating coils designated LPHW (Low Pressure Heated Water) or LTHW (Low Temperature Heated Water).

In Nuaire products this designation refers to a maximum allowable media temperature of 90°C. Other specifications may be available (e.g. HTHW or Steam).

For water based cooling coils, the minimum media temperature is 4°C.

If fluid additives are used (e.g. anti-freeze, anti-corrosion), the designer shall ensure that these are compatible with the coil / valve / fitting materials used in the product.

Maximum operating pressure is 6 Bar.

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All "DX" coils shall include fluid type and operating pressure in their specification.

Certain Nuaire products may include a degree of protection from low (freezing) temperatures in their control strategy. The designer shall ensure that such control strategy is suitable for the application.

Where units are supplied without controls, the control designer / supplier shall ensure that a suitable protection strategy exists.

Weathering

Where units are described as "Weatherproof" or similar, this statement refers to their ability to function external to the building, when correctly installed, without further protection being required. The conditions anticipated are those applicable to the UK mainland, in suburban areas, less than 100m above sea level. Specific advice should be sought for installation locations outside these parameters.

Partial Installation

It is a requirement of the warranty that once a unit has been removed from its protective packaging it will be immediately installed in accordance with the instructions supplied. Where an installation is partially completed, the installer shall make provision to protect and secure the unit in all respects.

Electrical Installation

Electrical connection of the product to the mains supply shall be carried out by a suitably qualified operative. Compliance with the installation regulations in force shall take precedence over any product installation instruction, and where a conflict exists or is suspected, advice shall be sought.

Electrical Supply

The electrical supply connected to the unit must conform to the levels and stated tolerances for mains voltage and frequency in the country of installation.

Supply defects may result in failure or abnormal operation of the equipment.

Cabling

Cabling used for electrical supply and control purposes shall be capable of carrying the rated current of the equipment at the voltage levels required. Cabling shall not place any undue mechanical stress on the equipment, and where run within the unit, shall not operate at more than 5°C above ambient temperature. Appropriate levels of mechanical cable protection shall be used.

A degree of mechanical vibration may be expected at the unit surface (<G6.3), and this may affect cable selection.

In some cases, a cable specification requirement may be indicated in the product data, and this shall be observed unless an alternative is approved.

Earthing and Earth bonding

Earthing and earth bonding of equipment may be required for safety purposes, refer to installation manual. Where a product is supplied in sectional format, it is a general requirement that the sections shall be equipotentially bonded to maintain a common electrical ground reference.

Control Connections

All control connections to and from the unit shall be segregated from the supply connections and shall be routed in separate containment.

Appropriate levels of shielding or other means of protection shall be used. Note that certain elements of unit controls may generate electrical interference (notably VSDs) and control circuits should be designed to accept this.

EMC

All Nuaire equipment is supplied with the appropriate level of EMC protection (Electro Magnetic Compatibility) for its intended environment. This does not imply "total" immunity or "zero" emissions, and the regulatory limits complied with (as stated in I&M documents) shall be properly observed.

Control interface

A wide variety of control strategies may be specified for air movement equipment of types available within the Nuaire range.

Nuaire's own controls are well documented in terms of operation and means of interface with wider control systems, but it is not possible to describe all of the control systems that could be potentially applied to the equipment.

Key areas that must be addressed in any applicable control strategy are: Starting / Stopping

The control system shall be engineered to prevent more than 10 stop / start operations in any 1 hour period.

Where it is not possible to arrange this under automatic control, the minimum acceptable provision is to make this limiting factor clear in the Operation Manual for the building services system.

Important: The final designed control system shall not allow any component to work outside of its intended operating parameters; particular care should be taken to ensure motors do not exceed their rated speed limits.

Control Interlocks

Provision shall be made to prevent operation of the fans without the associated airflow dampers being opened.

Note: dampers may not be part of the equipment supplied and may be physically remote from the unit.

Provision shall be made to prevent the operation of heating and cooling systems without proven availability of airflow.

Note: frost protection strategies may temporarily override this interlock.

Note: This is particularly relevant to Electrical Resistance based heating systems, where failure to observe this provision may result in catastrophic component failure and safety hazard.

Provision shall be made to avoid backflow of air through systems with a heating function.

Explanatory note: where water flow to heater coils is not halted when fans are switched off, it is possible for low rates of airflow, driven by other systems or natural buoyancy, to pick up heat from the coil and flow in reverse through the unit at approximately the temperature of the circulating media. Over time this can cause degradation of seals and plastics within the product.

Provision shall be made to ensure that heating and cooling systems cannot operate at the same time on a common system or zone.

Provision shall be made to prevent heating or cooling systems operating when an associated heat recovery system is in “bypass” mode.

General Issues

Use within or combined with other systems

In complex buildings, ventilation equipment may be operationally combined with other equipment to create a system (a simple example would be where an axial fan is used to provide or boost a fresh air supply system to set of air handling units.)

This is perfectly acceptable – as long as all of the potential operating conditions are considered, and the various resulting duty points assessed for suitability for all the units involved.

Fan “Stall”

One of the potential consequences of the previous point is that a fan may be forced into a “stall” condition. This is defined as an operating condition where the airflow randomly or (worse) periodically detaches from the fan blade surfaces.

This is commonly associated with axial flow fans, but a similar condition may occur with centrifugal and mixed flow fans, and is one of the reasons that fan performance curves are sometimes truncated.

The least consequence of this effect is an increase in noise and a relatively large decrease in performance. The worst consequence is a premature failure of the fan impeller.

The problem is best avoided by selecting fans with at least 10% operating pressure in hand.

System operating points should be verified by commissioning, but the designer should be aware of how the system characteristics can change over time (operation of dampers and control grilles, and filter contamination).

Guarding

Nuaire fans are either supplied with appropriate levels of guarding or are accompanied by a Declaration of Incorporation - a statement of the system design features required to safely integrate the product into the system.

Fans have a specific Type C standard relating to guarding:- BS EN ISO 12499:2008, BS 848-5:1999 Industrial fans. Mechanical safety of fans: Guarding.

Guards that are fitted to the product should not be removed unless alternative provision is made.

Unit Modifications /Drilling of Cases, etc.

Physical modification of any kind without published instruction or prior engineering approval may compromise unit operation and safety and will automatically invalidate warranty.

Mechanical Loading

Units are not designed to support the weight of any other structure or equipment, and should not be subject to mechanical loading or vibration levels beyond that associated with their application.

This condition includes the support of ducting, attenuators and other connected ancillary items unless specifically provided for.

Note: connection points may be provided, but this does not imply the provision for mechanical support.

Running hours

The typical service life for products driven by conventional AC motors is around 40000 hours. This is referred to as the L10 life expectancy, and approximates a time (based on motor bearing life) within which 10% of the products supplied may have failed.

Care and Handling of Equipment Prior to Installation

Equipment delivered to site shall be stored in dry, thermally stable conditions and shall be protected from excessive ingress of dust and other contaminants.

Units are only suitable for stacking where stated, and it is recommended that the original packaging and transit pallets are retained for protection and to ensure safe handling.

Specific instructions exist for the protection of products to be placed into long term storage (mothballing).

Personal Protective Equipment (PPE)

This section is intended to be used as guidance only and is not a substitute for a site based Risk Assessment which should be conducted by a competent person.

The PPE noted here is the bare minimum required when interacting with installed Nuaire product and does not take into account any additional PPE requirements related to site specific hazards.

For the avoidance of doubt PPE requirements for lifting, handling and other installation based activities (including any involving working at height) are not in the scope of this guidance. Nuaire would always recommend a site specific risk assessment is completed by a competent person to determine if any additional PPE is required.

Like all products, when interacting with installed Nuaire products, care should be taken to avoid injury. There are a number of foreseeable residual risks which can be minimized by the correct use of appropriate Protective Personal Equipment (PPE). Nuaire would advise anyone interacting with a finished installed Nuaire product to ensure they are wearing the following items as a bare minimum for the operations described below:

Protective steel toed shoes when handling heavy objects such as replacement spare parts or removable panels.

Full finger gloves (Marigold PU800 or equivalent) should be used when handling sheet metal components. The gloves should meet the following minimum requirements in accordance with EN 388: Abrasion Level 4; Cut Level 3; Tear Level 4; Protection Level 2

Semi fingerless gloves (Marigold PU3000 3DO or equivalent) should be used when conducting light work on the unit requiring tactile dexterity (exchanging filters, fitting spares or programming internal controllers). The gloves should meet the following minimum requirements in accordance with EN 388: Abrasion Level 4; Cut Level 3; Tear Level 3; Protection Level 2.

Safety glasses should be worn when conducting any cleaning operation or exchanging filters. Care should be taken when removing filters, especially if they are overhead, as debris may fall from them; wearing safety glasses will prevent dust entering the eyes.

Reusable half mask respirators should be worn when replacing filters which have been in contact with normal room or environmental air. If the unit is in a highly polluted area or has been exposed to substances or contaminants outside of normal day-to-day use (Hazardous chemicals, viruses, bacteria etc.) then additional PPE may be required and should be determined through appropriate risk assessment by a competent person who can account for all of the site based risks specific to that unit.

If you have any further questions regarding appropriate PPE for tasks not listed above or any of the above information is unclear then please contact our aftersales team on 02920 858 400 or technicalsupport@nuaire.co.uk for more information.

Product Testing

Nuaire product data is primarily based on tests conducted to widely accepted standards: - Performance testing BS EN ISO 5801:2017, Fans. Performance testing using standardized airways.

The product data sheets show the performance curve with the appropriate installation type symbol: A (tested without ducting), B (tested with ducted outlet), C (tested with ducted inlet), D (tested with ducted inlet and outlet).

It is important to realise that the performance of a fan may be strongly influenced by the attachment or omission of ducting (this comment relates to the entry and exit conditions of the airflow, and not to the ductwork resistance). It is therefore important to include this effect in system designs. If the data is not available for the installation type required, it is generally the case that Type A and C results are similar, and Type B and D results are similar.

Acoustic Testing

AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans - and / or BS ISO 13347-2:2004 + A1:2010, BS 848-2.2:2004: Industrial fans. Determination of fan sound power levels under standardized laboratory conditions - Reverberant room method.

The text “BS848 Part 2.2 and AMCA 300” appears on the data sheets. Sound Power levels are correctly referenced to 1pW and identified as “Induct Inlet, Open outlet” etc.

dBA values @ 3m are shown, and are stated as hemispherical or spherical, and are based on sound pressure levels referenced to 20 Pa.

Nuaire elected to operate under the AMCA standard 300 (last update 2014) several years ago. This standard is substantially similar to BS ISO 13347-2:2004 + A1:2010.

The main point of note is that the standard allows the measurement of In-duct sound power levels by using a duct section that terminates in the reverberant chamber – thereby providing the correct fan operating conditions and a consistent acoustic transition to the measurement zone.

The correction for the "end reflection" of the duct termination is calculated by a detailed method defined in the standard. Wherever Nuaire quote "Induct" Sound Power levels, the values include any corrections for end reflection.

AMCA 300 does not specify a requirement for the presentation of test data. It is sufficient to describe the data given as "Induct / Open inlet" etc. as we do. The former implying that the corrections had been made.

Type A & D test laboratories are independently approved by AMCA for performance and sound measurement.

Test Method Uncertainty Analysis

The uncertainties analysis is described in Appendix C.

The first uncertainty is reverberant room response, the room has been qualified in 1/3rd octaves in accordance with appendix A, the standard deviation is quoted as less than 1.5dB.

The next uncertainty discusses the problem associated with fan operating points and the effect on noise generation.

No measure of standard deviation or tolerance is quoted in this section.

Instrument error is accounted for in section C.5, see the table below:

Tolerance for Instrument System Frequency

Frequency (Hz)	125	250	500	1000	2000	4000	8000
Tolerance (db)	+/- 1	+/- 1	+/- 1	+/- 1	+/- 1	+/- 1	+/- 1.5

The Reference Sound Source has been calibrated in accordance with the standard, the accuracy of the calibration is quoted in section C.6.

RSS Calibration Accuracy

Frequency (Hz)	125	250	500	1000	2000	4000	8000
Tolerance (db)	+/- 1	+/-0.5	+/- 0.5	+/- 0.5	+/- 0.5	+/- 0.5	+/- 1

Section C.7 states the cumulative effects of all causes of measurement uncertainty mentioned above except for duct end reflection corrections and the testing of products containing pure tones in an unqualified room are given in the table below.

Estimated Deviation of Sound Power Level Determination

Frequency (Hz)	125	250	500	1000	2000	4000	8000
Standard Deviation (db)	3	2	1.5	1.5	1.5	1.5	3

The uncertainties in the end reflection correction are based on the following:

(ii) a) r - the ratio of duct diameter to orifice diameter, for tests carried out at NAL this is 1.
(see page 26 Figure E1 - no orifice is used)

(iii) b) The duct configuration, for tests carried out at NAL the duct is in free space (ie Protruding)
c) A function of wave number (k) and diameter (D)

To calculate the uncertainty in end reflection, the wave number is calculated for each frequency and with reference to table C.5, the uncertainty determined.

λ = speed of sound/ frequency

Wave number k =2pi/lambda

Speed of Sound (m/s)	343	343	343	343	343	343	343
Frequency (Hz)	125	250	500	1000	2000	4000	8000
λ(m)	2.744	1.372	0.686	0.343	0.1715	0.08575	0.042875
k (m-1)	2.29	4.58	9.16	18.32	36.64	73.27	146.55

Frequency (Hz)	125	250	500	1000	2000	4000	8000
Duct Diameter (m)	0.5kD						
0.315	0.36	0.72	1.44	2.89	5.77	11.54	23.08
0.4	0.46	0.92	1.83	3.66	7.33	14.65	29.31
0.5	0.57	1.14	2.29	4.58	9.16	18.32	36.64
0.63	0.72	1.44	2.89	5.77	11.54	23.08	46.16
0.8	0.92	1.83	3.66	7.33	14.65	29.31	58.62
1	1.14	2.29	4.58	9.16	18.32	36.64	73.27
1.25	1.43	2.86	5.72	11.45	22.9	45.8	91.59
1.6	1.83	3.66	7.33	14.65	29.31	58.62	117.24

Uncertainty in End Reflection Correction

Duct Configuration	r	Range for 0.5kD		
		<0.25	0.25-1	>1
Free Space	1	+/-0.3	+/- 0.2	+/- 0.5

Based on the table of 0.5kD values the uncertainties in end reflection for each duct diameter are given below:

Frequency (Hz)	125	250	500	1000	2000	4000	8000
Duct Diameter (m)	Uncertainties in End Reflection Correction						
0.315	+/-2	+/-2	+/-0.5	+/-0.5	+/-0.5	+/-0.5	+/-0.5
0.4	+/-2	+/-2	+/-0.5	+/-0.5	+/-0.5	+/-0.5	+/-0.5
0.5	+/-2	+/-0.5	+/-0.5	+/-0.5	+/-0.5	+/-0.5	+/-0.5
0.63	+/-2	+/-0.5	+/-0.5	+/-0.5	+/-0.5	+/-0.5	+/-0.5
0.8	+/-2	+/-0.5	+/-0.5	+/-0.5	+/-0.5	+/-0.5	+/-0.5
1	+/-0.5	+/-0.5	+/-0.5	+/-0.5	+/-0.5	+/-0.5	+/-0.5
1.25	+/-0.5	+/-0.5	+/-0.5	+/-0.5	+/-0.5	+/-0.5	+/-0.5
1.6	+/-0.5	+/-0.5	+/-0.5	+/-0.5	+/-0.5	+/-0.5	+/-0.5

The total uncertainty in the measurement is the addition of the estimated deviation in sound power level and the end reflection values of uncertainty.

Measurement uncertainty for AMCA 300

	Frequency (Hz)							
Duct Diameter (m)	63	125	250	500	1000	2000	4000	8000
0.315	-	+/-5	+/-4	+/-2	+/-2	+/-2	+/-2	+/-3.5
0.4	-	+/-5	+/-4	+/-2	+/-2	+/-2	+/-2	+/-3.5
0.5	-	+/-5	+/-2.5	+/-2	+/-2	+/-2	+/-2	+/-3.5
0.63	-	+/-5	+/-2.5	+/-2	+/-2	+/-2	+/-2	+/-3.5
0.8	-	+/-5	+/-2.5	+/-2	+/-2	+/-2	+/-2	+/-3.5
1	-	+/-3.5	+/-2.5	+/-2	+/-2	+/-2	+/-2	+/-3.5
1.25	-	+/-3.5	+/-2.5	+/-2	+/-2	+/-2	+/-2	+/-3.5
1.6	-	+/-3.5	+/-2.5	+/-2	+/-2	+/-2	+/-2	+/-3.5

Appendix E states the calculation for duct end reflection which is a function of, the speed of sound in air, frequency, diameter and duct configuration. End reflection values for the NAL test ducts are given below.

End Reflection for Duct Terminated in Free Space

	Frequency (Hz)						
Duct Diameter (m)	125	250	500	1000	2000	4000	8000
0.315	9	5	2	1	0	0	0
0.4	7	3	1	0	0	0	0
0.5	6	2	1	0	0	0	0
0.63	5	2	1	0	0	0	0
0.8	3	1	0	0	0	0	0
1	2	1	0	0	0	0	0
1.25	2	1	0	0	0	0	0
1.6	1	0	0	0	0	0	0

(i) NAL test units in accordance with ISO5801:2017 for air performance, this standard allows transition from a test duct diameter to a unit diameter within certain limits.

The table below shows the range of NAL test ducts.

Unit Diameter (m)	Test Duct Diameter (m)
0.315	0.315
0.35	0.4
0.4	0.4
0.45	0.5
0.5	0.5
0.56	0.63
0.63	0.63
0.71	0.8
0.8	0.8
0.9	1
1	1
1.12	1.25
1.25	1.25
1.6	1.6