

 <p>7660 QUINCY ST.—WILLOWBROOK, IL 60521-5596 TEL: (630) 794-5700 • FAX: (630) 794-5776 WEB: http://www.nyb.com • E-MAIL: nyb@nyb.com</p>	Fan Balance and Vibration	SALES BULLETIN SB-504 June 18, 1998
---	--	--

The intent of this sales bulletin is to explain **nyb's** wheel balance and fan vibration criteria. **nyb's** policy concerning customer specifications, special balancing requirements, and field balancing are reviewed.

NEW YORK BLOWER BALANCE AND VIBRATION CRITERIA

Wheel/Rotor Balance

New York Blower's wheel balance criteria dictates that wheels are dynamically balanced prior to installation in the fan assembly. **nyb** standard balance for wheels using up to 400 horsepower is Quality Grade G 6.3 and for wheels using 400 horsepower and above, Quality Grade G2.5. Special balance is available for some wheels and is limited to Quality Grade G2.5 when pre-approved by **nyb**. (See Fan Components Catalog Sheet #851 for further details.)

Fan Vibration

The completed fan assembly is trim balanced after wheel installation. This final balancing procedure decreases vibration caused by the accumulation of various manufacturing tolerances. **nyb** factory vibration limits are in accordance with AMA 204, Section 6, Table 6-3 for Industrial Process & Power Generation Equipment level BV-3. All fans are test run in a rigidly mounted configuration. Pickup locations, measurement planes, and specific criteria are detailed in Table 1. Special balance criteria requires pre-approval by **nyb** due to certain product limitations and is provided at additional cost.

Table 1: nyb Factory Vibration Criteria for Rigidly Mounted Fans

	PROCESS INDUSTRIAL FANS	PACKAGE INDUSTRIAL FANS	LIGHT DUTY INDUSTRIAL FANS
Products	Single-Width AcF/PLR, Class I-IV Double-Width AcF FRP Fume Exhauster FRP Radial Fume Exhauster FRP Gen Purpose Fume Exhauster FRP Pressure Blower Series 20 GI Arr. 1, 8, 9, 9F Series 30 GI Series 45 GI Plug Pressure Blower Arr. 1, 4, 8 RTS AF-Forty Series 60 Type HP Pressure Blower	Duct Tubeaxial Vaneaxial Series 20 GI Arr. 10 General Purpose Plenum Pressure Blower Arr. 10 Tubular AcoustaFoil™	Compact GI GPA Junior
Standard Factory Criteria	.15 in/sec Inboard and outboard bearings Horizontal and vertical planes Filter-in at fan speed Fan rigidly mounted	.15 in/sec Inboard and outboard bearings Horizontal and vertical planes Filter-in at fan speed Fan rigidly mounted	.15 in/sec Inboard bearing Horizontal and vertical planes Filter-in at fan speed Fan rigidly mounted
Special Factory Criteria	.10 in/sec Inboard and outboard bearings Horizontal and vertical planes Filter-in at fan speed Fan rigidly mounted	None Available	None Available

NOTE: Plug, Tubeaxial, Vaneaxial, Duct, and Tubular AcoustaFoil fans are trim balanced only when the motor and drives are mounted by nyb (see Limitations).

For Process Industrial Fans over 400 horsepower, the standard factory criteria is .10 in/sec. Readings are taken at the inboard and outboard bearings, horizontal and vertical planes, filter-in at the fan operating speed.

Exclusions

Vibration levels on Propeller Fans, Unit Heaters, and Upblast and Hooded Roof Ventilators are not governed by this standard, they are test run after final assembly. These products are checked for speed, rotation, and general operating condition when motors and drives are installed by nyb. Any products displaying noticeable vibration will be repaired and/or balanced prior to shipment.

Limitations

Available Voltage: 110, 208, 240, 480, 575

Available Frequency: 60 cycle and 50 cycle. 50 cycle capability has certain horsepower and motor voltage limitations.

Test Running Speeds: Fans are tested at operating speed if known. If unknown, with package nyb drive, fan is tested at midrange of drive. If unknown and without a packaged drive, fan is generally tested at 90% of maximum RPM.

Axial and Plug fans without motors and drives are not trim balanced but they are subjected to a mechanical test run. A trim balance is not performed on these bare fans because the fan without the motor, belts, and sheaves does not accurately represent the assembled unit which will be installed in the field. Therefore, any trim balancing done on the bare fan would not necessarily improve the operating condition of the assembled product in the field. **It should be expected that these fans will require trim balancing after installation.**

Horsepower: Motors over 300 horsepower cannot be test run in nyb's factories.

Construction: Duct, Tubeaxial, and Vaneaxial fans, size 12-60 and Tubular AcoustaFoil fans, size 12-30 cannot be test run with the motor mounted on the fan if the motor is frame size 364T or larger or if the motor weighs 600 lbs. or more.

The following fans cannot be test run unless the motor is mounted by nyb.

Fan Type	Size	Fan Type	Size	Fan Type	Size
Pressure Blower Arr. 4	14-26	Series 20 GI Arr. 8	144-294	Plug	12-49
Single-Width AcF/PLR Arr. 8	12-30	Compact GI	85-146	Propeller	8-48
Fume Exhauster Arr. 8	18-30	GPA	12-22	Tubular AcoustaFoil	33-73
FRP Pressure Blower Arr. 8	18-28	Junior	53-155		

PICK-UP LOCATIONS

The pick-up is placed in horizontal and vertical directions. New York Blower measures fan assembly vibration in horizontal and vertical directions with "filter in" at the fan's operating speed. Vibration levels in the axial direction are affected by other variables and may not provide an accurate measure of wheel imbalance. Transducers are mounted on the fan bearings or the shortest, direct mechanical path to the bearings. On Arrangement 4 fans, the transducer is placed at the motor feet.

The pick-up is placed on the inboard bearing only on CGI, GPA, and Junior fans. All other fans will have the pick-up placed on the inboard and outboard bearings.

FAN TRIM BALANCE WEIGHTS

Clip-on weights are used on all clean-air, low temperature fans: Junior, AcF/PLR, General Purpose, GPA, Pressure Blower, Plenum, and DWDI fans. Weights are riveted on for Duct Fans.

Weld-on weights are used on all: General Industrial, RTS, Class IV, AF-Forty, Series 60, Type HP Pressure Blower, Vaneaxial, and Tubeaxial fans and Upblast and Hooded Roof Ventilators. They are also used on all clean-air, high temperature fans: Junior, Air Kit, AcF/PLR, Tubular AcoustaFoil, and Plug fans.

WHEEL BALANCE WEIGHTS

All stainless steel wheels receive weld-on 316L SST weights. All aluminum wheels (except Pressure Blowers) use welded aluminum weights. Pressure Blowers have weights riveted to the frontplate or the backplate.

Compact GI wheels have weight removed from a balance ring or the blades by grinding.

Coated steel and stainless steel wheels are drilled through the frontplate or backplate. SST bolts, nuts, and washers are added for weight. Weights are touched-up with coating material.

Fiberglass wheels have patch of parent material added to backplate or material is ground from backplate as required. All ground surfaces are then resin coated.

Tubeaxial and Vaneaxial wheels have material ground off the hub for balancing. Duct Fan wheels have weights or bolted.

CUSTOMER SPECIFICATIONS

Customer specifications frequently include a variety of requirements which differ from **nyb's** standard. In all cases, **nyb's** preference is to take exception to customer specifications and apply **nyb's** standard which is documented in this sales bulletin. It does not conform entirely to specifications such as ANSI or API. Those specifications must be thoroughly reviewed for areas of non-compliance with **nyb**. **Any deviation from the nyb standard must be approved by nyb prior to quotation.** In instances where the user is not amenable to exceptions from their specification, consult **nyb**. After review of the specification, **nyb** will select one of the following alternatives:

1. Provide special balancing or documentation in the factory, at additional charge.
2. Provide special balancing or related services in the field with start-up service, at additional charge.
3. Contract with independent consultant to provide special balancing, at additional charge.
4. Decline to offer quotation.

Typical requirements found in specifications:

- Tighter vibration.
- Certification of vibration levels at **nyb's** factory.
- Filter-out readings.
- Readings at locations other than standard (motor bearings, unitary base).
- Field (In-situ) vibration levels after installation (must include start-up service).
- Three-plane balance.
- Documentation of vibration signatures of overall amplitude.
- Traceability of balance equipment.
- Spike energy measurements.

TERMS

Commonly used terms found in balance and vibration specifications include:

Acceleration:	The rate of change of velocity (m/sec. ²)
Amplitude:	Amount of vibration
Frequency:	Cycles per second (RPM/60)
Mil:	Unit of displacement (1 thousandth of an inch)
Pick-up:	Vibration transducer
Inboard Bearing:	Bearing closest to the wheel (drive side bearing on Arrangement 3 and 7 fans)
Displacement:	The measurement of vibration from one extreme to the other (mil. or in.)
Velocity:	Change in displacement with respect to time (in./sec.)

CONVERSIONS

Displacement (mils peak-to-peak) and velocity (in./sec.) are the most common units of measure.

F = Frequency V = Velocity Di = Displacement (in.) Dm = Displacement (mils.)

Convert Displacement to Velocity

$F = \text{RPM}/60$ $D_i = D_m \times (.001)$ $V = D_i \times \pi \times F$

Example: Convert .6 mils to in./sec. (fan speed is 1200 RPM)

$F = 1200/60 = 20$ revolutions per second

$D_i = (.001)(.6) = .0006$ in.

$V = (.0006)(\pi)(20) = .0377$ in./sec.

Convert Velocity to Displacement

$F = \text{RPM}/60$ $D_i = V/(\pi)(F)$ $D_m = D_i/.001$

Example: Convert .0785 in./sec. to mils. (fan speed is 1200 RPM)

$F = 1200/60 = 20$ revolutions per second

$D_i = .0785/(\pi \times 20)$ in.

$D_i = .0125$ in.

$D_m = .00125/.001$ mils.

$D_m = 1.25$ mils.

RESONANT FREQUENCIES

A source of fan vibration is resonant frequencies within the fan mounting structure. Vibration caused by resonance can be very damaging to the fan. If the structure has a natural frequency near that of the fan operating speed, it is very difficult to balance the fan to an acceptable level. This cause of vibration can only be diagnosed through use of sophisticated electronic diagnostic equipment. There are two ways to remedy the situation: change the fan speed or modify the fan mounting structure.

FIELD VIBRATION PROBLEMS

New York Blower's local sales representatives are the initial contact for customers who perceive a vibration problem in the field. The representative will visit the job site to assess the situation, and report any findings to **nyb**. If **nyb** deems it necessary, field balancing will be initiated. Field balancing will be performed by an independent contractor or a member of **nyb**'s field service staff. **Consult nyb prior to commissioning an independent balancer so that nyb can provide necessary authorization and documentation.**

New York Blower's vibration standard dictates acceptable vibration levels for shipment of equipment from **nyb**'s factory. Equipment is tested in the factory under ideal conditions. Vibration levels may be higher when the fan is installed in the field, in less that ideal conditions, which are beyond the control of **nyb** and beyond the scope of **nyb**'s responsibility.

TROUBLESHOOTING

Check all setscrews and mounting bolts for looseness upon inspection of the fan installation. A visual inspection of the following items should also be performed; drive alignment, ductwork configurations, inlet and outlet conditions (elbows, blast-gate dampers . . . etc.), fan support structure, and unsupported equipment mounted to the fan. If possible, the fan speed should be verified and the wheel rotation checked (jog drive).

AERODYNAMIC VIBRATION

Cause	Diagnosis	Solution
Unstable fan performance (left of peak)	Open access door, remove section of ductwork.	Redesign system, increase wheel/inlet cone overlap (if small decrease in flow is practical).
Faulty system design (elbows at wheel/inlet, etc.)	Remove inlet/outlet ductwork, inlet box.	Redesign system, add turning vanes, install factory designed inlet box.

MECHANICAL VIBRATION

Cause	Diagnosis	Solution
Material build-up on wheel	Visual inspection.	Clean wheel.
Abrasion/Corrosion	Check for pitting, unusual wear.	Replace wheel, explore use of abrasion resistant construction or special coating.
Drive/Coupling	Check alignment/clearances.	Re-align drive/coupling.
Bearings	Listen for unusual noises, determine if inner race is skidding on shaft.	Replace bearings.
Condensation Inside hollow blades	Turn wheel by hand and listen for movement of water.	Drill weep holes.
Bent shaft	Check shaft for straightness.	Straighten or replace shaft.
Inadequate foundation/members	Check for large unsupported spans, weak sway bracing, or supporting structure natural frequency which coincides with operating speed.	Install additional structural bracing on foundation/support structure.

VIBRATION IDENTIFICATION

Analysis of diagnostic balancing data reveals distinctive signatures for various sources of vibration. The frequency of vibration can indicate the source of vibration.

Cause	Frequency relative to fan speed	Plane	Amplitude
Unbalance	1 X RPM	Radial	Proportional to degree of unbalance.
Defective bearing	2 to 100 x RPM	Radial	Low
Bent shaft	1 or 2 X RPM	Axial	High
Faulty belts	1 to 5 X RPM	Radial	Unsteady
Looseness	2 X RPM	Any	Proportional to looseness
Poor foundation	Unsteady	Any	Erratic
Resonance	Specific critical speeds	Any	High