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INDUSTRIAL PROCESS/ POWER GENERATION FAN MANUAL

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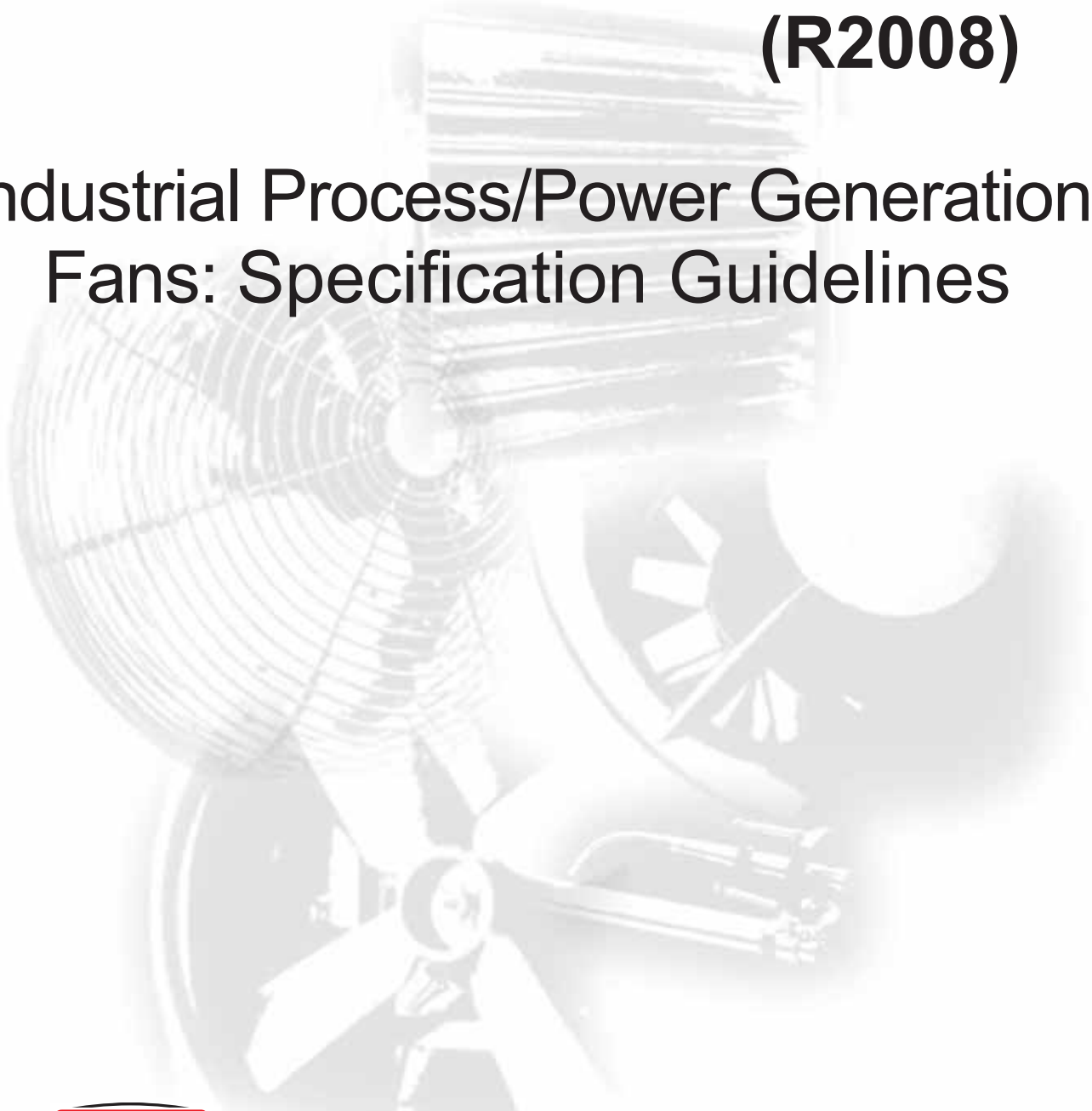
Industrial Process/Power Generation Fans: Specification Guidelines



AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.

The International Authority on Air System Components

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AMCA PUBLICATION 801-01 (R2007)

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Air Movement and Control Association International, Inc.
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Authority

AMCA Publication 801-01 was adopted by the membership of the Air Movement and Control Association International, Inc. on January 14, 2001. It was reaffirmed on May 4, 2008.

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RELATED AMCA STANDARDS

For Air Performance:

ANSI/AMCA Standard 210	*Laboratory Method of Testing Fans for Aerodynamic Performance Rating*
AMCA Standard 803	*Industrial Process/Power Generation Fans: Site Performance Test Standard*

For Sound:

AMCA Standard 300	*Reverberant Room Method for Sound Testing of Fans*
AMCA Standard 301	*Methods for Calculating Fan Sound Ratings from Laboratory Test Data*

For Balance and Vibration:

ANSI/AMCA Standard 204	*Balance Quality and Vibration Levels for Fans*

Industrial Process / Power Generation Series:

AMCA Publication 801	*Industrial Process/Power Generation Fans: Specification Guidelines*
AMCA Publication 802	*Industrial Process/Power Generation Fans: Establishing Performance Using Laboratory Models*
AMCA Standard 803	*Industrial Process/Power Generation Fans: Site Performance Test Standard*

Fan Application Manual:

AMCA Publication 200	*Air Systems*
AMCA Publication 201	*Fans and Systems*
AMCA Publication 202	*Troubleshooting*
AMCA Publication 203	*Field Performance Measurement of Fan Systems*

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INDEX BY FAN APPLICATION

The following is a list of common industrial fan applications that includes types of fans typically employed, major design considerations, and corresponding sections of this document. Users of this publication can employ this table as a guideline for specific applications as well as an index to related topics.

KEY TO FAN TYPES:
AF = airfoil
BC = backward curved
BI = backward inclined
FC = forward curved
PW = paddle wheel
RT = radial tip
VA = vaneaxial

INDUSTRIAL PROCESS FANS

Application	Typical Fan Employed	Usual Major Consideration	Applicable 801 Section
A. CLEAN AIR, SUPPLY, and GENERAL VENTILATION	BI/BC AF VA FC Radial blade	Sound Efficiency Means of control Indoor, outdoor	4.2.8; 8 (all) 5 (all) 4.2.2-5
B. CONVEYING MATERIAL	Radial blade PW	Durability-impact on impeller, shaft, bearings Capture velocities, Entrainment velocity, Equivalent density, (includes material conveyed) Wear Build up Leakage from housing & around shaft	3.2 (all) 3.1.9-10 3.3.6-12; 4.2.7; 6 (all) 6 (all); esp. 6.2 3.3.3; 7 (all)
C. HOT GAS RECIRCULATION "DRYERS" <540°C (1000°F)	All	Spark resistance, dependent upon material Temperature Rate of temperature change Sealing and leakage Bearing cooling & lubrication Insulation Durability Method of support & materials of construction	3.2.13; 3.3.2 3.2.13; 3.3.2 3.3.3; 7 (all) 3.3.2; 7.3.8; 7.6.4

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INDUSTRIAL PROCESS FANS

Application	Typical Fan Employed	Usual Major Consideration	Applicable 801 Section
D. GENERAL EXHAUST HOODS	All	Wear	3.3.6-12; 4.2.7; 6 (all)
		Corrosion	6 (all)
		Sealing	7 (all)
		Noise	4.2.8; 8 (all)
		Temperature	3.2.13; 3.3.2
		Toxicity	6.1
E. CORROSIVE FUME/GAS/ODOR CONTROL	All	Corrosion	6.1
		Seal	3.3.3; 7.3
		Material	6.1-2
		Paint	
		Coatings	
		Spark resistance	7.6.1
		Explosion resistance	
		Air density	3.1.9-10
		High tip speed	
		Noise	8 (all)
		Build-up	6.2
F. AIR CLEANING SCRUBBER BOOSTER FAN BAG HOUSE FAN	AF, BI/BC (clean air) RT, PW (dirty gas)	Air density	3.1.9-10
		High tip speed	
		Noise	8 (all)
		Build-up	6.2
		High pressure	
		Wear & corrosion	3.3.6-12; 6.1
G. PELLETIZING/ SINTERING	BI/BC (limited appl.) Radial blade RT VA (sinter cooling)	Wear (severe)	3.3.6-12; 6.1
		High temperature	3.2.13
		Rate of temperature change	3.2.13
		Build up	6.2
		Vibration	3.2.11

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INDUSTRIAL PROCESS FANS

Application	Typical Fan Employed	Usual Major Consideration	Applicable 801 Section
H. MINING AND TUNNEL	VA AF BI/BC	Efficiency Sound Reliability Flow reversal Explosion resistance Spark resistance Corrosion Wear Mine safety & government reg.	 4.2.8; 8 (all) 7.6.1 6.1 3.3.6-12; 6.2
I. EXPLOSIVE GAS	All	Spark resistance Explosion doors and protection Leakage-housing & shaft Corrosion	7.6.1 7.1-5 6.1
J. INCINERATION	Radial blade BI/BC AF (Depends on material being burned)	Air composition Wear Toxic gas High Temperature Rate of temperature change Sound (residential areas) High tip speed construction Leakage Sealing Reliability	 3.3.6-12; 4.2.7; 6.1 3.2.13; 3.3.2 3.2.13; 3.3.2 4.2.8; 8 (all) 7.1-7.6 7.1-7.6
K. BASIC OXYGEN (System operates at shut off and periodically goes to full flow)	Radial blade BI/BC	Non-surge & stability over range of operation Gas tightness High tip speed construction Starts and stops Wear (water erosion) Build up Corrosion	 5 (all) 7.1-7.6 9.3.6 3.3.6-12; 4.2.7; 6.1 6.2 6.1

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Industrial Process Fans

Application	Typical Fan Employed	Usual Major Consideration	Applicable 801 Section
L. HOT GAS EXHAUST (Coal Drying Kiln)	All	Duty cycle	
		Build up	6.2
		Wear	3.3.6-12; 4.2.7; 6.1
		High temperature	3.2.13; 3.3.2
		Rate of temperature change	3.2.13; 3.3.2
M. HIGH PRESSURE BLOWERS (Combustion air)	Radial blade BI/BC AF	High tip speed construction	
		Bearing thrust & max. bearing speed	3.3.5
		Leakage and seals	7.1-6
		Air Dynamics: Mach number, compressibility, regain, noise	
		Stability-turn down ratio	5 (all)
N. HIGH TEMPERATURE FANS >540°C (1000°F)	All	Thermal expansion	3.2.13; 3.3.2
		Structural integrity	
		Bearings-cooling & lubrication	3.3.5
		Materials of construction	
		Insulation	
		Corrosion	6.1
O. BRAKE FAN (Power absorption fan) Absorb power in spillways, etc. when dropping gates.	BI/BC (running backwards) FC	High power (for volume and pressure)	
P. FOOD & TEXTILE (Smooth finish fan)	AF BI/BC Radial blade	Super smooth finish Stainless construction	7.6.2

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POWER GENERATION FANS

Application	Typical Fan Employed	Usual Major Consideration	Applicable 801 Section
A. FORCED DRAFT (FD)	AF	Efficiency & operating point	3.1.13-16
1. Supplies combustion air to a boiler	BI/BC	Means of control-turndown & leakage	4.2
2. Provides excess air for complete combustion.	FC	Indoor/outdoor operation	9.3.6
3. Overcomes losses from fan to balance draft point in boiler.	VA	Sound	8.4.2.8
		Reliability (mechanical)	3.2 (all); 13 (all)
		Stress analysis & structural specs	3.2 (all); 13 (all)
		Quality assurance programs	10; (all)
B. INDUCED DRAFT (ID)	AF	Same as FD +	See A, above, plus:
1. Exhausts products of combustion	BI/BC	Air analysis & density	3.1.9-10
2. Exhausts excess air	FC	Corrosion	6 (all)
3. Provides necessary draft at fire and overcomes losses to the end of the system minus any natural draft.	VA	Wear	3.3.6-12; 4.2.7; 6 (all)
	RT	Turning gear	3.3.1
		Maximum temperature	3.2.13; 3.3.2
		Rate of temperature change	3.2.13; 3.3.2
		Leakage-housing & seals	3.3.3; 7 (all)
		Means of support for thermal expansion	3.3.2; 7.6.4; 9.3.8
C. PRIMARY AIR	AF	Same as FD +	See A, above, plus:
HOT	BI/BC	Temperature	3.2.13
1. Transports powdered fuel from pulverizer to burner.	Radial blade	Wear	6 (all)
2. Provides some combustion air.		Leakage-housing & seals	7 (all)
3. Makes up for some leakage out of the boiler.			
4. Takes air after air heater and fan overcomes losses in transporting fuel plus air losses minus energy from the FD fan.			
COLD			
1. Air is taken from ambient sources.	VA		
2. See HOT #1 through #3 above.			

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POWER GENERATION FANS

Application	Typical Fan Employed	Usual Major Consideration	Applicable 801 Section
D. FLUIDIZED BED BOILER 1. Provides some combustion air. 2. Floats bed	AF BI/BC Radial blade	Very high pressure High stress High fixed resistance	5 (all) 3.2 (all) 5 (all)
E. GAS RECIRCULATION 1. Redirects boiler gases increasing mass flow through various parts of the furnace, super-heaters, reheaters, economizers. 2. Tempers hot gases in the boiler to 1040°C (1900°F). 3. Overcomes losses though boiler passages & the recirculation ductwork.	AF BI/BC RT	Same as I.D. + Shut off pressure considerations Leakage-housing & seals	See B, above, plus: 5 (all) 3.3.3; 7 (all)
F. OVERFIRE AIR 1. Delivers air over the fire to improve combustion and reduce smoking. 2. Reduced FD requirements, overcomes piping losses and provides turbulent mixing action.	AF BI/BC	Same as FD	See A, above

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POWER GENERATION FANS

Application	Typical Fan Employed	Usual Major Consideration	Applicable 801 Section
G. FLUE GAS DESULFURIZATION (FGD) BOOSTER In series with ID fan to provide added pressure capability to overcome air pollution devices in retrofit application.	Same as ID fan lower temperature	Same as ID but at	Same as B, above
H. INDIRECT REHEAT Adds clean heated air to system	Same as FD	Same as FD	Same as A, above.
I. SECONDARY AIR Provides additional combustion air	Same as FD	Same as FD	Same as A, above
J. CYCLONE BURNER Provides combustion air plus energy to produce cyclonic action in burner and furnace.	Same as FD	Same as FD	Same as A, above
K. SEAL AIR 1. Provides clean air to chamber surrounding furnace 2. Creates pressure large enough to prevent the escape of dirty gas from the furnace and any auxiliary (dampers, etc.)	AF, BI/BC	Same as FD	Similar to those listed under A
L. WASTE ENERGY FAN 1. Takes hot gases including waste from waste heat boiler.	Same as ID	Build up Clogging of parts	6 (all)

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Industrial Process/Power Generation Fans: Specification Guidelines

1. Purpose

The purpose of this publication is to familiarize the reader with the practices fan manufacturers follow in the specification of fan equipment, and to provide application information. Good communication will be ensured if recommendations given herein are followed.

There are numerous fan manufacturers supplying equipment to industry throughout the world. Due to differences in rating and proposal practices among fan manufacturers, it is vitally important that the consulting engineer, system designer, and the user thoroughly understand all fan-related concepts. Conversely, it is the responsibility of the fan manufacturers to explain these practices and, if possible, develop a common method of presenting information that will aid in making a proper equipment evaluation. This will ensure a more systematic approach to the testing, rating, specification, and construction of industrial process and power generation fans.

2. Scope

This publication provides information on testing and rating industrial process and power generation fans, and covers construction features and related appurtenances. Sample equipment specifications are included which outline information a fan manufacturer requires to select the best fan for an application. Common fan industry practices are also defined and explained.

3. Terminology

The following list of terms and their related symbols will be applied to testing, rating, specifications, and construction of industrial process and power generation fans. To avoid confusion and misunderstanding, this terminology should be used.

3.1 Rating criteria

3.1.1 Fan. A fan is a device that utilizes a power-driven rotating impeller for moving air and has at least one inlet opening and one outlet opening. The openings may or may not have elements for connection to ductwork. A fan may have various appurtenances that affect aerodynamic performance. It is necessary to establish which appurtenances are to be considered part of the fan.

3.1.2 Fan inlet. The plane perpendicular to the airstream where it first meets the inlet cone, the inlet box or other appurtenances furnished by the fan manufacturer. In this publication, the fan inlet is indicated by "Plane 1". (See Figures 15.4 and 15.5.)

3.1.3 Fan outlet. The plane perpendicular to the airstream at the outlet opening of the fan, the outlet opening at the evasé or diffuser or other appurtenances furnished by the fan manufacturer. In this publication, the fan outlet is indicated by "Plane 2". (See Figures 15.4 and 15.5.)

3.1.4 Air. A mixture of gases; also, a term commonly used to denote any gaseous medium measured, moved or controlled and which may include solid or liquid particulate.

3.1.5 Fan airflow rate. The volumetric airflow rate at fan air density at the fan inlet.

3.1.6 Total pressure. The air pressure that exists by virtue of the degree of compression and the rate of motion. It is the algebraic sum of the velocity pressure and the static pressure at a point.

3.1.7 Velocity pressure. The portion of the air pressure that exists by virtue of the rate of motion only. It is always positive.

3.1.8 Static pressure. The portion of the air pressure that exists by virtue of the degree of compression only. It may be positive or negative relative to the ambient atmospheric pressure.

3.1.9 Fan pressure relationships and interpretations. The definitions of total pressure, velocity pressure, and static pressure are presented in Sections 3.1.6 to 3.1.8. However, when applying these definitions to fan performance, there are distinct relationships that exist between each variable. This section describes these relationships.

3.1.9.1 Fan total pressure (P_t). The difference between the total pressure at the fan outlet and the total pressure at the fan inlet.

$$P_t = P_{t2} - P_{t1}$$