

INDUSTRIAL VENTILATION

A Manual of Recommended Practice
for Design

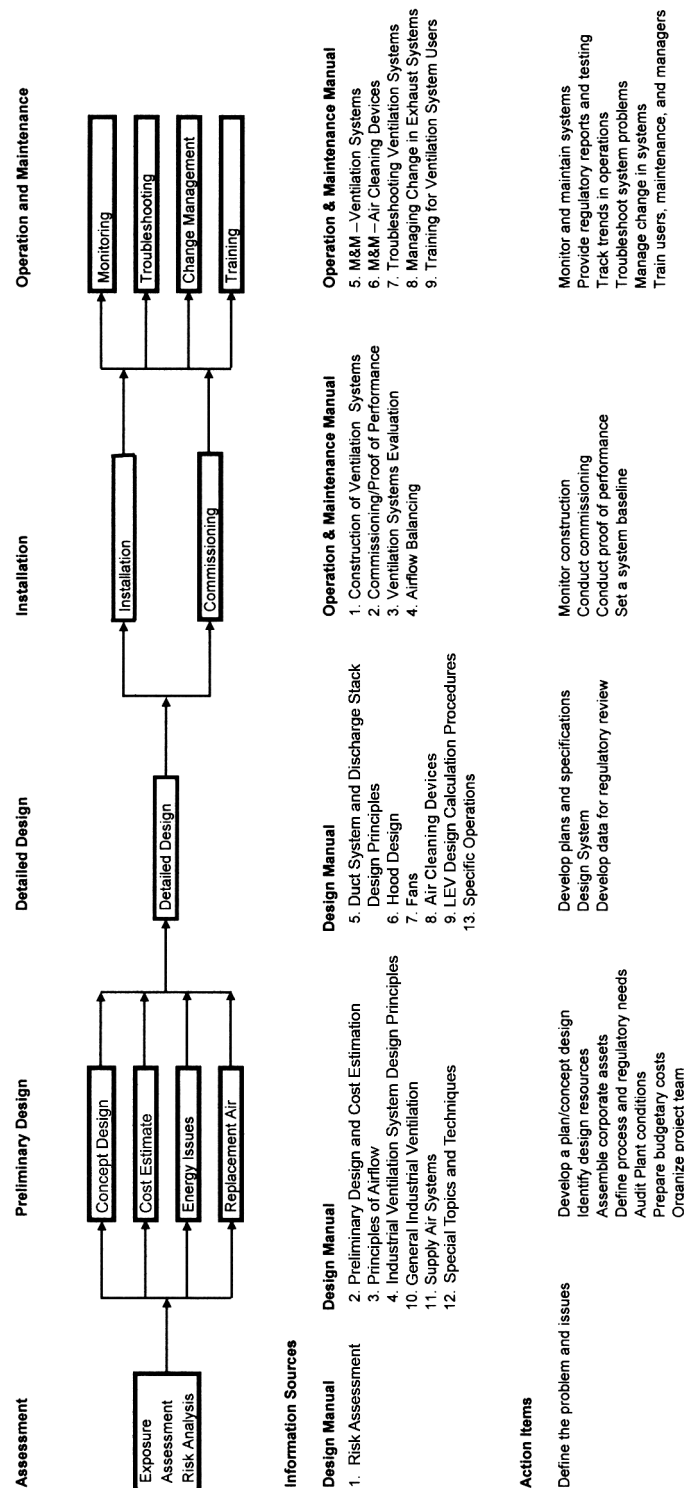
30th Edition



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LIFE CYCLE OF AN INDUSTRIAL VENTILATION SYSTEM



ACGIH®, *Industrial Ventilation: A Manual of Recommended Practice for Design*, 30th Edition
Errata Listing (as of 01/21/2020)

CHAPTER	SECTION	PAGE	DESCRIPTION
9	N/A	9-54	Table 9-7 (SI) has been corrected below. Do not use Table 9-7 (SI) as displayed in the 30th Edition of the ACGIH® publication, <i>Industrial Ventilation, A Manual of Recommended Practice for Design</i> as it is incorrect.
11	11.7.6	11-26	Replace last sentence of section with the following: The application of heat exchangers to industrial exhaust systems is discussed in Chapter 10 of the ACGIH® Publication, <i>Industrial Ventilation, A Manual of Recommended Practice for Operation and Maintenance</i> , which is to be published in 2020.
13	VS-95-30	13-197	Replace 3. with the following: 3. $Q_e = 50$ acfm [$0.025 \text{ am}^3/\text{s}$] at approximately 25" wg [6.3 kPa].
13	VS-95-31	13-198	Replace 2. with the following: 2. $Q_e = 50$ acfm at 25" wg [$0.025 \text{ am}^3/\text{s}$ at 6.3 kPa].

Table 9-7 (IP). Air Density Correction Factor (Temperature and Elevation Only), $df_T \times df_e$

ALTITUDE RELATIVE TO SEA LEVEL (ft)																
	-5,000	-4,000	-3,000	-2,000	-1,000	0	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
BAROMETRIC PRESSURE																
"Hg	35.7	34.5	33.3	32.1	31.0	29.9	28.9	27.8	26.8	25.8	24.9	24.0	23.1	22.2	21.4	20.6
"wg	485.9	469.5	453.2	436.9	421.9	406.9	393.3	378.4	364.7	351.1	338.9	326.6	314.4	302.1	291.3	280.4
Temp (F)	DENSITY FACTOR (df)															
-40	1.50	1.45	1.40	1.35	1.31	1.26	1.22	1.18	1.13	1.09	1.05	1.02	0.98	0.94	0.91	0.87
0	1.37	1.32	1.28	1.24	1.19	1.15	1.11	1.07	1.04	1.00	0.96	0.93	0.89	0.86	0.83	0.80
40	1.26	1.22	1.18	1.14	1.10	1.06	1.02	0.99	0.95	0.92	0.89	0.85	0.82	0.79	0.76	0.73
70	1.19	1.15	1.11	1.07	1.04	1.00	0.97	0.93	0.90	0.87	0.84	0.81	0.78	0.75	0.72	0.69
100	1.13	1.09	1.05	1.02	0.98	0.95	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.71	0.68	0.66
150	1.03	1.00	0.97	0.93	0.90	0.87	0.84	0.81	0.78	0.75	0.73	0.70	0.67	0.65	0.63	0.60
200	0.96	0.92	0.89	0.86	0.83	0.80	0.78	0.75	0.72	0.70	0.67	0.65	0.62	0.60	0.58	0.56
250	0.89	0.86	0.83	0.80	0.77	0.75	0.72	0.70	0.67	0.65	0.62	0.60	0.58	0.56	0.54	0.52
300	0.83	0.80	0.77	0.75	0.72	0.70	0.67	0.65	0.63	0.60	0.58	0.56	0.54	0.52	0.50	0.48
350	0.78	0.75	0.73	0.70	0.68	0.65	0.63	0.61	0.59	0.57	0.55	0.53	0.51	0.49	0.47	0.45
400	0.73	0.71	0.68	0.66	0.64	0.62	0.59	0.57	0.55	0.53	0.51	0.50	0.48	0.46	0.44	0.43
450	0.69	0.67	0.65	0.62	0.60	0.58	0.56	0.54	0.52	0.50	0.49	0.47	0.45	0.44	0.42	0.40
500	0.66	0.63	0.61	0.59	0.57	0.55	0.53	0.51	0.50	0.48	0.46	0.44	0.43	0.41	0.40	0.38
550	0.62	0.60	0.58	0.56	0.54	0.52	0.51	0.49	0.47	0.45	0.44	0.42	0.41	0.39	0.38	0.36
600	0.60	0.57	0.56	0.54	0.52	0.50	0.48	0.47	0.45	0.43	0.42	0.40	0.39	0.37	0.36	0.35
700	0.54	0.53	0.51	0.49	0.47	0.46	0.44	0.43	0.41	0.40	0.38	0.37	0.35	0.34	0.33	0.32
800	0.50	0.48	0.47	0.45	0.44	0.42	0.41	0.39	0.38	0.36	0.35	0.34	0.33	0.31	0.30	0.29
900	0.46	0.45	0.43	0.42	0.40	0.39	0.38	0.36	0.35	0.34	0.33	0.31	0.30	0.29	0.28	0.27
1000	0.43	0.42	0.40	0.39	0.38	0.36	0.35	0.34	0.33	0.31	0.30	0.29	0.28	0.27	0.26	0.25

Note that Table 9-7 (SI) has been corrected below. Do not use Table 9-7 (SI) as displayed in the 30th Edition of the ACGIH book, *Industrial Ventilation, A Manual of Recommended Practice for Design*, (i.e., the blue ventilation book) as it is incorrect.

Table 9-7 (SI). Air Density Correction Factor (Temperature and Elevation Only), $df_T \times df_e$

ALTITUDE RELATIVE TO SEA LEVEL (m)																
	-1500	-1200	-900	-600	-300	0	300	600	900	1200	1500	1800	2100	2400	2700	3000
BAROMETRIC PRESSURE																
mm Hg	905	875	845	816	787	760	733	707	682	658	634	611	589	567	546	526
kPa	120.7	116.6	112.6	108.7	105.0	101.3	97.8	94.3	91.0	87.7	84.6	81.5	78.5	75.6	72.8	70.1
Temp (C)	DENSITY FACTOR (df)															
-10	1.33	1.29	1.24	1.20	1.16	1.12	1.09	1.04	1.01	0.97	0.94	0.91	0.87	0.84	0.81	0.78
0	1.29	1.24	1.20	1.16	1.12	1.08	1.05	1.00	0.97	0.94	0.91	0.87	0.84	0.81	0.78	0.76
10	1.24	1.20	1.15	1.11	1.08	1.04	1.01	0.97	0.94	0.90	0.87	0.84	0.81	0.78	0.75	0.73
20	1.19	1.15	1.11	1.07	1.04	1.00	0.97	0.93	0.90	0.87	0.84	0.81	0.78	0.75	0.72	0.70
30	1.15	1.12	1.08	1.04	1.01	0.97	0.94	0.90	0.87	0.84	0.81	0.79	0.76	0.73	0.70	0.68
40	1.12	1.08	1.04	1.01	0.98	0.94	0.91	0.87	0.85	0.82	0.79	0.76	0.73	0.71	0.68	0.66
50	1.08	1.05	1.01	0.97	0.95	0.91	0.88	0.85	0.82	0.79	0.76	0.74	0.71	0.68	0.66	0.64
60	1.05	1.01	0.98	0.94	0.92	0.88	0.85	0.82	0.79	0.77	0.74	0.71	0.69	0.66	0.63	0.62
70	1.02	0.99	0.95	0.92	0.89	0.86	0.83	0.80	0.77	0.75	0.72	0.70	0.67	0.65	0.62	0.60
80	0.99	0.95	0.92	0.89	0.86	0.83	0.81	0.77	0.75	0.72	0.70	0.67	0.65	0.62	0.60	0.58
90	0.96	0.93	0.90	0.87	0.84	0.81	0.79	0.75	0.73	0.70	0.68	0.66	0.63	0.61	0.58	0.57
100	0.94	0.91	0.88	0.85	0.82	0.79	0.77	0.73	0.71	0.69	0.66	0.64	0.62	0.59	0.57	0.55
120	0.89	0.86	0.83	0.80	0.78	0.75	0.73	0.70	0.68	0.65	0.63	0.61	0.59	0.56	0.54	0.53
140	0.84	0.82	0.79	0.76	0.74	0.71	0.69	0.66	0.64	0.62	0.60	0.58	0.55	0.53	0.51	0.50
160	0.81	0.78	0.75	0.73	0.71	0.68	0.66	0.63	0.61	0.59	0.57	0.55	0.53	0.51	0.49	0.48
180	0.77	0.75	0.72	0.70	0.68	0.65	0.63	0.60	0.59	0.57	0.55	0.53	0.51	0.49	0.47	0.46
200	0.74	0.71	0.69	0.66	0.64	0.62	0.60	0.58	0.56	0.54	0.52	0.50	0.48	0.47	0.45	0.43
250	0.67	0.64	0.62	0.60	0.58	0.56	0.54	0.52	0.50	0.49	0.47	0.45	0.44	0.42	0.40	0.39
300	0.61	0.59	0.57	0.55	0.53	0.51	0.49	0.47	0.46	0.44	0.43	0.41	0.40	0.38	0.37	0.36
400	0.52	0.51	0.49	0.47	0.46	0.44	0.43	0.41	0.40	0.38	0.37	0.36	0.34	0.33	0.32	0.31
500	0.45	0.44	0.42	0.41	0.40	0.38	0.37	0.35	0.34	0.33	0.32	0.31	0.30	0.29	0.27	0.27
600	0.40	0.39	0.38	0.36	0.35	0.34	0.33	0.32	0.31	0.30	0.29	0.28	0.27	0.26	0.24	0.24
700	0.36	0.35	0.33	0.32	0.31	0.30	0.29	0.28	0.27	0.26	0.25	0.24	0.23	0.23	0.22	0.21

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ACGIH®

Kemper Woods Center

1330 Kemper Meadow Drive

Cincinnati, Ohio 45240-4148

Telephone: 513-742-2020 Fax: 513-742-3355

Email: Publishing@acgih.org

<http://www.acgih.org>

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FOREWORD

This 30th edition of ACGIH®'s *Industrial Ventilation: A Manual of Recommended Practice for Design*, is to be used just as the name implies – A Manual of Recommended Practices in the design of industrial ventilation systems. This publication has been developed to serve as a guide to assist in the control of airborne contaminants that may pose occupational health hazards to employees. The recommendations provided herein are intended for use in the practice of industrial hygiene and are to be interpreted and applied by a person trained in the discipline. The information contained in this Manual are not to be construed or used in any way as legal standards, and ACGIH® does not advocate their use as such. However, it is recognized that in certain circumstances individuals or organizations may wish to make use of these recommendations as such. ACGIH® will not oppose use of the Manual in this manner, as in these instances its use will contribute to overall improvement in worker protection. However, the user must recognize the constraints and limitations subject to proper use of the Manual and will bear the responsibility for such use.

Practitioners should also note that this Manual contains techniques and conceptualizations of designs submitted and adopted through the years as an approach to reduce worker exposure to airborne contaminants, and as new and better solutions are submitted/approved ACGIH® will update the Manual with improved design concepts. However, while the techniques in this primer are based on the best available science, alternative designs may improve upon the conceptualizations contained herein and are encouraged. If a reader becomes aware of a better means of protecting workers with the use of air movement, one is encouraged to submit such a concept to the ACGIH® Industrial Ventilation Committee for review. Submissions must be sent to the ACGIH® Science and Education Group by e-mail to science@acgih.org.

This Manual has undergone significant changes in the last few issues and this edition is no exception. Major changes will be found in many of the chapters herein and conceptual figures that incorporate computational fluid dynamics (CFD) have been added for clarification and incorporated for simpler conceptual understanding of air flow patterns.

The chapter addressing *General Industrial Ventilation* (formerly Chapter 4) has been moved and is now located in Chapter 10 and still includes dilution ventilation techniques and equations. Chapter 4 now addresses *Industrial Ventilation System Design Principles*; it provides the overview of local exhaust ventilation principles. Chapter 5 now addresses *Duct Components and Stack Designs*. Finally, Chapter 12 now addresses *Special Topics*, including EPA method 204, Computational Fluid Dynamics as a design tool, and combustible dust.

Due to the inherent complexity of the science associated with design of industrial ventilation systems, this edition of the Manual is written with deference toward a simpler and briefer means of explanation. Care has been taken to make this manual a practical user's handbook and not a theoretical treatise. The reader is encouraged to reference available publications addressing fluid dynamics should a more comprehensive understanding of this topic be required.

Special Note to User

This Manual is intended for use in the practice of industrial hygiene and industrial ventilation design as guidelines or recommendations to assist in the control of potential workplace health hazards and for no other use. These guidelines or recommendations *should not* be used by anyone untrained in the discipline of industrial hygiene or industrial ventilation design. ACGIH® disclaims liability with respect to the use of this Manual.

Metric (SI) to English (IP) Conversions

Conversion from metric to English is being utilized more and more in the international, commercial, and regulatory marketplaces. Guidelines have been published and this Manual uses the U.S. Department of Defense Document SD-10 (published December 2003) for its nomenclature and presentation.

There are some key definitions to be considered going forward in the Manual:

Metric Units (SI) – A system of basic measures defined by the International Symbol of Units on “Le Système International d’Unités (SI).” These units are described in IEEE/ASTM SI 10.

Inch-Pound Units (IP) – The standards as previously adopted in the United States and some other parts of the world. There are still some units that have been adopted internationally in some areas.

Soft Conversion – The process of changing a measurement from inch-pound (IP) units to equivalent metric units (SI) with acceptable measurement tolerances without changing the physical configuration of the item. For example, one pound = 453.592 grams.

Hard Conversion – The process of changing a measurement in inch-pound units (IP) to metric units (SI), which necessitates physical configuration changes of the item outside those