

APPENDIX 13.1-G
INDOOR AIR CONTAMINANT GUIDELINES AND RECOMMENDATIONS
(NON-INDUSTRIAL)

CHEMICAL SOURCES

Cadmium

Reference 13.1G-3a 5 ng/m³, annual average

Carbon Dioxide

Reference 13.1G-1 ≤ 700 ppm above acceptable outdoor air concentrations typically satisfies a substantial majority (~ ≥80%) of visitors with respect to human bioeffluents (body odor). 300-500 ppm is a typical range of acceptable outdoor air concentrations of CO₂.

Carbon Disulfide

Reference 13.1G-3a 100 µg/m³, 24 hour average
20 µg/m³, 30 minute average

Carbon Monoxide

Reference 13.1G-2 35 ppm, 1 hour average (not to be exceeded more than once per year) (primary)
9 ppm, 8 hour average (not to be exceeded more than once per year) (primary)

Reference 13.1G-3c 100 mg/m³, 15 minute average
35 mg/m³, 1 hour average
10 mg/m³, 8 hour average
7 mg/m³, 24 hour average

Reference 13.1G-4 9 ppm (not to exceed 2 ppm above outdoor levels), maximum concentration

1,2-Dichloroethane

Reference 13.1G-3a 0.7 mg/m³, 24 hour average

Dichloromethane

Reference 13.1G-3a 3 mg/m³, 24 hour average
0.45 mg/m³, week average

Environmental tobacco smoke (ETS)

Reference 13.1G-3a No evidence for a safe exposure level

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Formaldehyde

- Reference 13.1G-3c 0.1 mg/m³, 30 minute average
- Reference 13.1G-4 27 ppb, maximum concentration
16.3 ppb, Healthcare Only, maximum concentration

Hydrogen Sulfide

- Reference 13.1G-3a 150 µg/m³, 24 hour average
7 µg /m³, 30 minute average

Lead

- Reference 13.1G-2 0.15 µg/m³, rolling 3 month average (Not to be exceeded) (primary and secondary)
- Reference 13.1G-3a 0.5 µg/m³, annual average

Manganese

- Reference 13.1G-3a 0.15 µg/m³, annual average

Mercury

- Reference 13.1G-3a 1 µg/m³, annual average

Naphthalene

- Reference 13.1G-3c 0.01 mg/m³, annual average

Nitrogen Dioxide

- Reference 13.1G-2 100 ppb, 1 hour average (98th percentile, averaged over 3 years) (primary)
53 ppb, annual average (arithmetic mean) (primary and secondary)
- Reference 13.1G-3c 200 µg/m³, 1 hour average
40 µg/m³, annual average

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Ozone

- Reference 13.1G-2 0.075 ppm, 8 hour average (Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years) (primary and secondary)
- Reference 13.1G-3b 100 $\mu\text{g}/\text{m}^3$, 8 hour average
- Reference 13.1G-4 0.075 ppm, maximum concentration (for buildings in EPA nonattainment areas)

Particulates

PM_{2.5}

- Reference 13.1G-2 35 $\mu\text{g}/\text{m}^3$, 24 hour average (98th percentile, averaged over 3 years) (primary and secondary)
12 $\mu\text{g}/\text{m}^3$, annual average (arithmetic mean) (annual mean, averaged over 3 years) (primary)
15 $\mu\text{g}/\text{m}^3$, annual average (arithmetic mean) (annual mean, averaged over 3 years) (secondary)
- Reference 13.1G-3b 25 $\mu\text{g}/\text{m}^3$, 24 hour average
10 $\mu\text{g}/\text{m}^3$, annual average
- Reference 13.1G-4 15 $\mu\text{g}/\text{m}^3$, maximum concentration (for buildings in EPA nonattainment areas, or local equivalent)

PM₁₀

- Reference 13.1G-2 150 $\mu\text{g}/\text{m}^3$, 24 hour average (not to be exceeded more than once per year on average over 3 years)
- Reference 13.1G-3b 50 $\mu\text{g}/\text{m}^3$, 24 hour average
20 $\mu\text{g}/\text{m}^3$, annual average
- Reference 13.1G-4 50 $\mu\text{g}/\text{m}^3$, maximum concentration
20 $\mu\text{g}/\text{m}^3$, Healthcare Only, maximum concentration

Styrene

- Reference 13.1G-3a 0.26 mg/m^3 , week average
70 $\mu\text{g}/\text{m}^3$, 30 minute average

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CHEMICAL SOURCES

Sulfur Dioxide

- Reference 13.1G-2 75 ppb, 1 hour average (99th percentile of 1-hour daily maximum concentrations, averaged over 3 years) (primary)
0.5 ppm, 3 hour average (not to be exceeded more than once per year) (secondary)
- Reference 13.1G-3b 500 $\mu\text{g}/\text{m}^3$, 10 minute average
20 $\mu\text{g}/\text{m}^3$, 24 hour average

Tetrachloroethylene

- Reference 13.1G-3c 0.25 mg/m^3 , annual average

Toluene

- Reference 13.1G-3a 0.26 mg/m^3 , week average
1 mg/m^3 , 30 minute average

Vanadium

- Reference 13.1G-3a 1 $\mu\text{g}/\text{m}^3$, 24 hour average

Volatile Organic Compounds (VOCs) and Total VOCs (TVOCs)

VOCs

- Reference 13.1G-1 Concentrations of concern must be determined for each individual compound.

TVOCs

- Reference 13.1G-1 Precise guidance on TVOC concentrations cannot be given. Setting target concentrations for TVOCs is not recommended. Setting target concentrations for specific VOCs of concern is preferred.
- Reference 13.1G-4 500 $\mu\text{g}/\text{m}^3$, maximum concentration
200 $\mu\text{g}/\text{m}^3$, Healthcare Only, maximum concentration
- Reference 13.1G-5 Expect complaints when $>5 \text{ mg}/\text{m}^3$

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PHYSICAL SOURCES

Relative Humidity and Temperature

Reference 13.1G-1 ≤ 65% relative humidity for mechanical systems with dehumidification capabilities (exceptions include spaces where processes or occupancy requires higher humidity conditions or that are designed and constructed to manage moisture. (e.g., kitchens, refrigerated or frozen storage rooms, ice rinks, hot tub rooms, shower rooms, pools, spas, etc.))

Reference 13.1G-6 No recommended lower humidity limit for thermal comfort. However, non-thermal comfort factors (e.g., drying or irritation of skin, eyes or mucus membranes, static electricity, etc.) may limit the lower humidity based on occupant acceptability.

See Figure 5.3.1 of reference 13.1.G-6. This figure has a chart that shows typical temperature and humidity ranges that provide 80% occupant satisfaction for thermal comfort for spaces where occupants have activity levels that produce a metabolic rate between 1.0 – 1.3 met and wear clothing that provides between 0.5 – 1.0 clo of thermal insulation. This chart takes only thermal comfort into consideration, not conditions to prevent growth of biological contamination nor conditions to prevent discomfort from dryness. The ranges roughly fall between ~67° Fahrenheit with ~83% relative humidity to ~83° Fahrenheit with ~<10% relative humidity, depending on clothing.. However, you need to refer to the actual chart. See below for rough examples of acceptable temperature ranges from the chart at two relative humidity levels for the two clothing groups. Please keep in mind that the indoor temperatures are operative temperatures that combine Dry Bulb Temperature and Mean Radiant Temperature. Dry Bulb Temperature can be used as a proxy for operative temperature under certain conditions. See reference 13.1.G-6 Informative Appendix C for other specific information.

Operative Temperature and Relative Humidity for 80% Occupant Acceptability with given Garment Thermal Insulation Clo values		
1.0 clo Heavier Clothing Cooler Outdoor Environment Indoor Operative Temperature Range °F	0.5 clo Lighter Clothing Warmer Outdoor Environment Indoor Operative Temperature Range °F	Relative Humidity %
~70 to ~78	~76 to ~82	~20
~69 to ~76	~75 to ~80	~50

See reference 13.1G-6, Figure 5.3.1 for actual acceptable ranges of acceptable operative temperature and humidity.)

APPENDIX 13.1-G INDOOR AIR CONTAMINANT GUIDELINES AND RECOMMENDATIONS (NON-INDUSTRIAL)

PHYSICAL SOURCES

Relative Humidity and Temperature

Reference 13.1G-6 See Figure 5.4.2 of reference 13.1.G-6. This figure has a chart that shows typical temperature ranges that provide 80% or 90% occupant satisfaction for thermal comfort for spaces that are naturally conditioned (opening/closing windows) where occupants have activity levels that produce a metabolic rate between 1.0 – 1.3 met. Since this chart takes into consideration people’s clothing adaptation in naturally conditioned spaces by relating acceptable indoor temperatures and outdoor temperatures, clo values do not need to be estimated. This chart also does not require humidity or air speed measurements. See below for rough examples of acceptable temperature ranges from the chart at three mean monthly outdoor temperatures for the two occupant satisfaction levels. Please keep in mind that the indoor temperatures are operative temperatures that combine Dry Bulb Temperature and Mean Radiant Temperature. Dry Bulb Temperature can be used as a proxy for operative temperature under certain conditions. See reference 13.1.G-6 Informative Appendix I for specific information.

80% Acceptability Limits Indoor Temperature Range °F	90% Acceptability Limits Indoor Temperature Range °F	Monthly Outdoor Temperature °F
~63 to ~76	~65 to ~74	50
~69 to ~81	~71 to ~79	68
~74 to ~87	~76 to ~85	86

See reference 13.1G-6, Figure 5.4.2 for actual acceptable ranges of operative temperature.)

Radon (Radiation)

Reference 13.1G-7 4 pCi/L (fix problem)
2 – 4 pCi/L (consider fixing problem)
1.3 pCi/L (average indoor level)
0.4 pCi/L (average outdoor level)

Reference 13.1G-8 100 Bq/m³, annual average (recommended national reference level)
300 Bq/m³, annual average (if 100 Bq/m³, annual average, cannot be implemented under the prevailing country specific conditions)

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PHYSICAL SOURCES

Ventilation

Reference 13.1G-1 (Default Combined Outdoor Air Rate)	Office spaces - 17 cfm outdoor air/person Classrooms – 13-15 cfm outdoor air/person Lecture classroom/hall - 8 cfm outdoor air/person Libraries – 17 cfm outdoor air/person Auditorium – 5 cfm outdoor air/person Cafeteria – 9 cfm outdoor air/person Smoking lounge – Reference does not provide ventilation rates for smoking areas. (See reference 13.1G-1, Table 6.2.2.1 for full listing and notes on minimum ventilation rates in breathing zone.)
Reference 13.1G-1 Informative Appendix C)	General ventilation to dilute human bioeffluent odors, to satisfy a substantial majority of visitors to a space with sedentary persons - 15 cfm outdoor air/person

ABBREVIATIONS

ppm = parts per million
mg = milligram
m³ = cubic meter
µg = microgram
% = percent
met = metabolic rate
clo = clothing thermal insulation value
° F = degrees Fahrenheit
pCi = picoCuries (pico = 10⁻¹²; 1 curie = 3.7x10¹⁰ Bq; 1 pCi/L = 37 Bq/m³)
L = liter
Bq = Becquerels
cfm = cubic feet per minute

APPENDIX 13.1-G REFERENCES CITED

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