ANSI/ASHRAE/IESNA Addendum *g* to
ANSI/ASHRAE/IESNA Standard 90.1-2001

# ASHRAE STANDARD

# Energy Standard for Buildings Except Low-Rise Residential Buildings

**Approved by the ASHRAE Standards Committee on June 28, 2003; by the ASHRAE Board of Directors on July 3, 2003; and by the American National Standards Institute on August 6, 2003.**

**This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE web site, *http://www.ashrae.org*, or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard and printed copies of a public review draft may be purchased from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: *orders@ashrae.org*. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in U.S. and Canada).**



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ASHRAE obtains consensus through participation of its national and international members, associated societies, and public review.

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## FOREWORD

*This revision of Table 9.3.1.1 and replacement of Table 9.3.1.2 represent a complete update of the LPD values in the tables based on a comprehensive review of the inputs to the space and building models used to derive these values. The review included recent research data on fluorescent fixture light loss factors and space type characteristics of new commercial construction, as well as revised lighting level recommendations as published in the* IESNA Lighting Handbook*, 9th edition. The review covered all model inputs and applied current knowledge of lighting principles, design applications, and efficient equipment availability.*

- ***Light level inputs.*** *Each of the 124 individual space models was reviewed and both task lighting and general lighting levels compared with the new IESNA 9th edition recommendations. Changes were made where appropriate.*
- ***Applied lighting technologies.*** *Each of the 124 individual space models incorporates up to three specific lighting technologies represented by generic luminaire (fixture) types. Changes were made to more appropriate technologies where current design practice warranted.*
- ***Lighting technology application formula.*** *The formula was revised to directly weight the technologies by lumen output of each technology, providing a more accurate assessment of power needs for all technology types.*
- ***Lighting technology efficiencies and light loss factors.*** *The lamp efficacy for each of the 35 generic luminaire/fixture types and the associated lamp lumen depreciation factors were reevaluated based upon current, commonly available technologies. A recent study (Luminaire Dirt Depreciation Study, July 2000, NALMCO No. CX824574-01-0) was used to update these values for most fluorescent luminaire types. The luminaire dirt depreciation value for all remaining types was reviewed against the latest* IESNA Lighting Handbook*.*
- ***Luminaire/fixture data.*** *The generic luminaire type performance characteristics (efficiency, etc.) are based on the actual tested characteristics of over 240 specific luminaire products. These were reviewed and generally found to be still valid. New luminaire data were incorporated where applicable.*
- ***Whole building LPD development data.*** *The proposed whole building values are derived by applying the 124 space models to detailed interior space type data on a set of 246 buildings (increased from 95).*

## ADDENDUM *g* to 90.1-2001 (I-P and SI EDITIONS)

***1. Revise Table 9.3.1.1 as shown to incorporate revised whole building LPD values and split the previous hospital/health care category into two separate categories. The revised LPD values reflect current light source efficiency data, recent research work on light loss factors, and the latest IESNA light level recommendations.***

### *I-P TABLES:*

**TABLE 9.3.1.1**
**Lighting Power Densities Using the Building Area Method**

| Building Area Type[a] | Lighting Power Density (W/ft$^2$) |
|---|---|
| Automotive Facility | ~~1.5~~0.9 |
| Convention Center | ~~1.4~~1.2 |
| Court House | ~~1.4~~1.2 |
| Dining: Bar Lounge/Leisure | ~~1.5~~1.3 |
| Dining: Cafeteria/Fast Food | ~~1.8~~1.4 |
| Dining: Family | ~~1.9~~1.6 |
| Dormitory | ~~1.5~~1.0 |
| Exercise Center | ~~1.4~~1.0 |
| Gymnasium | ~~1.7~~1.1 |
| Healthcare-Clinic | 1.0 |
| Hospital~~/Healthcare~~ | ~~1.6~~1.2 |
| Hotel | ~~1.7~~1.0 |
| Library | ~~1.5~~1.3 |
| Manufacturing Facility | ~~2.2~~1.3 |
| Motel | ~~2.0~~1.0 |
| Motion Picture Theatre | ~~1.6~~1.2 |
| Multi-Family | ~~1.0~~0.7 |
| Museum | ~~1.6~~1.1 |
| Office | ~~1.3~~1.0 |
| Parking Garage | 0.3 |
| Penitentiary | ~~1.2~~1.0 |
| Performing Arts Theatre | ~~1.5~~1.6 |
| Police/Fire Station | ~~1.3~~1.0 |
| Post Office | ~~1.6~~1.1 |
| Religious Building | ~~2.2~~1.3 |
| Retail | ~~1.9~~1.5 |
| School/University | ~~1.5~~1.2 |
| Sports Arena | ~~1.5~~1.1 |
| Town Hall | ~~1.4~~1.1 |
| Transportation | ~~1.2~~1.0 |
| Warehouse | ~~1.2~~0.8 |
| Workshop | ~~1.7~~1.4 |

a In cases where both general building area type and a specific building area type are listed, the specific building area type shall apply.

*2. Replace Table 9.3.1.2 with the following new table to incorporate revised space-by-space LPD values and provide a table format that includes the same space categories as the previous table but in a clearer, easier-to-use format. These revised LPD values reflect current light source efficiency data, recent research on light loss factors, and the latest IESNA light level recommendations.*

**TABLE 9.3.1.2 Lighting Power Densities Using the Space-by-Space Method**

| Space-by-Space Method Lighting Power Density (LPD) | | | |
|---|---|---|---|
| **Common Space Types[a]** | **LPD (W/ft$^2$)** | **Building Specific Space Types (Continued)** | **LPD (W/ft$^2$)** |
| Office-enclosed | 1.1 | Fire Stations | |
| Office-open plan | 1.1 | Fire Station Engine room | 0.8 |
| Conference/ Meeting/ Multipurpose | 1.3 | Sleeping Quarters | 0.3 |
| Classroom/ Lecture/ Training | 1.4 | Post Office - Sorting Area | 1.2 |
| For Penitentiary | 1.3 | Convention Center - Exhibit Space | 1.3 |
| Lobby | 1.3 | Library | |
| For Hotel | 1.1 | Card File & Cataloguing | 1.1 |
| For Performing Arts Theater | 3.3 | Stacks | 1.7 |
| For Motion Picture Theatre | 1.1 | Reading Area | 1.2 |
| Audience/ Seating Area | 0.9 | Hospital | |
| For Gymnasium | 0.4 | Emergency | 2.7 |
| For Exercise Center | 0.3 | Recovery | 0.8 |
| For Convention Center | 0.7 | Nurse station | 1.0 |
| For Penitentiary | 0.7 | Exam/Treatment | 1.5 |
| For Religious Buildings | 1.7 | Pharmacy | 1.2 |
| For Sports Arena | 0.4 | Patient Room | 0.7 |
| For Performing Arts Theatre | 2.6 | Operating Room | 2.2 |
| For Motion Picture theatre | 1.2 | Nursery | 0.6 |
| For Transportation | 0.5 | Medical Supply | 1.4 |
| Atrium-first three floors | 0.6 | Physical Therapy | 0.9 |
| Atrium-each additional floor | 0.2 | Radiology | 0.4 |
| Lounge/Recreation | 1.2 | Laundry-Washing | 0.6 |
| For Hospital | 0.8 | Automotive – Service/Repair | 0.7 |
| Dining area | 0.9 | Manufacturing | |
| For Penitentiary | 1.3 | Low Bay (<25 ft Floor to Ceiling Height) | 1.2 |
| For Hotel | 1.3 | High Bay (>25 ft Floor to Ceiling Height) | 1.7 |
| For Motel | 1.2 | Detailed Manufacturing | 2.1 |
| For Bar Lounge/Leisure Dining | 1.4 | Equipment room | 1.2 |
| For Family Dining | 2.1 | Control room | 0.5 |
| Food Preparation | 1.2 | Hotel/ Motel Guest Rooms | 1.1 |
| Laboratory | 1.4 | Dormitory - Living Quarters | 1.1 |
| Restrooms | 0.9 | Museum | |
| Dressing/Locker/Fitting Room | 0.6 | General Exhibition | 1.0 |
| Corridor/Transition | 0.5 | Restoration | 1.7 |
| For Hospital | 1.0 | Bank/Office - Banking Activity Area | 1.5 |
| For Manufacturing Facility | 0.5 | Religious Buildings | |

a In cases where both a common space type and a building specific space type are listed, the building specific space type shall apply.

**TABLE 9.3.1.2 Lighting Power Densities Using the Space-by-Space Method (Continued)**

| | | | |
|---|---|---|---|
| Stairs – active | 0.6 | Worship-pulpit, choir | 2.4 |
| Active Storage | 0.8 | Fellowship Hall | 0.9 |
| For Hospital | 0.9 | Retail [For accent lighting see 9.3.1.2.1.(c)] | |
| Inactive storage | 0.3 | Sales area | 2.1 |
| For Museum | 0.8 | Mall Concourse | 1.7 |
| Electrical/ mechanical | 1.5 | Sports Arena | |
| Workshop | 1.9 | Ring Sports Area | 2.7 |
| | | Court Sports Area | 2.3 |
| **Building Specific Space Types** | | Indoor Playing Field Area | 1.4 |
| Gymnasium/ Exercise Center | | Warehouse | |
| Playing Area | 1.4 | Fine Material Storage | 1.4 |
| Exercise Area | 0.9 | Medium/Bulky Material Storage | 0.9 |
| Courthouse/ Police Station/ Penitentiary | | Parking Garage - Garage Area | 0.2 |
| Courtroom | 1.9 | Transportation | |
| Confinement Cells | 0.9 | Airport - Concourse | 0.6 |
| Judges Chambers | 1.3 | Air/Train/Bus - Baggage Area | 1.0 |
| | | Terminal - Ticket counter | 1.5 |

***SI TABLES:***

**TABLE 9.3.1.1**
**Lighting Power Densities**
**Using the Building Area Method**

| Building Area Type[a] | Lighting Power Density ($W/m^2$) |
|---|---|
| Automotive Facility | ~~16~~10 |
| Convention Center | ~~15~~13 |
| Court House | ~~15~~13 |
| Dining: Bar Lounge/Leisure | ~~16~~14 |
| Dining: Cafeteria/Fast Food | ~~19~~15 |
| Dining: Family | ~~20~~17 |
| Dormitory | ~~16~~11 |
| Exercise Center | ~~15~~11 |
| Gymnasium | ~~18~~12 |
| Healthcare-Clinic | 11 |
| Hospital~~/Healthcare~~ | ~~17~~13 |
| Hotel | ~~18~~11 |
| Library | ~~16~~14 |
| Manufacturing Facility | ~~24~~14 |
| Motel | ~~22~~11 |
| Motion Picture Theatre | ~~17~~13 |
| Multi-Family | ~~11~~8 |
| Museum | ~~17~~12 |
| Office | ~~14~~11 |
| Parking Garage | 3 |
| Penitentiary | ~~13~~11 |
| Performing Arts Theatre | ~~16~~17 |
| Police/Fire Station | ~~14~~11 |
| Post Office | ~~17~~12 |
| Religious Building | ~~24~~14 |
| Retail | ~~20~~16 |
| School/University | ~~16~~13 |
| Sports Arena | ~~16~~12 |
| Town Hall | ~~15~~12 |
| Transportation | ~~13~~11 |
| Warehouse | ~~13~~9 |
| Workshop | ~~18~~15 |

a In cases where both general building area type and a specific building area type are listed, the specific building area type shall apply.

## TABLE 9.3.1.2 Lighting Power Densities Using the Space-by-Space Method

| Space-by-Space Method Lighting Power Density (LPD) | | | |
|---|---|---|---|
| **Common Space Types[a]** | **LPD ($W/m^2$)** | **Building Specific Space Types (Continued)** | **LPD ($W/m^2$)** |
| Office-enclosed | 12 | Fire Stations | |
| Office-open plan | 12 | Fire Station Engine room | 9 |
| Conference/ Meeting/ Multipurpose | 14 | Sleeping Quarters | 3 |
| Classroom/ Lecture/ Training | 15 | Post Office - Sorting Area | 13 |
| For Penitentiary | 14 | Convention Center - Exhibit Space | 14 |
| Lobby | 14 | Library | |
| For Hotel | 12 | Card File & Cataloguing | 12 |
| For Performing Arts Theater | 36 | Stacks | 18 |
| For Motion Picture Theatre | 12 | Reading Area | 13 |
| Audience/ Seating Area | 10 | Hospital | |
| For Gymnasium | 4 | Emergency | 29 |
| For Exercise Center | 3 | Recovery | 9 |
| For Convention Center | 8 | Nurse station | 11 |
| For Penitentiary | 8 | Exam/Treatment | 16 |
| For Religious Buildings | 18 | Pharmacy | 13 |
| For Sports Arena | 4 | Patient Room | 8 |
| For Performing Arts Theatre | 28 | Operating Room | 24 |
| For Motion Picture theatre | 13 | Nursery | 6 |
| For Transportation | 5 | Medical Supply | 15 |
| Atrium-first three floors | 6 | Physical Therapy | 10 |
| Atrium-each additional floor | 2 | Radiology | 4 |
| Lounge/Recreation | 13 | Laundry-Washing | 6 |
| For Hospital | 9 | Automotive - Service/Repair | 8 |
| Dining area | 10 | Manufacturing | |
| For Penitentiary | 14 | Low Bay (<25 ft Floor to Ceiling Height) | 13 |
| For Hotel | 14 | High Bay (>25 ft Floor to Ceiling Height) | 18 |
| For Motel | 13 | Detailed Manufacturing | 23 |
| For Bar Lounge/Leisure Dining | 15 | Equipment room | 13 |
| For Family Dining | 23 | Control room | 5 |
| Food Preparation | 13 | Hotel/ Motel Guest Rooms | 12 |
| Laboratory | 15 | Dormitory - Living Quarters | 12 |
| Restrooms | 10 | Museum | |
| Dressing/Locker/Fitting Room | 6 | General Exhibition | 11 |
| Corridor/Transition | 5 | Restoration | 18 |
| For Hospital | 11 | Bank/Office - Banking Activity Area | 16 |
| For Manufacturing Facility | 5 | Religious Buildings | |
| Stairs – active | 6 | Worship-pulpit, choir | 26 |
| Active Storage | 9 | Fellowship Hall | 10 |
| For Hospital | 10 | Retail [For accent lighting see 9.3.1.2.1.(c)] | |
| Inactive storage | 3 | Sales area | 23 |

a In cases where both a common space type and a building specific space type are listed, the building specific space type shall apply.

**TABLE 9.3.1.2 Lighting Power Densities Using the Space-by-Space Method (Continued)**

| | | | |
|---|---|---|---|
| For Museum | 9 | Mall Concourse | 18 |
| Electrical/ mechanical | 16 | Sports Arena | |
| Workshop | 20 | Ring Sports Area | 29 |
| | | Court Sports Area | 25 |
| **Building Specific Space Types** | | Indoor Playing Field Area | 15 |
| Gymnasium/ Exercise Center | | Warehouse | |
| Playing Area | 15 | Fine Material Storage | 15 |
| Exercise Area | 10 | Medium/Bulky Material Storage | 10 |
| Courthouse/ Police Station/ Penitentiary | | Parking Garage - Garage Area | 2 |
| Courtroom | 20 | Transportation | |
| Confinement Cells | 10 | Airport - Concourse | 6 |
| Judges Chambers | 14 | Air/Train/Bus - Baggage Area | 11 |
| | | Terminal - Ticket counter | 16 |

## POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the standards and guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive technical committee structure, continue to generate up-to-date standards and guidelines where appropriate and adopt, recommend, and promote those new and revised standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating standards and guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.