



Approved Method: **IES Spatial Daylight
Autonomy (sDA) and
Annual Sunlight Exposure
(ASE)**

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and
Annual Sunlight Exposure (ASE)**

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has been approved by IES.
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should be directed to IES.

**Prepared by:
The Daylight Metrics Committee**

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IES Approved Method for Daylight Metrics

FOREWORD

Assessing the dynamic qualities of a daylit space requires different methods of assessment than those that have been developed for a space that is electrically lighted. With electric lighting, average illuminance is a significant and useful metric, especially in designs that aim to provide general illumination at a predetermined target illuminance. However, in a daylit space, average illuminance has less meaning. One reason is purely spatial; for example, sidelit environments inherently have non-uniform illuminance distributions due to the geometric relation of room and aperture, and internal shading from furnishings. Typically there is a high illumination level near the window which quickly diminishes with increased distance. Another reason is both spatial and temporal; the daylight sources of sun, sky and clouds vary in luminous intensity and position each hour of the day and over the course of a year, and corresponding illumination within the space varies relative to the geometry of daylight apertures such as windows and skylights. In addition, daylight performance metrics must also consider the likely impact of daylight control devices, such as blinds or shades, which may be static, manually operated or automated.

Because daylight illumination levels are dynamic, the performance of daylight needs to be considered over time. Annual daylight performance integrates variations over one full year, including both daily and seasonal variations. Because the variability of daylight is highly dependent upon local climate conditions, especially the daily and seasonal balance of daylight provided from direct sunlight versus the sky and clouds, accounting for local climate conditions is also critical. The optimal design of a daylit system is likely to be very different for a foggy coastline location compared to a nearby inland desert.

Over the last few decades a variety of new daylighting metrics have been proposed to overcome the inability of older metrics to assess these dynamic conditions. Most of these new metrics require substantial computational power to process a large number of input variables such as building and site data, climate data, occupancy schedules, and sun control device operation. Given the range of inputs, the variations in methodology to generate these metrics can be substantial, but also not readily apparent to users.

INTRODUCTION

IES LM-83-12 was created to develop a new suite of metrics capable of describing multiple important dimensions of daylighting performance in an existing building and a new design, from concept through construction documents. The intent of these new climate-based metrics is to improve on the predictive performance of historical metrics, such as Daylight Factor^{9,10,15,19} and define a consistent calculation methodology that would allow for multiple design alternatives of proposed designs, daylit buildings, and/or climatic locations to be compared, in a consistent manner.

During the metric development process, existing accepted daylight performance metrics were identified, reviewed, and assessed.³ It was determined that no single metric could adequately address all of the factors involved in a successful daylighting system. The committee also concluded that a core set of useful and meaningful metrics must provide for the evaluation of an entire daylit area or building over the course of a full year, accounting for daily and yearly climatic variation, rather than the historical approach of analysis of a single point in space at a singular design condition or one point in time. In assessing candidate climate-based metrics, outputs from annual simulation methodologies that account for the dynamics of climatic variation and building operation were compared to evaluations of real spaces by both experts and occupants.

Two metrics have been developed to date, and are described in this document, which allow a daylit space to be evaluated for a one year period using two different performance parameters: sufficiency of daylight illuminance and the potential risk of excessive sunlight penetration. The first metric is Spatial Daylight Autonomy (sDA), a measure of daylight illuminance sufficiency for a given area, reporting a percentage of floor area that exceeds a specified illuminance level (e.g. 300 lux) for a specified amount of annual hours (e.g. 50% of the hours from 8AM-6PM). The second metric is Annual Sunlight Exposure (ASE), which provides a second dimension of daylight analysis, looking at one potential source of visual discomfort: direct sunlight. Both metrics use the same building information and simulation methodology to analyze hourly illumination patterns, summed for an annual period, across an analysis area. Both should be reported together to evaluate building designs. When used together, these two metrics provide a meaningful first-level understanding of how a space/design is expected to

perform, and can help inform the daylighting design evaluation process as design solutions are developed and refined. These metrics can be referenced by building codes or design guidelines to describe acceptable occupant comfort expectations for daylit spaces. Additionally, they can enable controlled research studies on other aspects of daylight performance, such as whole building energy efficiency or occupant behavior.

These first two metrics were developed from supporting field research which included comparison of expert and occupant assessments of 61 daylit spaces to very detailed simulation model output.^{3,20,21} While there are many limitations of this research, further experience with these metrics will continue to refine recommendations for their application. Subsequent metrics are planned which will allow a daylighting design or daylit space to be further evaluated relative to other aspects of a daylit space, such as uniformity, contrast, or glare, and eventually human health and building energy impacts.

A daylit environment is the result of many complex inputs, thus it is possible to vary the range or values of numerous inputs. For consistency, the inputs to generate the IES metrics described herein have been standardized in order to enable their use in codes, standards and specifications that must answer the question: “Is this a daylit space?”, “How much of this space or building is illuminated by daylight?”, “What is the potential for visual discomfort from too much direct sunlight in this space?” These questions imply the establishment of criteria that can enable an equitable comparison across spaces, using a continuous ranking along one or more dimensions. Thus, the goal of the Committee has been to define a suite of metrics, and supporting methodology, that will enable professionals to distinguish between the performance of spaces along a continuous scale, rather than only answering a simplified yes/no question.

1.1 SCOPE

The metrics described in this document are intended to be applicable to common workplace environments. They are based on an analysis of open offices, classrooms, meeting rooms, multi-purpose rooms, and service areas in libraries and lobbies, and so are most applicable to areas with similar visual tasks. These metrics are neither counter to, nor do they supersede, IES task lighting criteria for these space types. These metrics do not directly address energy consumption, as electric lighting management is highly variable.

The area of analysis for these metrics is ideally a coherent “space”, defined by opaque walls and access to daylight through at least one wall or ceiling surface. It is also possible to apply these metrics to the “regularly occupied” floor area of a building, or some part of a building, such as one floor plate. It is important to specify the “area of analysis” to which the percentages apply.

These metrics were derived from a study of daylit spaces in the continental United States, and thus are most applicable to similar latitudes and cultures.

2.0 SPATIAL DAYLIGHT AUTONOMY (sDA)

2.1 sDA – Introduction

2.1.1 Definition Spatial Daylight Autonomy (sDA) is a metric describing annual sufficiency of ambient daylight levels in interior environments. It is defined as the percent of an analysis area (the area where calculations are performed—typically across an entire space) that meets or exceeds a minimum daylight illuminance level for a specified fraction of the operating hours per year, i.e. the Daylight Autonomy value following Reinhart & Walker, *ibid.*, 2001.¹² The illuminance level and time fraction are included as subscripts, as in sDA_{300,50%}. The sDA value is expressed as a percentage of area.

2.1.2 Standard Thresholds for Analysis Spatial Daylight Autonomy_{300/50%} (sDA_{300/50%}) is recommended as the preferred metric for analysis of daylight sufficiency. This metric uses an analysis illuminance threshold of 300 lux on horizontal surfaces to first assess the number of hours per year that each analysis point within a given analysis area meets or exceeds this value from daylight alone. Daylight conditions are based on typical meteorological year (TMY) data, with an analysis time period extending from 8AM to 6PM local clock time (10 hours per day), which will hereafter be referred to as the analysis period. Blinds or shades are operated hourly to block direct sunlight penetration into the space as defined in **Section 2.2 Building 3D Modeling Methodology**.

sDA_{300/50%} is then reported as the percent of analysis points across the analysis area that meet or exceed this 300 lux value for at least 50% of the analysis period. While alternative thresholds and analysis periods may be appropriately used for more detailed performance analysis of an individual daylit space, these standard analysis thresholds—of 300 lux and 50% temporal threshold over a 10 hour day—are recommended for specification and reporting so that comparisons can also be made to a consistent performance standard.