

2019 Title 24 Codes & Standards Enhancement (CASE) Proposal

Advanced Daylighting Design

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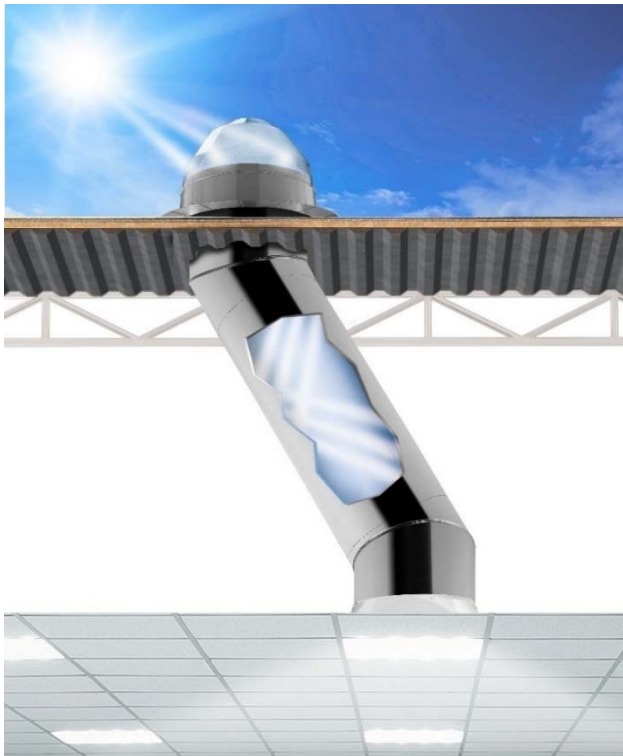
Proposed Code Change Overview

1. Update to the prescriptive requirements for Minimum Visible Transmittance (Min VT) for Tubular Daylighting Devices (TDDs) based on a new National Fenestration Rating Council (NFRC) Test Procedure
2. Update to the skylit daylit zone definition / user manual to ensure proper interpretation for skylights in atriums

The proposed code changes will impact all commercial buildings that comply using the prescriptive method and use skylights for daylighting.

Proposed Code Change Overview

1. Update to the prescriptive requirements for Minimum Visible Transmittance (Min VT) for Tubular Daylighting Devices (TDDs) based on a new NFRC Test Procedure



Images credit: Solatube, Sunoptics

Proposed Code Change History

- NFRC recently developed a new procedure (NFRC 203) for determining Visible Transmittance (VT) of Tubular Daylighting Devices (TDDs) termed VT_{annual}
 - This new procedure calculates VT more appropriately for the complex geometry of various TDDs
 - Title 24 prescriptive requirements for Minimum VT needs to be updated to reflect these changes from NFRC

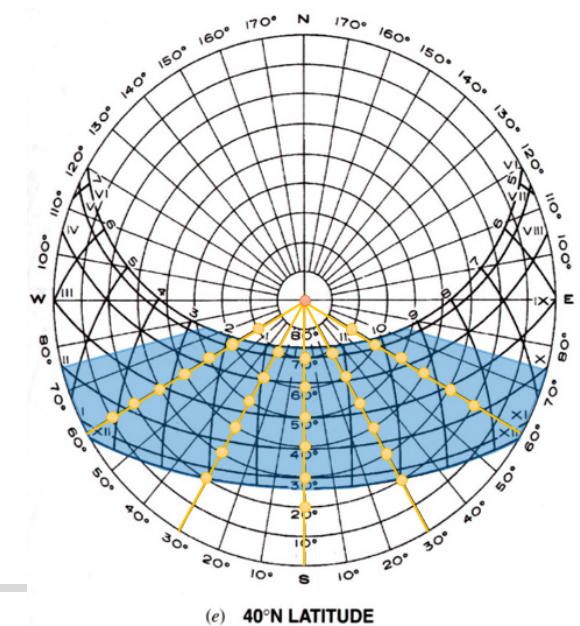
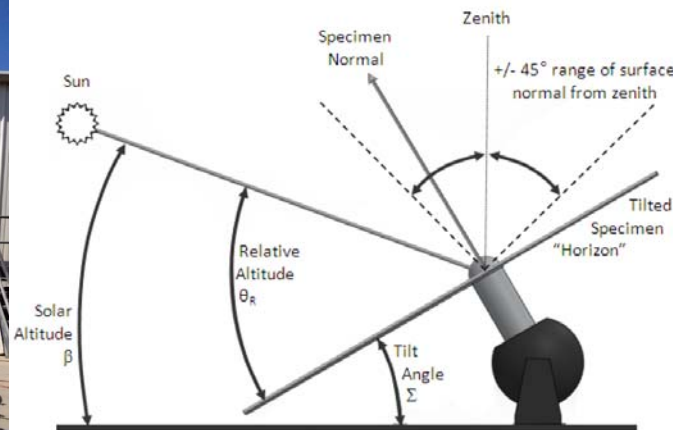
Context

- TDDs have optics designed to **selectively** transmit or reflect light and heat from **various sun angles**
 - A rating method that uses only **direct-normal angle** does not capture its performance at other angles



Context

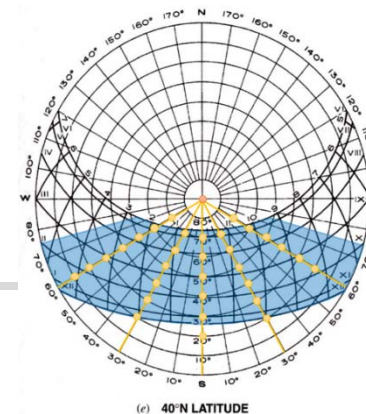
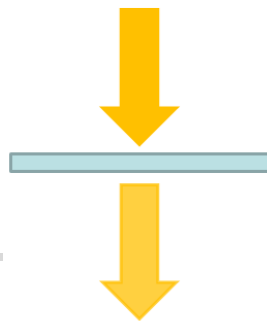
- NFRC 203-2014 – A new Test Apparatus and Methodology for Determining the VT_{annual} Product Rating for Optically-Complex TDDs
 - Rates a TDD product under **multiple different angles** of incidence



Context

- NFRC 203 procedure differs from the traditional NFRC 200 procedure

NFRC 200	NFRC 203
Products rated under direct-normal illumination (a vertical beam of light directed perpendicular to a test sample of glazing)	Products rated under 18 different angles of incidence and time-weighted averaged (angles represents the sun's actual movement through the sky for Middle America - 40° North Latitude)
Rating: VT	Rating: VT _{annual}




Context


- NFRC 203 makes it possible to compare performance of optically complex products

	NFRC 200	NFRC 203
Simple glazing products (like flat windows)	✓	✓
Complex optics products (like TDDs)	✗	✓

Context

- VT_{annual} is clearly displayed on the TDD product's NFRC label

 National Fenestration Rating Council CERTIFIED	SOLATUBE International Inc. Tubular Daylighting Device Molded Single or Double Plastic Dome, Single Glazed Plastic Diffuser Thermal Opening Area= 0.1 m ² Part No. 501685 Rev. B			STU-K-6
	ENERGY PERFORMANCE RATINGS			
Product Description	Insulation at Ceiling			
	U-Factor (U.S./I-P)	Solar Heat Gain Coefficient (SHGC)	VT _{annual}	
	Individual Option Number			
M74 DS-O Dual Dome with Prismatic Diffuser	1.06	0.28	—	
	STU-K-6-00002-00001			
M74 DS-O Dual Dome with Prismatic Diffuser	1.39	0.29	0.52	
	STU-K-6-00001-00001			
Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information. www.nfrc.org				

 National Fenestration Rating Council CERTIFIED	SOLATUBE International Inc. Hybrid Tubular <i>Daylighting Device</i> Molded Single or Double Plastic Dome, Dual or Quad glazed Plastic Diffuser Thermal Opening Area = 0.33m ² Part No. 501703 Rev. C CPD # STU-K-3		
	ENERGY PERFORMANCE RATINGS		
Product Description	Insulation at Ceiling		
	U-Factor (U.S./I-P)	Solar Heat Gain Coefficient (SHGC)	VT _{annual}
750 DS-C Dual Dome with Optiview Diffuser	0.51	0.19	0.39
			STU-K-3-00007-00002
750 DS-C Dual Dome with Prismatic Diffuser	0.51	0.21	0.39
			STU-K-3-00007-00001
750 DS-C Single Dome with Optiview Diffuser	0.51	0.22	0.43
			STU-K-3-00006-00002
750 DS-C Single Dome with Prismatic Diffuser	0.51	0.23	0.43
			STU-K-3-00007-00002
330 DS-C Single Dome with Optiview Diffuser	0.51	0.32	0.37
			STU-K-3-00005-00002
330 DS-C Single Dome with Prismatic Diffuser	0.51	0.34	0.37
			STU-K-3-00005-00001
Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information. www.nfrc.org			

Current Code Requirements

Existing Title 24 2016 Requirements

– Table 140.3-B Prescriptive Envelope Criteria

CONTINUED: TABLE 140.3-B – PRESCRIPTIVE ENVELOPE CRITERIA FOR NONRESIDENTIAL BUILDINGS (INCLUDING RELOCATABLE PUBLIC SCHOOL BUILDINGS WHERE MANUFACTURER CERTIFIES USE ONLY IN SPECIFIC CLIMATE ZONE; NOT INCLUDING HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS)

Envelope	Fenestration			All Climate Zones				
					Fixed Window	Operable Window	Curtainwall or Storefront	Glazed Doors ²
		Vertical	Area-Weighted Performance Rating	Max U-factor	0.36	0.46	0.41	0.45
				Max RSHGC	0.25	0.22	0.26	0.23
			Area-Weighted Performance Rating	Min VT	0.42	0.32	0.46	0.17
				Maximum WWR%	40%			
		Skylights			Glass, Curb Mounted	Glass, Deck Mounted	Plastic, Curb Mounted	
			Area-Weighted Performance Rating	Max U-factor	0.58	0.46	0.88	
				Max SHGC	0.25	0.25	NR	
			Area-Weighted Performance Rating	Min VT	0.49	0.49	0.64	
Maximum SRR%	5%							

Current Code Requirements

Existing Title 24 2016 Requirements

SECTION 110.6 – Mandatory Requirements For Fenestration Products And Exterior Doors

- (a) 4. Visible Transmittance (VT). The fenestration product's VT shall be rated in accordance with NFRC 200 or ASTM E972, for **tubular skylights** VT shall be rated using NFRC 203

Typical Practices

- Many TDD products rated with the **new** NFRC 203 procedure have a VT_{annual} lower than the Min VT threshold set for plastic, curb mounted skylights of 0.64.
- As a result ...
 - Architects/designers using the prescriptive code cannot use TDDs to comply with daylighting requirements
 - Performance method also does not provide TDDs with credit for solar angle based transmittance

Typical Practices

- Architects and designers use TDDs as an option for daylighting spaces
 - Where traditional skylights may not be appropriate
 - Spaces with dropped ceilings
 - Buildings with limited roof area available for skylights
 - Retrofit projects with existing plenums and duct work



Images credit: Solatube, Sunoptics

Market Overview and Analysis

Current Market

- TDDs have been available in the market since 2001 and have a well established network of dealers and installers.

Market impacts

- Expected to promote products with complex optics optimized for selective transmittance of solar angles

Market barriers

- Current prescriptive code Min VT requirement

Other market information sources we should know about?

Methodology for Analysis

Methodology for analysis

- Spreadsheet based analysis to compare performance of TDDs and traditional plastic curb mounted skylights
 - Determine an “equivalent” Min VT_{annual} threshold for TDDs

Data sources for analysis

- NFRC 203 testing data from various TDD manufacturers
- NBI PIER Skylight Photometry Data (HMG 2003) for traditional skylights
- Third party testing data on traditional skylights from manufacturers
- Other data sources?

Compliance and Enforcement- Market Actors

- Market Actor #1 – Architects / Designers
- Market Actor #2 – Code Officials / Plan checkers / Field Inspector
- Market Actor #3 – TDD Manufacturers
- Market Actor #4 – NFRC and Members
- Market Actor #5 – Compliance Software Manufacturer
- Others?

Compliance and Enforcement—Tasks

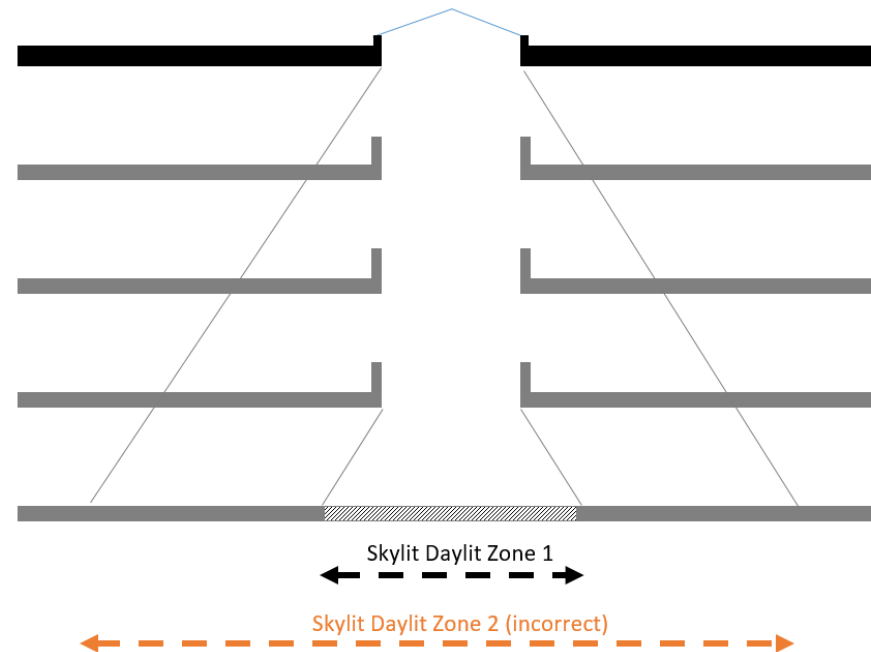
Market Actor	Task(s)	Success Criteria
Architect/Designer	<ul style="list-style-type: none"> - Design building envelope to meet Title 24, Part 6 - Specifies products 	<ul style="list-style-type: none"> - Design buildings that meet building owner's needs and comply with Title 24, Part 6
Code Officials / Plan Checkers / Field Inspector	<ul style="list-style-type: none"> - Check to ensure all components of building envelope meet code 	<ul style="list-style-type: none"> - Understand Title 24, Part 6 - Properly inspect everything
TDD Manufacturers	<ul style="list-style-type: none"> - Provide products that meet Title 24, Part 6 requirements - Educate distributors of the new code update 	<ul style="list-style-type: none"> - Develop products that meet Title 24, Part 6 requirements that are cost-effective
NFRC and Members	<ul style="list-style-type: none"> - Inform of change in code - Enlist for support in outreach 	<ul style="list-style-type: none"> - Properly understand technologies being rated - Understand Title 24, Part 6
Compliance Software Manufacturer	<ul style="list-style-type: none"> - Incorporate new technologies in compliance software 	<ul style="list-style-type: none"> - Properly understand new technologies and code

Compliance and Enforcement—Resources

Market Actor	Resource(s)
Architect/Designer	<ul style="list-style-type: none">- Resources: Compliance manual, CEC hotline, EnergyCodeAce- Tools: CBECC-Com, EnergyPro/Compliance Software, SkyCalc, Radiance, others?
Code Officials / Plan Checkers / Field Inspector	<ul style="list-style-type: none">- Resources: CABEC Courses on code change
TDD Manufacturers	<ul style="list-style-type: none">- Resources: NFRC Meetings
NFRC and Members	<ul style="list-style-type: none">- Resources: NFRC Meetings
Compliance Software Manufacturer	<ul style="list-style-type: none">- Resources: Conferences (ASHRAE, IBPSA, SimBuild)

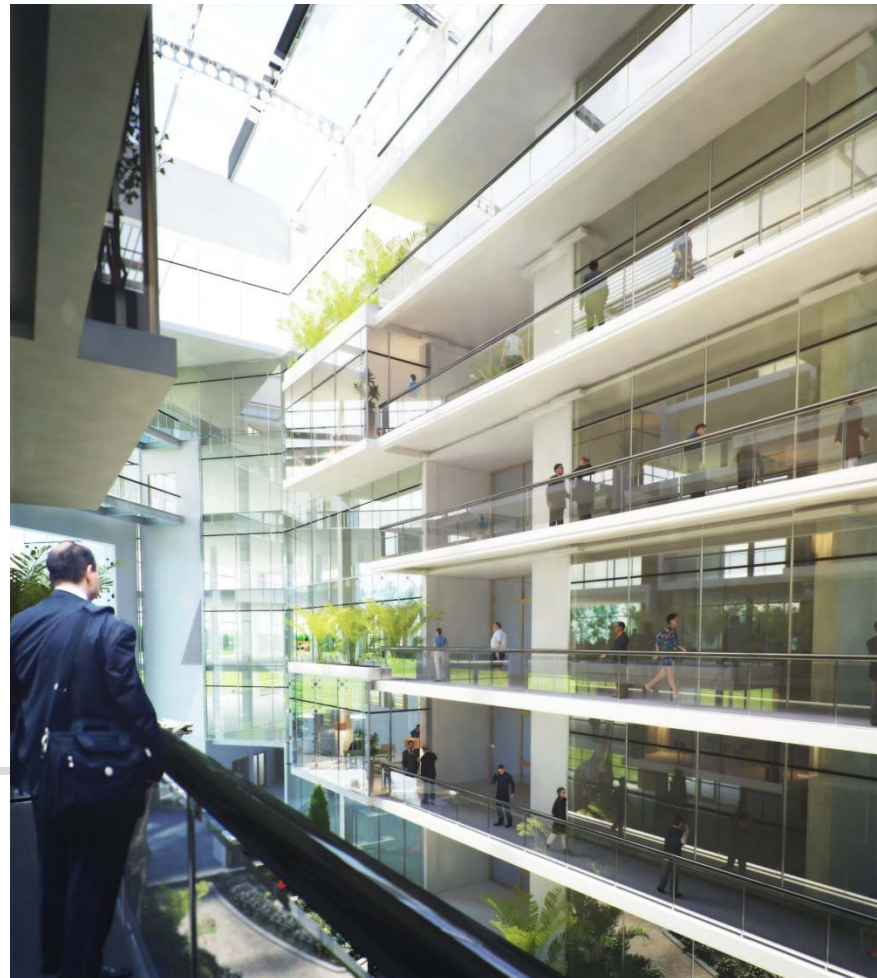
Proposed Code Change Overview

Update to the skylit daylit zone definition / user manual to ensure proper interpretation for skylights in atriums



Examples

Symmetrical atriums



Examples

Asymmetrical atriums



Proposed Code Change History

The skylit daylit zone definition in Title 24 2016 Code and the explanation in the User Manual do not consider the case of skylights in Atriums.

- Vertical obstruction are considered

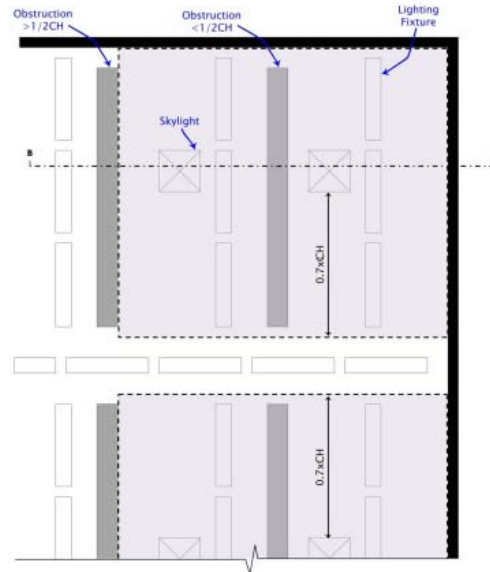


Figure 5-5 – Skylit Daylit Zone Diagram 1

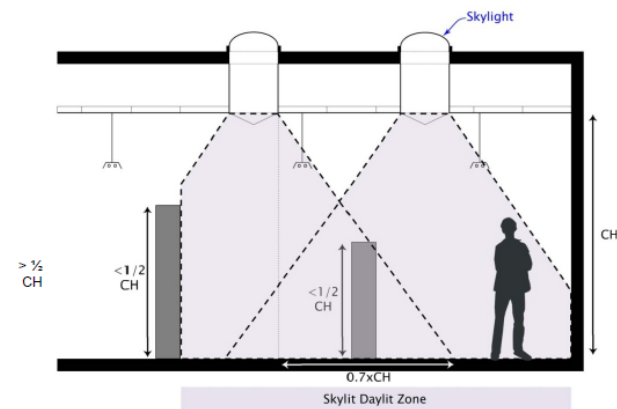


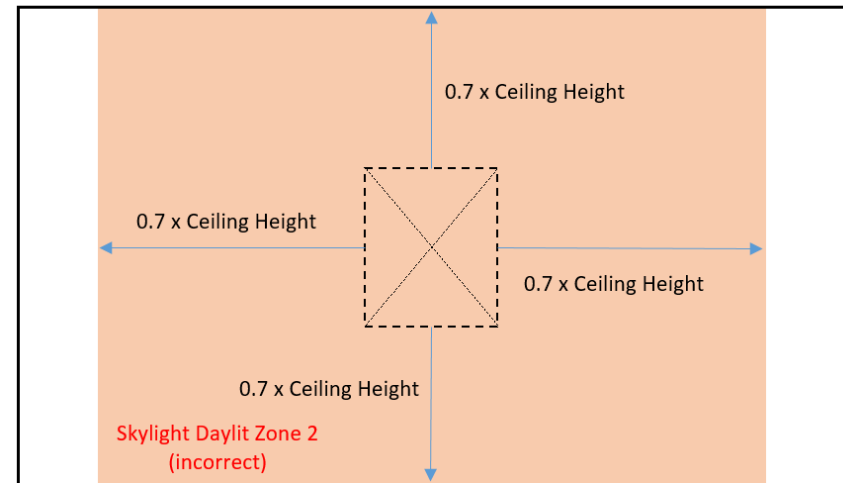
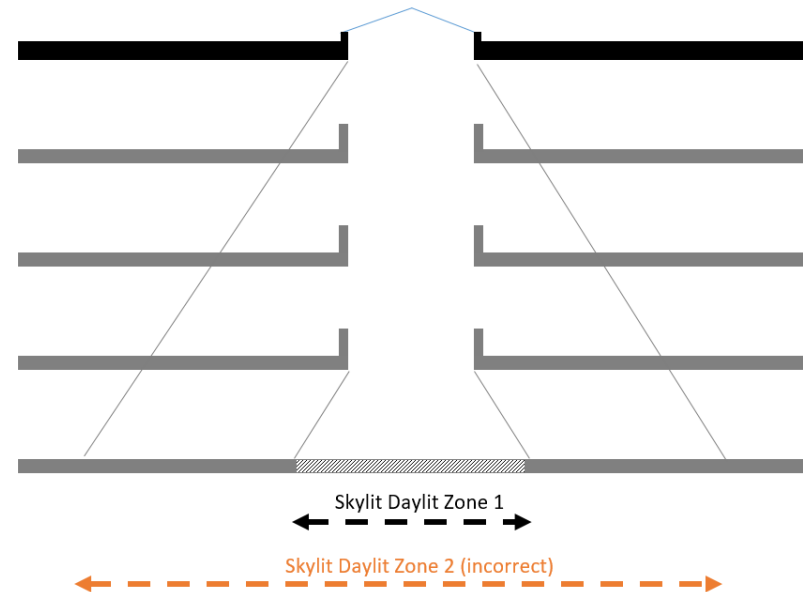
Figure 5-6 – Skylit Daylit Zone Diagram 2

Current Code Requirements

SKYLIT DAYLIT ZONE is the rough area **in plan view** under each skylight, plus 0.7 times the **average ceiling height in each direction from the edge of the rough opening of the skylight**, minus any area on a plan beyond a permanent obstruction that is taller than the following: A permanent obstruction that is taller than one-half the distance from the floor to the bottom of the skylight. The bottom of the skylight is measured from the bottom of the skylight well for skylights having wells, or the bottom of the skylight if no skylight well exists.

Context

- For a building with an atrium (example hotel or office lobby/common area, etc.)
 - In plan view**, roof plan layered over the first floor plan may result in an incorrect skylit daylit zone (shown as Skylit Daylit Zone 2)

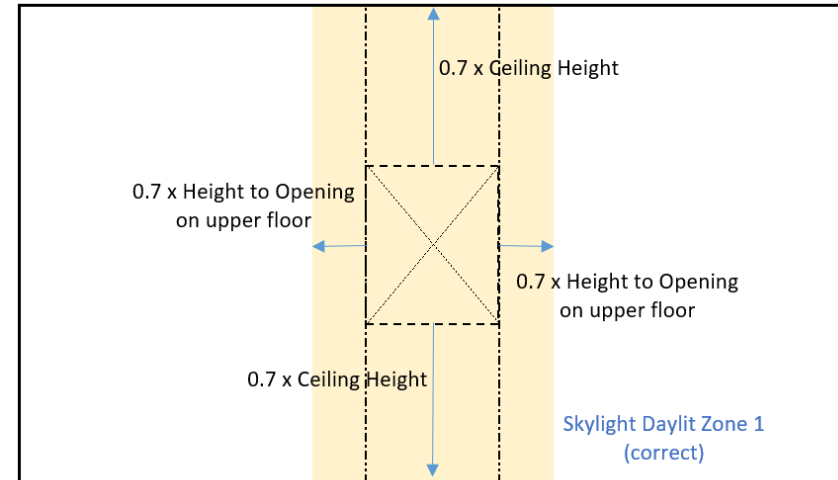
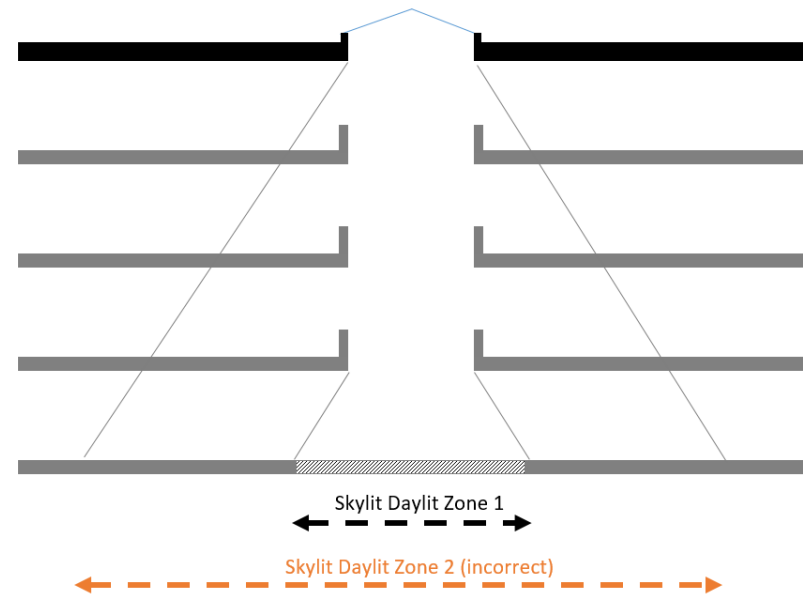


First floor plan showing
only skylight

PLAN

Context

- The rough opening on the upper floor needs to be considered to develop the correct skylit daylit zone (shown as Skylit Daylit Zone 1)



First floor plan showing
skylight and opening on
2nd floor

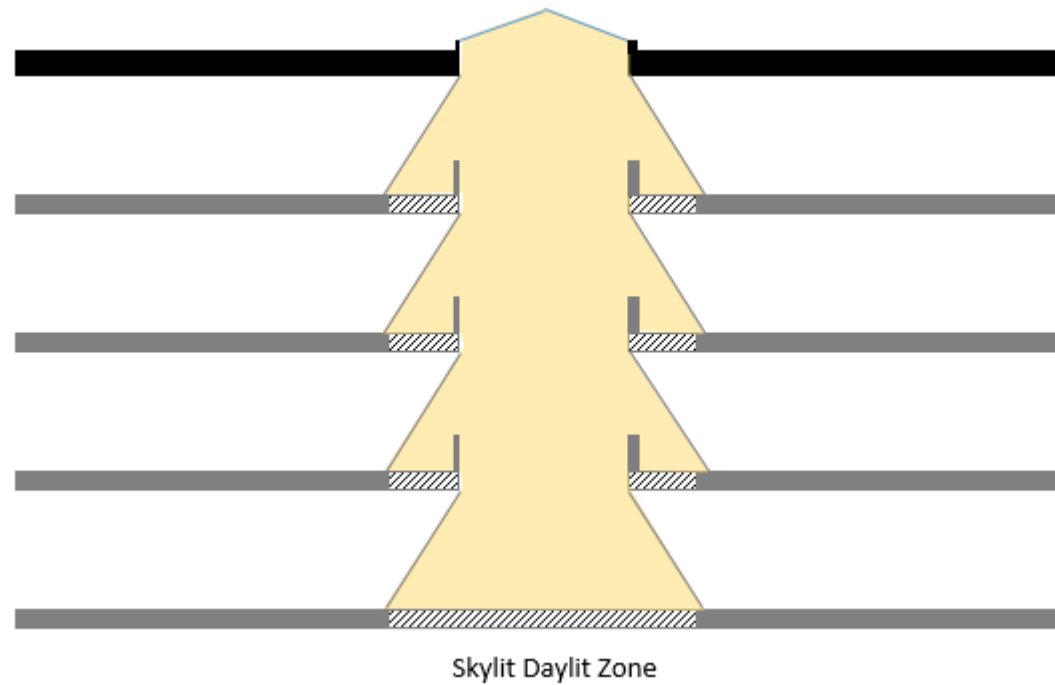
PLAN

Strawman Code Change Language

SKYLIT DAYLIT ZONE is the rough area in plan view under each skylight, plus 0.7 times the average ceiling height in each direction from the edge of the rough opening of the skylight, minus any area on a plan beyond a permanent obstruction that is taller than the following: A permanent obstruction that is taller than one-half the distance from the floor to the bottom of the skylight. The bottom of the skylight is measured from the bottom of the skylight well for skylights having wells, or the bottom of the skylight if no skylight well exists. **If a floor receives daylight from an opening in the floor above, then the edge of that opening is to be considered the bottom of the skylight well.**

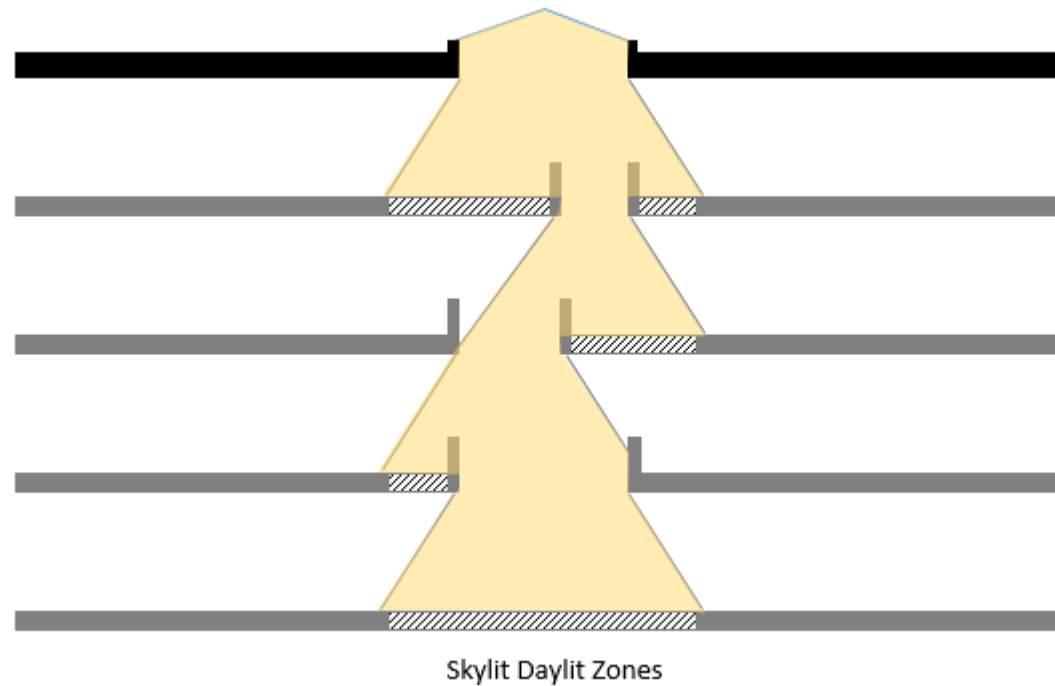
Code Interpretation

- Symmetrical Atrium Section



Code Interpretation

- Asymmetrical Atrium Section



Feedback Request from Stakeholders

- Are there Skylight/TDD performance data that we should review for our analysis?
- Should the skylight daylight zone definition be modified to include the atrium case and/or explained in the User Manual?
 - If you wish to provide information, please email CASE author **Mudit Saxena (MSaxena@vistar-energy.com)**

Thank you.

Mudit Saxena: MSaxena@vistar-energy.com

