MAINTENANCE TECHNICAL SUPPORT CENTER
HEADQUARTERS MAINTENANCE OPERATIONS
UNITED STATES POSTAL SERVICE

Maintenance Management Order

SUBJECT: Snow Accumulation on Postal Facility Roofs

DATE: December 11, 2015
NO: MMO-070-15
FILE CODE: P
bell:mm15053ag

TO: Area Managers
District Offices
Maintenance Capable Facilities
Area Maintenance
Safety Managers

This Maintenance Management Order (MMO) **supersedes MMO-026-83**, and provides a framework for assessing and confirming design snow loads for United States Postal Service (USPS) facility roofs. Roof collapse due to snow or ice accumulation is a real concern during winter storms. Therefore, sites should inspect roofs, drawings, and specifications to ensure that the roofs conform to the minimum design loads for building and structures. Sites should correct inadequately designed roofs or develop and document interim procedures for minimizing roof snow accumulations. **All sites must post, in a visible fashion, the roof load capacity in pounds per square foot (lb/ft^2) at all access doors to the roof.** This bulletin applies to Acronym BLDG and Class Code BA.

Direct any questions or comments concerning this bulletin to the MTSC HelpDesk, online at https://tickets.mtsc.usps.gov/login.php or call (800) 366-4123.

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Attachment: Snow Removal Criteria

ATTACHMENT

SNOW REMOVAL CRITERIA

1.0. BACKGROUND

All states in the United States except for Florida must consider roof snow loading. The American Society of Civil Engineers (ASCE) Standard 7, "Minimum Design Loads for Buildings and Other Structures," establishes snow load design criteria in the United States. Buildings' structural design, as well as configuration and thermal design influence the distribution of snow and ice on roofs. Therefore, sites should ensure that building design drawings and specifications meet ASCE minimum design loads for roof snow loads.

Roof snow load is the weight of the snow and ice on the roof, and it is generally reported in pounds per square foot, lb/ft^2. The weight of the snow, however, will vary depending on its water content and location. Snow load on the ground can provide a rough indication of roof snow load. However, roof snow loads depend on a variety of factors, such as melting and re-freezing of snow and ice; drifting; roof slope; type of roof; and design features.

NOTE

The National Weather Service (NWS) is the largest source of information on snow on the ground in the United States. Each NWS station determines the maximum depth of snow on the ground each winter and its water equivalent load. To determine the snow loads maps, the NWS uses 50-year loads.

2.0. CALCULATING SNOW LOAD

If the facility does not know the snow load for the roof, the snow load can be calculated using the information in this section.

The calculations contained in this section originated from The American Society of Civil Engineers (ASCE) Standard 7, "Minimum Design Loads for Buildings and Other Structures."

ASCE 7, Chapter 7, Snow Loads, provides the formulas for calculating design snow loads on flat roofs (p_f), sloped roofs (p_s), and low-slope roofs (p_m) in pounds per square foot (lb/ft^2). Refer to Section 2.1 to acquire the necessary variables, Section 2.2 to calculate snow loads for flat roofs, Section 2.3 to calculate snows loads for sloped roofs, and Section 2.4 to calculate snow loads for low-slope roofs.

It will be necessary to first calculate the snow loads for flat roofs before calculating snow loads for sloped and low sloped roofs.

2.1. DETERMINING VARIABLES

Use the following sections for gathering the pertinent data for performing snow load calculations.

2.1.1 Calculating Exposure Factor (C_e)

1. Based on Table 1, find the Roof Exposure Factor based on the terrain type and the Exposure of Roof category.

Table 1. Exposure Factor Values

Terrain Type	Terrain Category	Exposure of Roof (C_e)		
		*Fully Exposed	**Partially Exposed	***Sheltered
Areas with many closely spaced obstructions, such as urban and suburban areas, wooded areas.	B	0.9	1.0	1.2
Open terrain with scatter obstructions. Airports and areas that are generally flat open country.	C	0.9	1.0	1.1
This category refers to flat, unobstructed areas and water surfaces outside hurricane prone regions; it includes smooth mud flats, salt flats, and unbroken ice that extend 5,000 ft. or 20 times the building height in the upwind direction.	D	0.8	0.9	1.0
Above tree line in windswept mountainous areas		0.7	0.8	N/A
Alaska – areas where trees do not exist with a 2 mile (3 km) radius of the site.		0.7	0.8	N/A

*Fully Exposed – Roofs exposed to all sides with no shelter afforded by terrain, higher structures, or trees. Roofs that contain several large pieces of mechanical equipment, parapets that extend above the height of the balance snow load (h_b), or other obstructions are not in this category.

**Partially Exposed – All roofs that do not qualify as Fully Exposed or Sheltered.

***Sheltered – Roofs located tight in conifers that qualify as obstructions.

2. Record the Roof Exposure Factor (C_e) here: _____

2.1.2 Calculating Thermal Factor (C_t)

1. Based on Table 2, find the Thermal Factor based on the thermal condition of the building.

Table 2. Thermal Factor Values

Thermal Condition	Value (C_t)
All structures except as indicated below, structures kept above freezing throughout the winter and have an R-value above 2.0 feet squared per hour per degree F / BTU. Or if the average temperature is above freezing and the roof is thoroughly ventilated. "Typically occupied dwellings that are heated have a thermal factor of 1.0."	1.0
Structures kept just above freezing and others with cold, ventilated roofs in which the terminal resistance (R-value) between the ventilated space and the heated space exceeds 25˚ F x h x ft^2/Btu (4.4 K x m^2/W).	1.1
Building is unoccupied throughout the winter and thus unheated. Or the average temperature in winter is below freezing, such as for an unheated garage or open air structure.	1.2
Structures intentionally kept below freezing	1.3
The average temperature is greater than 50 degrees F and R-value is less than 2.0 feet squared per hour per degrees F /BTU, such as a greenhouse. Continuously heated greenhouses with a roof having a thermal resistance (R-value) of less than 2.0˚ F x h x ft^2/Btu (0.4 K x m^2/W)	0.85

2. Record the Thermal Factor (C_t) here: _____

2.1.3 Calculating Importance Factor (I_s)

1. Based on Table 3, find the Snow Importance Factor based on the building use.

Table 3. Snow Importance Factor

Building Use	Risk Category	Snow Importance Factor (I_s)
In the event of failure, buildings and other structures that represent a low risk to human life.	1	0.80
All buildings and other structures except those listed in Risk Categories 1, 3, and 4.	2	1.00
In the event of failure, buildings and other structures pose a substantial risk to human life. Buildings and other structures, not included in Risk Category 4, with potential to cause a substantial economic impact and/or mass disruption of day-to-day civilian life in the event of a failure. Buildings and other structures, not included in Risk Category 4, with potential to cause a substantial economic impact and/or mass disruption of day-to-day civilian life in the event of a failure. Buildings and other structures, not included in Risk Category 4 (including, but not limited to, facilities that manufacture, process, handle, store, use or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing toxic or explosive substances where their quantity exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released.	3	1.10
Buildings and other structures designated as essential facilities. In the event of failure, buildings and other structures which could pose a substantial hazard to the community. Buildings and other structures (including, but not limited to, facilities that facilities that manufacture, process, handle, store, use or dispose of such substances as hazardous fuels, hazardous chemicals, or hazardous waste) containing sufficient quantities of highly toxic substances where the quantity exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released. Buildings and other structures required to maintain the functionality of other Risk Category 4 structures.	4	1.20

2. Record the Snow Importance Factor (I_s) here: _____

2.1.4 Calculating Ground Snow Load (p_g)

The Ground Snow Load (p_g) is based on data collected by the National Weather Service (NWS) collected over a 50-year period and is measured in pounds per square foot (lb/ft^2).

1. Refer to Figure 1 and Figure 2 to determine the Ground Snow Load for the Greater 48 States. Refer to Table 4 for the Ground Snow Load for Alaskan cities.

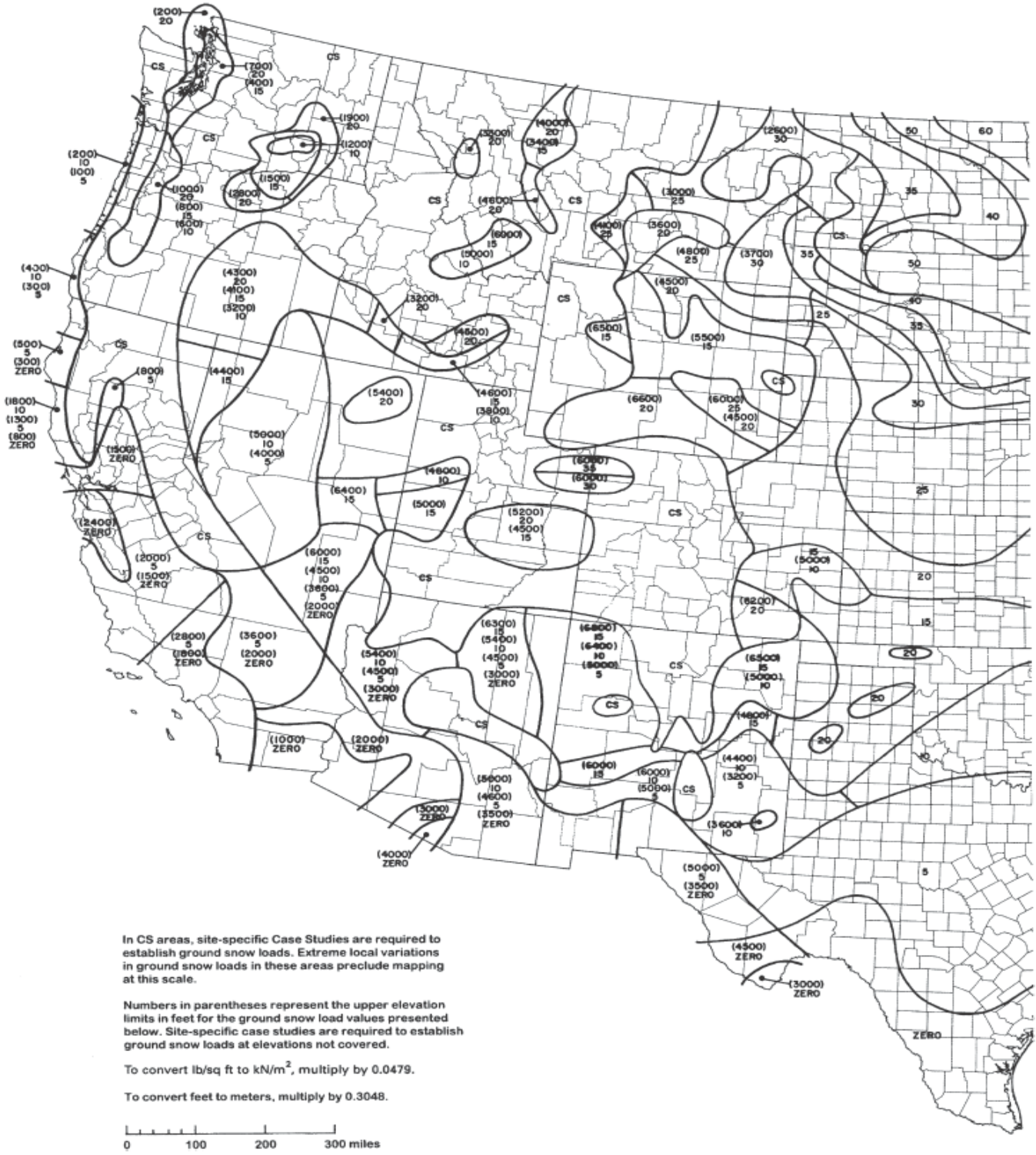


Figure 1. Ground Snow Loads (p_g) in lb/ft^2 for Western Half of USA

Figure 2. Ground Snow Loads (p_g) in lb/ft^2 for Eastern Half of USA

Table 4 Ground Snow Loads for Alaskan Locations

Location	p_g (lb/ft^2)	Location	p_g (lb/ft^2)	Location	p_g (lb/ft^2)
Adak	30	Galena	60	Petersburg	150
Anchorage	50	Gulkana	70	St. Paul	40
Angoon	70	Homer	40	Seward	50
Barrow	25	Juneau	60	Shemya	25
Barter	35	Kenai	70	Sitka	50
Bethel	40	Kodiak	30	Talkeetna	120
Big Delta	50	Kotzebue	60	Unalakleet	50
Cold Bay	25	McGrath	70	Valdez	160
Cordova	100	Nenna	80	Whittier	300
Fairbanks	60	Nome	70	Wrangell	60
Fort Yukon	60	Palmer	50	Yakutat	150

NOTE

The next step is an alternate method for determining Ground Snow Load (p_g).

2. If the Ground Snow Load (p_g) cannot be determined using Figure 1, Figure 2, and Table 4, manually measure the Ground Snow Load (p_g) using the following substeps:

   a. Cut out a 1-foot by 1-foot of full depth of the snow, including any ice, and place it in a plastic bag.

   b. Weigh the bag, snow, and ice. The weight of the snow and ice for the 1-foot by 1-foot (weight of snow (lb) / area (ft^2)) sample equals the snow load (in lb/ft^2).

NOTE

On some older buildings, minimum uniform design load for snow could be as low as 25 lb/ft^2, or an equivalent of 15 inches of snowfall. If the design snow load is not known, snow accumulation on the roof should not exceed depths of 15 inches.

   c. If the weight of the sample (per square foot) approaches or exceeds the design roof snow load (per square foot), snow removal is necessary.

3. Record the Ground Snow Load (p_g) here: _____

2.1.5 Calculating Roof Slope Factor (C_s)

1. Using the Thermal Factor (C_t) value recorded in Section 2.1.2, refer to Figure 3, Figure 4, and Figure 5 to find the Roof Slope Factor (C_S).
   a. For Warm Roofs with a $C_t \leq 1.0$, refer to Figure 3. The dashed line represents unobstructed slippery surfaces with R ≥ 30˚ for unventilated roofs, or R ≥ 20˚ for ventilated roofs. The solid line represents all other warm roofs.
   b. For Cold Roofs with a $C_t = 1.1$, refer to Figure 4. The dashed line represents unobstructed slippery surfaces. The solid line represents all other surfaces.
   c. For Cold Roofs with a $C_t \geq 1.2$, refer to Figure 5. The dashed line represents unobstructed slippery surfaces. The solid line represents all other surfaces.

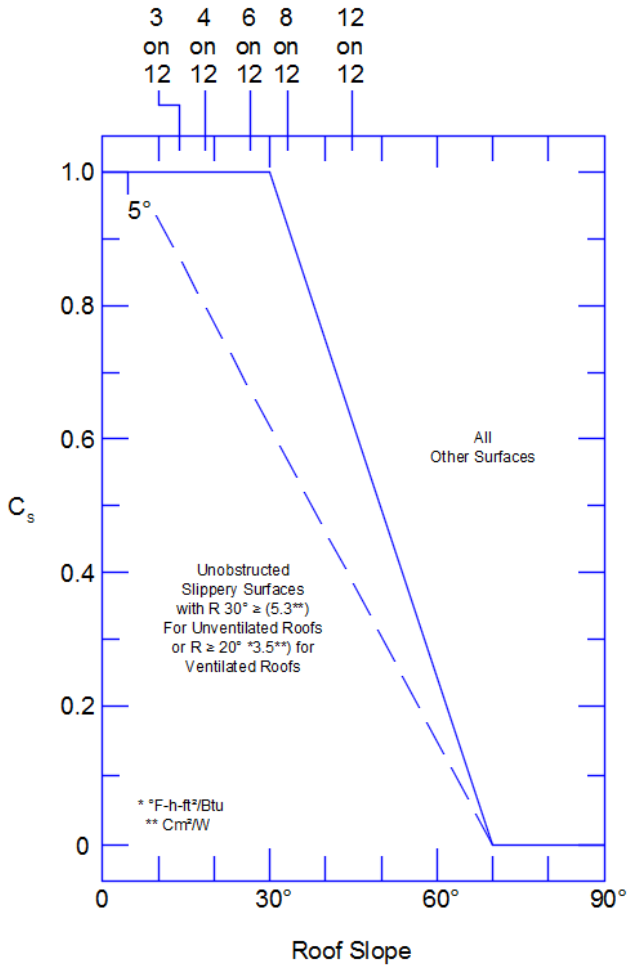


Figure 3. Roof Slope for Warm Roofs with Thermal Factor (C_t) ≤ 1.0

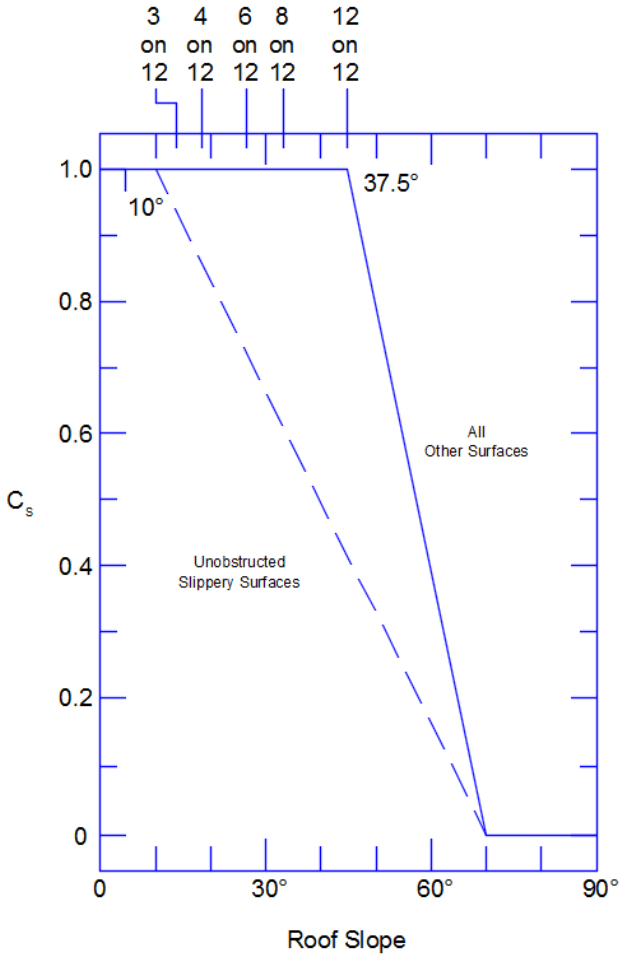


Figure 4. Roof Slope for Cold Roofs with Thermal Factor (C_t) = 1.1

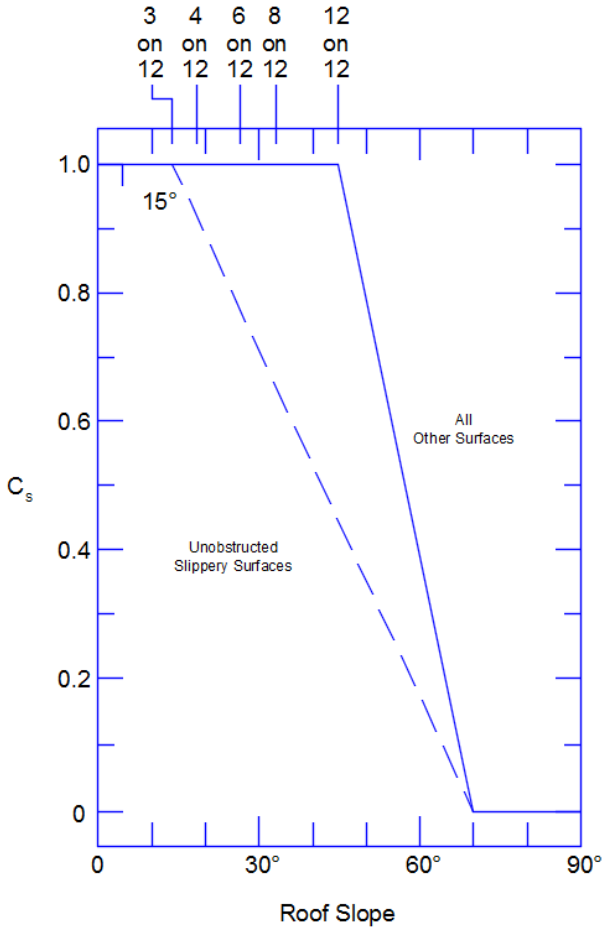


Figure 5. Roof Slope for Cold Roofs with Thermal Factor (C_t) ≥ 1.2

2. Record the Roof Slope Factor (C_s) here: _____

2.2. CALCULATING FLAT ROOF SNOW LOAD (p_f)

Flat roofs are defined as roofs that have a slope of 5˚ or less. The formula for calculating snow loads on flat roofs is:

$$p_f = 0.7C_eC_tI_sp_g$$

Refer to Table 5 for variable definitions for the Flat Roof Snow Load Calculation.

Table 5. Flat Roof Snow Load Calculation Variables

Variable	Definition	Section #
p_f	Flat Roof Snow Load	
C_e	Roof Exposure Factor	2.1.1
C_t	Thermal Factor	2.1.2
I_s	Importance Factor	2.1.3
p_g	Ground Snow Load	2.1.4

1. Substitute the variables recorded in the Sections listed in Table 5 into the formula:

$$p_f = 0.7C_eC_tI_sp_g$$

2. Solve for p_f to acquire the Flat Roof Snow Load.

3. Record the Flat Roof Snow Load (p_f) here: _____

2.3. CALCULATING SLOPE ROOF SNOW LOAD (p_s)

NOTE

To calculate slope roof snow load, Section 2.2 must be performed prior to calculating slope roof snow load.

Sloped roofs are defined as roofs that have a slope of 15˚ or more. The formula for calculating snow loads on sloped roofs is:

$$p_s = C_sp_f$$

Refer to Table 6 for variable definitions for the Slope Roof Snow Load Calculation.

Table 6. Slope Roof Snow Load Calculation Variables

Variable	Definition	Section #
p_s	Slope Roof Snow Load	
C_s	Roof Slope Factor	2.1.5
p_f	Flat Roof Snow Load	2.2

1. Substitute the variables recorded in the Sections listed in Table 6 into the formula:

$$p_s = C_s p_f$$

2. Solve for p_s to acquire the Slope Roof Snow Load.

3. Record the Slope Roof Snow Load (p_s) here: _____

2.4. CALCULATING LOW-SLOPE ROOF SNOW LOAD (p_m)

Low-Slope (mono-slope) Roofs (p_m) are defined as roofs with less than 15° of slope, and curved roofs where the vertical angle from eaves to the crown is less than 10° of slope.

The formula for calculating snow loads on sloped roofs is:

$$p_m = I_s p_g$$

Refer to Table 7 for variable definitions for the Low-Slope Roof Snow Load Calculation.

Table 7. Low-Slope Roof Snow Load Calculation Variables

Variable	Definition	Section #
p_m	Low-Slope Roof Snow Load	
I_s	Importance Factor	2.1.3
p_g	Ground Snow Load	2.1.4

1. Substitute the variables recorded in the Sections listed in Table 7 into the formula:

$$p_m = I_s p_g$$

NOTE

If the value in Section 2.1.4 for p_g less than or equal to 20lb/ft^2, use the actual numerical value recorded in Section 2.1.4 for p_g.

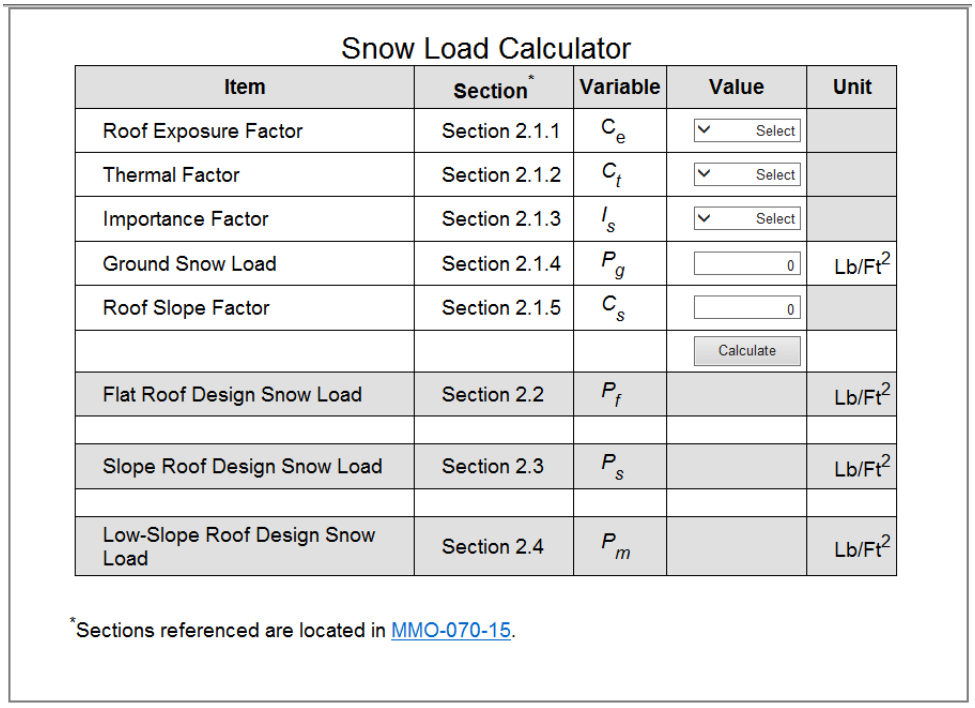
If the value in Section 2.1.4 for p_g greater than 20lb/ft^2, use 20lb/ft^2 for p_g.

2. Solve for p_m to acquire the Low-Slope Roof Snow Load.

3. Record the Low-Slope Roof Snow Load (p_m) here: _____

2.5. FINAL CALCULATION

An online calculator is available on the MTSC Building Equipment webpage. Navigate to http://www.mtsc.usps.gov > Equipment BUILDING > BUILDING POPULAR INFORMATION > Snow Load Calculator, to open the calculator and enter the collected variables. Use this calculator to ensure accurate snow load values. An example of the calculator is shown in Figure 6.



Snow Load Calculator

Item	Section*	Variable	Value	Unit
Roof Exposure Factor	Section 2.1.1	C_e	Select	
Thermal Factor	Section 2.1.2	C_t	Select	
Importance Factor	Section 2.1.3	I_s	Select	
Ground Snow Load	Section 2.1.4	P_g	0	Lb/Ft^2
Roof Slope Factor	Section 2.1.5	C_s	0	
			Calculate	
Flat Roof Design Snow Load	Section 2.2	P_f		Lb/Ft^2
Slope Roof Design Snow Load	Section 2.3	P_s		Lb/Ft^2
Low-Slope Roof Design Snow Load	Section 2.4	P_m		Lb/Ft^2

*Sections referenced are located in MMO-070-15.

Figure 6. Roof Snow Load Calculator Example

Use the building design specifications and drawings to determine the amount of weight the building roof can safely support per square foot and compare it to ASCE 7 STD calculation. If it is less than the than ASCEs calculation, inform your Facilities representative. Keep in mind that if the roof or supporting structure has deterioration, the roof is likely to support less weight than noted on the design specifications and drawings. Therefore, adequate maintenance of structural supports and roof is paramount. Additionally, post design equipment additions to the roof, or structural alterations, as well as alterations to adjacent structures could adversely influence roof-loading capacity. If the roof load capacity is in question, contact the Facilities Single Source Provider (FSSP) response line for assistance in determining the correct roof load capacity.

3.0. SNOW REMOVAL PRACTICES

3.1. MAINTENANCE MANAGER

The Maintenance Manager for maintenance capable sites should ensure that roof snow loading designs are known and readily available. Moreover, in the event that roofs require snow removal, the manager shall develop a written snow removal procedure taking into account all applicable Occupational Safety and Health Administration (OSHA) standards, and identify individual(s) responsible for supervising employees for roof snow removal tasks. Additionally, the manager must develop training or determine what available training is appropriate for employees who perform roof snow removal tasks. If the manager cannot satisfy all of the previously outlined requirements, the manager must use a qualified snow removal contractor via the Article-32 process. Refer to Section 3.7 and Section 4.0 for additional information.

3.2. HAZARD ALERT NOTES

Working on roofs with snow, ice, or wind carries a risk of a fall onto the roof, or a fall off the roof to the ground below or through a snow-covered skylight, all of which can be fatal. Thus, the overriding concern when removing snow or ice from roofs is the safety of employees. Therefore, USPS representatives are responsible for protecting employees from hazards associated with snow removal from roofs, as well as from roof collapse due to snow loads. This can be accomplished by developing and adhering to reliable and safe roof maintenance procedures.

Removing snow from roofs is not comparable to removing snow from parking lots. Roof snow removal techniques must account for structural elements supporting the roof, as well as but not limited to drift walls, parapets, roof drainage, multiple roof levels, and other tripping hazards. It is strongly recommended to consult a structural engineer when planning for roof snow removal. More importantly, anticipatory reaction ensures that USPS roofs can support ASCE snow load design criteria.

3.3. EVALUATE LOAD BEARING ON THE ROOF OR STRUCTURE

Before any USPS employees can access a roof or other elevated structure for snow or ice removal, all USPS facilities in snow areas should confirm that the roof or structure can support the added weight of snow, employees working on the roof, all equipment and ancillary materials brought onto the roof. Furthermore, for safety reasons, an employee should never be assigned to remove snow from a roof without at least one helper and appropriate communication equipment that not only enables communication between each other, but with the supervisor responsible for the snow removal work. Additionally, they should possess a schematic indicating the location of all roof openings, such as skylights, as well as tripping hazards and other structural elements supporting the roof. Employees should always use caution by remaining alert to unexpected sounds or movement around surfaces weighed down by snow (or water from melted snow), because these surfaces could collapse.

3.4. USE REQUIRED FALL PROTECTION

Falls cause most of the deaths and severe injuries that occur during snow removal operations. OSHA standards require employers to evaluate hazards and protect workers from falls when working at heights of 4 feet or more above a lower level (1910.23) when performing snow removal on roofs, the employee shall be tied off at all time by a retractable lanyard.

3.5. STRUCTURAL PROBLEMS

Warnings signs of structural problems due to excessive snow loads vary for different types of roofs and may include but are not limited to sudden roof leaks, cracks or movement in interior walls or ceilings, excessive sagging of structural roof elements or ceilings, and unusual sounds emanating from the attic space. These signs should be analyzed regardless of the season. Repeated or long term overloading of compromised roofs can cause roof fatigue, and significantly weaken roofs structure over time.

3.6. SAFE ROOF SNOW CLEARING PROCEDURE

Roof failures can be prevented using proper snow removal methods. The best approach is to remove the snow without accessing the roof. However, if roof access is necessary, it shall only occur after the design live load for the roof is known and supervision determines that the weight of snow, employees, additional tools, and ancillary materials brought on the roof do not exceed the design live load. All employees accessing any USPS roofs for snow removal shall be appropriately trained, equipped with the right tools, and proper personal protective equipment, including safety harnesses appropriately anchored.

3.7. RECOMMENDED SNOW REMOVAL ACTIONS

- If possible, use snow removal methods that do not involve employees on roofs.
- With a moderate to steep roof slope removal should be accomplished from the ground with a “snow rake.”
- If roof access is necessary, the potential load to be exerted on roof or structure (e.g., total weight of snow, workers, all equipment used and all ancillary materials to support work), must be compared to the load limit of the roof to determine if it is safe for employees to access the roof.
- If it is safe for employees to access the roof, use only personnel trained to remove snow and ice from roofs. All personnel on the roof shall adhere to OSHA requirements for safe work on roofs.
- Site managers shall review the potential hazards and require personal protection equipment (PPE) with employees prior to employees accessing the roof for snow and/or ice removal. PPE, such as retractable safety lanyards (for fall protection) shall be worn and secured to anchor points at all times during the roof snow removal process.

- Management shall clearly identify and rope off work areas on the roof, including a set back from the roof edge as required by OSHA, as well as designate and clearly mark access points to roof edge; and, limit the number of employees with access to the roof edge.
- Likewise, management shall instruct employees to rope off all affected ground areas and to secure an access area for a front loader.
- Provide employees with schematics indicating the location of all roof openings, such as but not limited to skylights, as well as tripping hazards and other structural elements supporting the roof. Some roofs have conduits and piping running across, it is important to identify roof tripping hazards and obstructions before assigning employees to roof snow removal.
- 2-way radio communication between Roof Team Members, as well as communication with the Ground Crew Leader is vital.
- Ensure that employees use ladders, aerial lifts, and any moving vehicles safely.
- It is also important to determine the direction of the roof trusses, and clear snow in a cross direction to these supports. Remove snow in narrow strips to keep the load somewhat even.
- Use a snow rake, and avoid chipping or picking away at ice as that may damage the roof. It is not necessary to remove all the snow; keeping a thin layer of snow can protect the roof from damage. Remove snow from sidewalls to prevent high snow mounds from pushing them in.
- If work is performed after daylight hours, appropriate illumination shall be provided.
- Temporarily shore up and brace dipping or sagging roofs or walls.
- Improper operation of doors or windows, deflection of ceiling finishes or exposed beams, roof leaks or sprinkler heads moved from their normal positions could be signs of roof failure.
- Inspect roofs for leaks or structural deficiencies that may develop during the storm.
- Clear snow and ice away from exhaust vents that go through exterior walls.
- Reduce deck stress by clearing snow off the deck.
- Clear areas around downspouts so that water from melting snow has a path to flow away from the building.

4.0. SAFE SNOW REMOVAL

1. Make certain gutters, drains and downspouts are clear of ice and debris. Shoveling several radial bands extending outward from the drain to the edge of the roof allows the snow to melt quickly and drain away while the crew is working. This also helps reduce loads, and allows the work area to drain as snow has a tendency to turn slushy as it is trampled.
2. Clear the center portion of each roof bay from the center ridge all the way to the foundation wall.
3. Remove snow from drift walls, skylights, parapets, or penthouse walls.
4. Divide the roof into sections, similar to Figure 7, and remove snow at a uniform rate. The best practice is to clear all areas at the same time. However, if a large crew is not available, remove snow from the center bay first, bay 1, then bay 2 and so on. Start between the primarily steels and clear a path from the peak to the eave, remove the snow completely off the roof.
5. Repeat for bay on the opposite side, before starting another section. Follow the numerical configuration depicted in Figure 6.

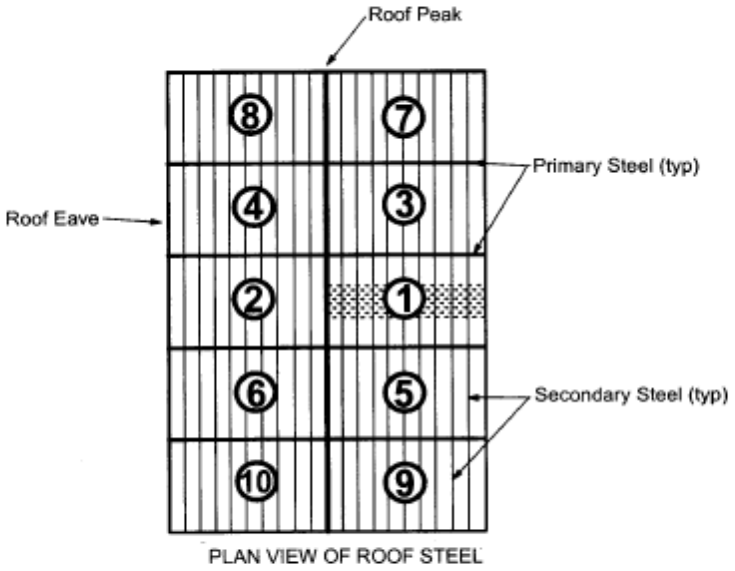


Figure 7. Snow Removal Pattern