

COUNTY REINSURANCE, LIMITED



Snow Load Risk Mitigation

2025



SOLUTIONS...DEFINED, DESIGNED, AND DELIVERED.

Introduction

Every year snow loading takes a toll in northern regions. Preparation start for snowfalls before winter approaches. This typically includes snow removal plans for sidewalks, parking lots, and roadways, contracting snowplows, and winterizing vehicles.

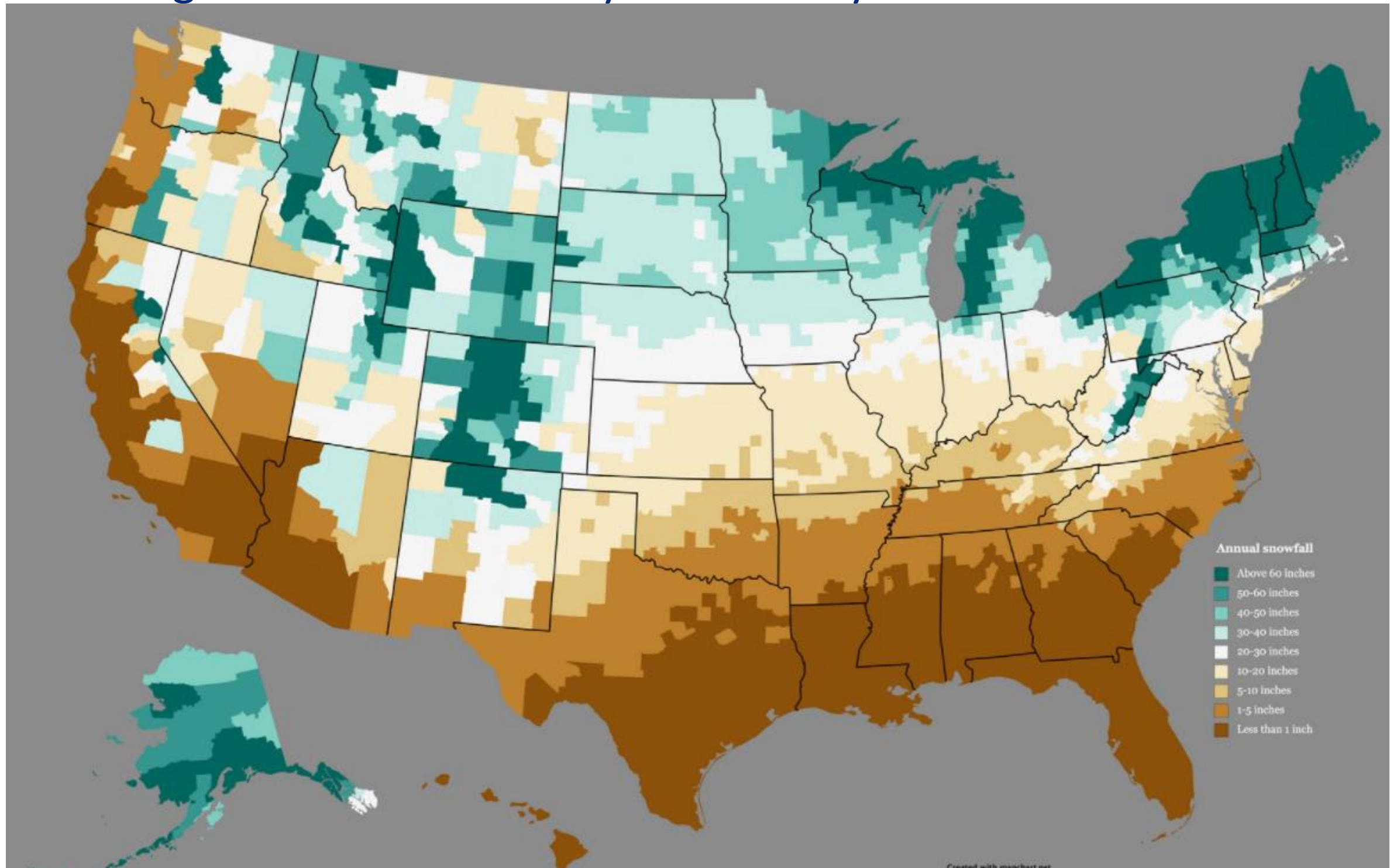
However, making a plan for **snow removal to prevent a roof collapse may be the most critical**. When a record storm occurs, or when a unique combination of moderate snowfall and thawing repeats, structures can be challenged to their design limits. When collapses occur, they are sudden and often catastrophic. These collapses can be very costly in terms of property damage and can interrupt production and operations.

With these repeated stresses and strains, “building to code” is often not a reliable defense against damage or collapse from snow loading. **Roof additions, changes to roof mounted equipment, and sustainability upgrades** (i.e., “green roofs”) **create added opportunities** for snow accumulation and drifting that did not exist prior. Further, joists and structural members installed at original construction may have reduced strength due to added interior loads (such as large fans or increased lighting), age, and wear and tear. The thousands of welds in open bar steel joists may not have been thoroughly inspected during construction and the hidden defect(s) never identified.

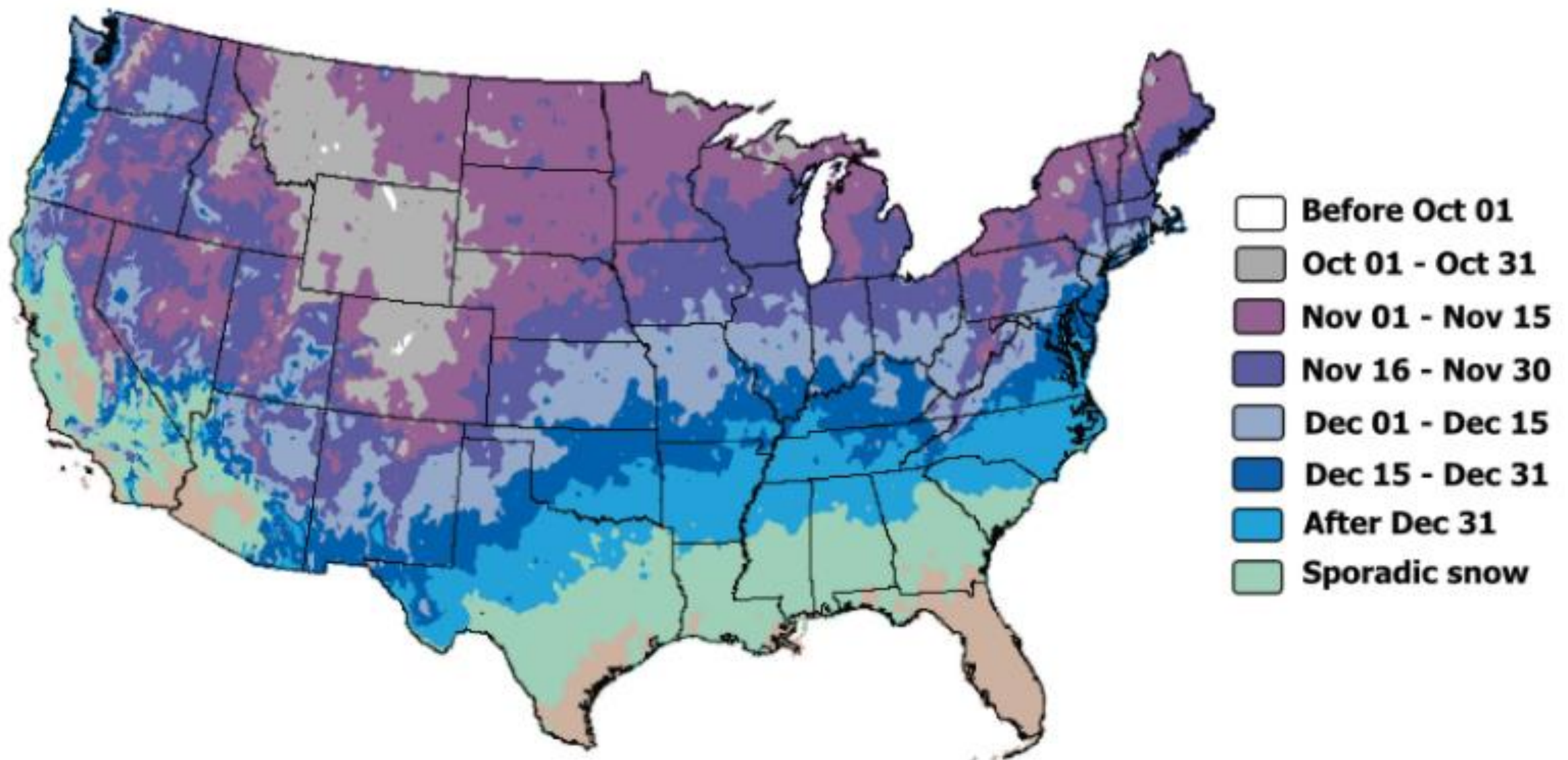
Heavy, repeated snowfall and subsequent melting between storms creates a freeze–thaw cycle that can cause roof overloading. Sloped roofs are subject to ice dams and water penetration to interiors; and once such a flow begins, it only ends when the snow is melted off the roof. Flat or low pitch roofs are subject to bellowing, which exacerbates the condition, followed by further deflection, further accumulation, and can lead to collapse.



Average Annual Snowfall By U.S. County



Median first date of snowfall in the US

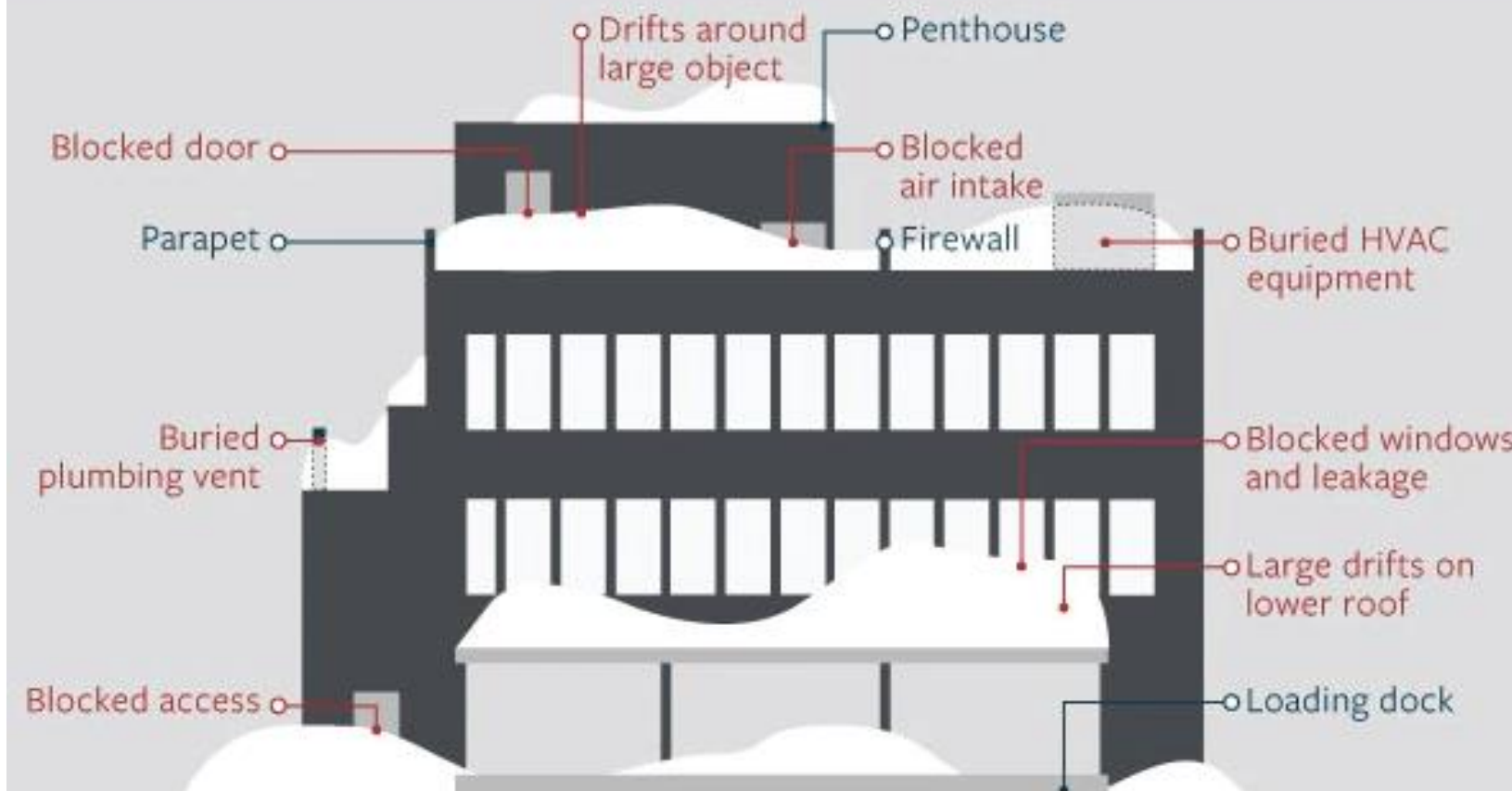


Common Problem Areas

Building design considerations do account for snow load. However, that load is only part of the total design load, which will include wind and dead loads. **Dead loads** are loads that account for the weight of the roof structure itself. While the total design load may be twice or four times greater than the design snow load alone, the weight of the snow and the water it holds may exceed the design snow load, which then may cause structural failure. In addition, building and roof configuration, the qualities and capabilities of roof insulation, wind speed, and drainage can dramatically influence the distribution of weight from snow, drifts, and ice on a roof.

SNOW LOAD DANGER ZONES

Some Areas to Watch



Example:

- **Live Load Capacity** (as determined through structural analysis) = 48 lb/ft²
- **One half Live Load Capacity** = 24 lb/ft² = 2 ft of moderately wet snow, or 1 foot of heavy wet snow



IMPORTANT: Very wet, heavy snow can weigh as much as 24 lb/ft³. *This type of snow will require you to initiate your snow removal process sooner.*

Potential Roof Design Issues Include:

- Large flat roof or roofs with slopes of less than 30° such as auditoriums and gymnasiums accumulate snow and drifts easier than sloped roofs.
- Saw tooth or barrel roofs have low points where snow can accumulate.
- Roofs with different elevations allow snow to accumulate and drift where the lower roof meets the higher roof.
- Curved roofs may accumulate snow on the leeward (downwind side) at the eaves.
- “Green” or heavily insulated roofs may slow the melting process (ice dams).

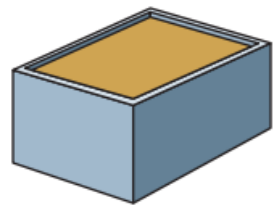


Figure 3a. Flat or low-slope roof with or without roof drains

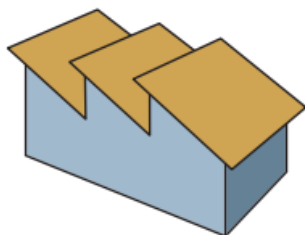


Figure 3c. Saw-tooth roof

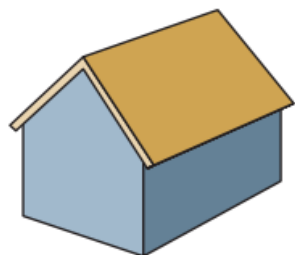


Figure 3e. Gable/multi-span gable roof

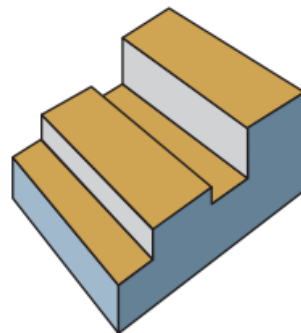


Figure 3b. Stepped roof

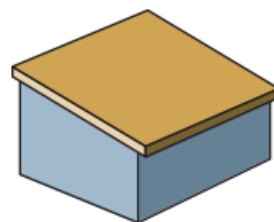
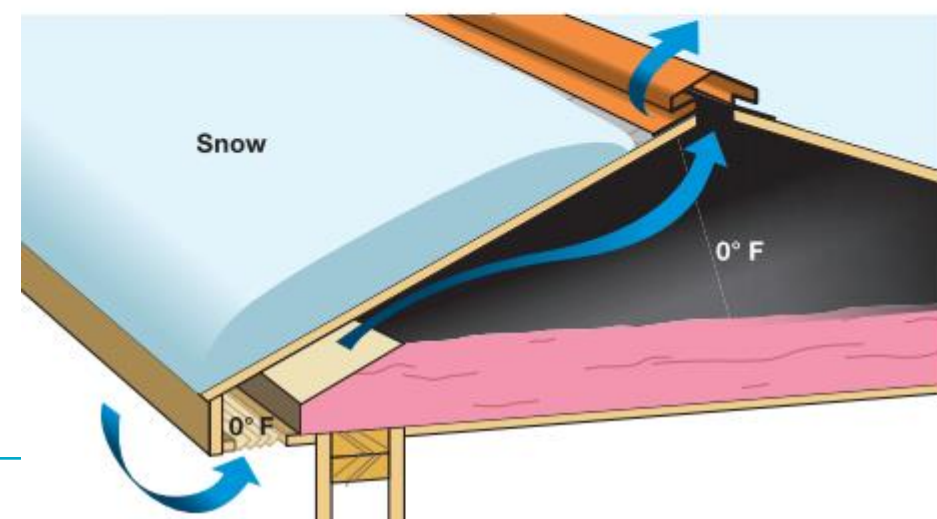
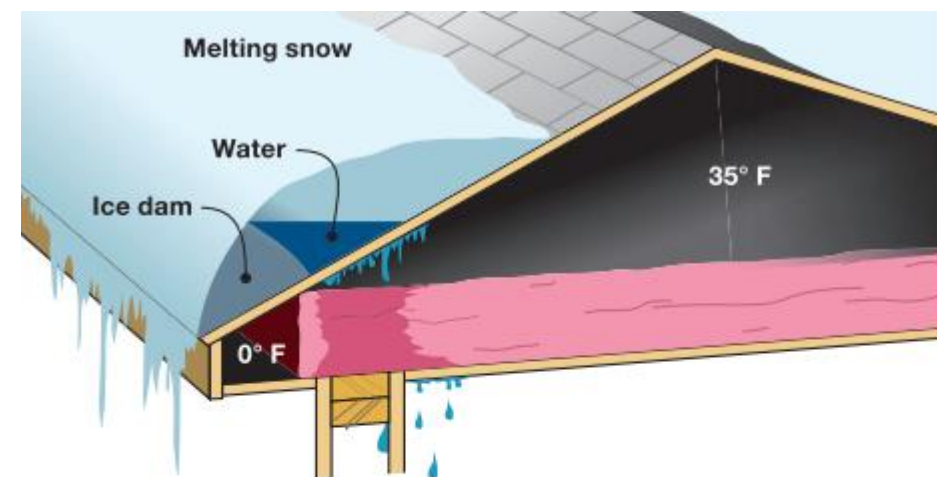


Figure 3d. Mono-slope roof



Other Issues That Can Also Materialize, Depending On The Maintenance Of The Facility:

- Identification and response to snow are left to the building owner after the certificate of occupancy is issued; plans often are not updated as occupants and conditions change.
- Roofs and roof equipment may not require service/attention during winter months, delaying “checking” of roof conditions.

Other areas not readily identified include :

- New equipment or piping running across the roof, which pose drifting potentials.
- Changed vent openings, which create freeze-thaw locations.
- Different occupancies below the roof, which result in differential temperatures on the underside of a roof, likewise creating freeze-thaw potentials.
- Changes in roof drain arrangements, obstructions, or discharge, including changes that could result in frozen downspouts.

It should be pointed out that no building is constructed such that it will fail, but a combination of assumptions and circumstances at design can lead to complacency about the integrity of the roof

Preparation For The Season

- Preparations for the season should **begin six to ten weeks before the onset of winter**. For snow removal planning, the roof should be reviewed to determine a safe maximum snow depth and critical loading areas. You should be prepared to remove snow from critical areas when no more than half this depth is reached. This allows sufficient roof load capacity for personnel and equipment. **If contractors are used**, arrangements should be made early as demand will increase during winter storms.
 - **You should plan to clear snow starting from interior areas to the edges of the roof**. You will need to ensure that proper roof safety procedures are observed, including tying off when working within six feet of any edge. If you will be utilizing contractors, be sure they are aware of your work safety measures with regard to roof operations, ladders, and equipment. Be sure to instruct contractors to protect the roof cover from damage.
 - **Your heating systems should be checked to ensure they are in good working order**. If using a finite fuel supply, i.e., fuel propane, tanks should be filled prior to a storm. Many facilities operate their heating systems at lower temperatures during off hours, such as nights and weekends. Heating systems should be run at normal operating temperatures for the duration of any snow loading event. Interior areas should have specific observation points established to alert plant engineers of roof sagging or other roof/wall movement. Downspouts, scuppers, and other drains should be inspected at least weekly in winter months to assure unobstructed performance.
 - **Any heat tracing should be serviced prior to the freezing season**, and should be inspected daily for operational integrity. All heat tracing should be provided with indicator lights or other means to facilitate the daily inspection during freezing periods. The roof's framework should be checked for damage or weakness and its capacity for snow loading should be reassessed.
 - **All shovels, snowblowers** (if used – not recommended for roof), and other removal equipment should be examined and put into good working order.
 - **Never use any equipment** that can **damage a roof** such as an ice chopper.
 - **Inspect all drains for debris** (i.e., leaves, dirt, silt) and clean them. The downspouts should also be clear, especially at the outlets.
- *Sprinkler riser and fire pump rooms should be heated and heaters should be inspected.*

Before A Snowfall

1. **Ensure you have and follow an occupational fall prevention plan** that is compliant with local regulatory agency requirements before engaging in roof preparation activities.
2. **Clearly identify safety protocols** and ensure they are followed.
3. **Train your emergency response team and contractors** to properly remove snow.
4. **Ensure generators are working and their fuel tanks are full. (*Inspect heat pumps and piping*)**
5. **Affix electrical heat tracing along the roof edge** up to the gutter to melt the snow and make it more liquid in the drain.
6. **Check roof drains and downspouts** to ensure they are clear. Remove leaves, pine needles and any other objects that would impede water drainage.
7. **Mark roof drains** with a visible flag high enough above expected snow.
8. **Check condition of rooftop equipment** and make any necessary repairs before snowfall and freeze.
9. **Check changes in roof elevation.** Adjoining roofs of different heights can lead to snow drifting onto lower roofs, so these areas must be reinforced to withstand the greater weight.
10. **Clearly mark fire hydrants and fire protection system control valves** to avoid damage from snow removal equipment. This identifies them for prompt snow removal along with access routes.

"These steps should be an ongoing process during the winter as part of your routine maintenance program,"

"Ensure that no obstructions have been created, particularly fall leaves and winter ice. It's all about getting water off the roof."

During A Snowfall And Accumulation

Continue the preparation tasks identified above. If your roofs show ice along the perimeters and deep snow pack (**12 inches or more**), your building may be subject to ice dams and collapse. Seek professional advice immediately. It may be unsafe to go on the roof at this time. The presence of snow and ice on a roof exerts vertical loads that can cause a roof to sag or bow downward. This loading also transfers horizontal forces that may cause the walls to deflect, or move slightly outward. Depending on the construction design, the deflection may be at the top or bottom of the wall.

When roof loads are below the actual load capacity, any sagging or deflection that occurs is temporary and will disappear after the load is removed. This level of loading and minor sagging or deflection of the roof structure will probably not be noticed. When the loading exceeds the design loads, the sagging and deflections become permanent. In extreme cases the roof collapses.

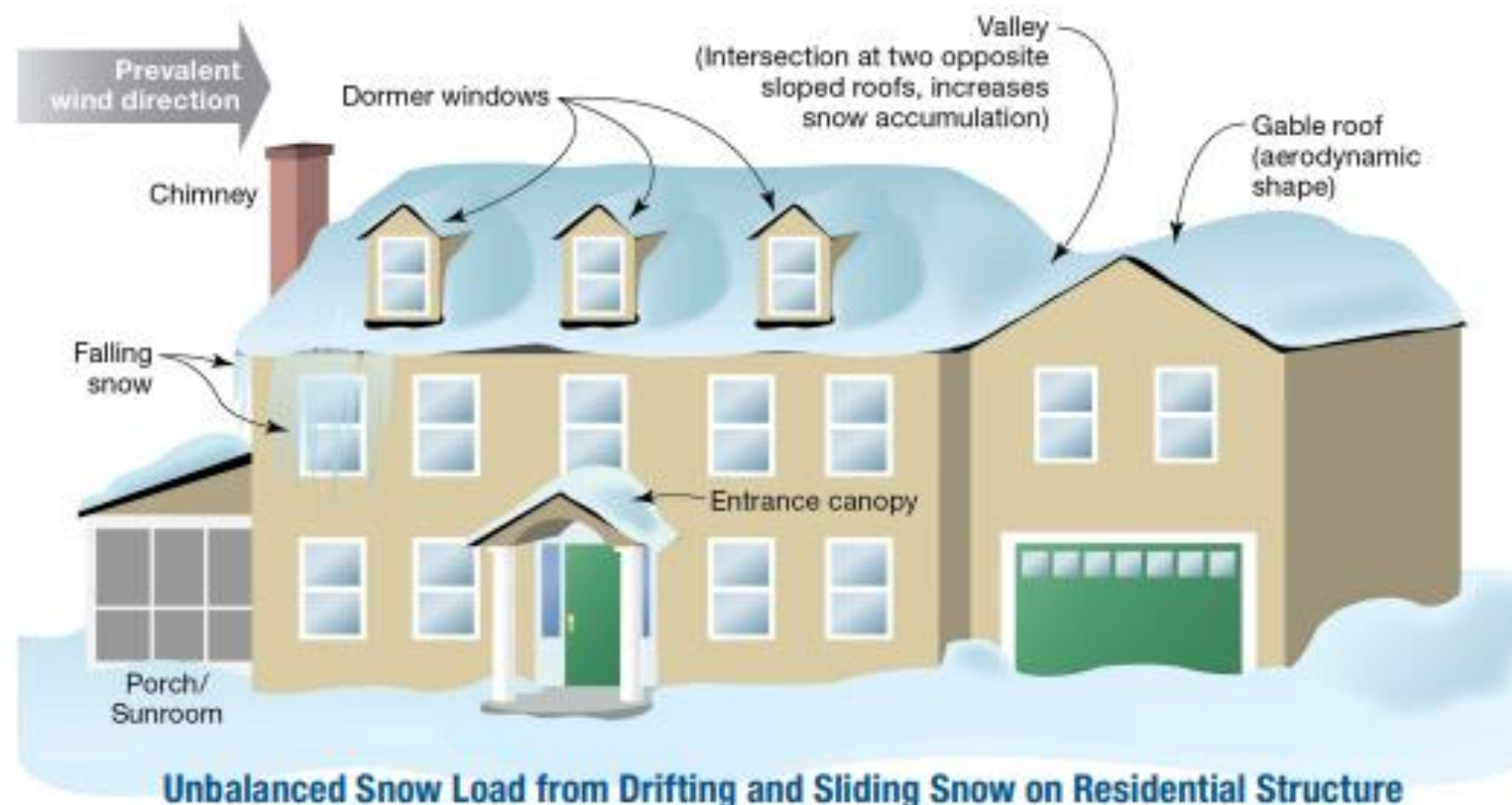
For example, if you leave the ice and snow on a roof, the roof may risk collapse. If you remove the snow, shingles and membranes may be damaged, or the person removing snow may get injured. **Once excessive loading and roof deflection is detected, it may be (and usually is) unsafe to attempt removal.**



Key Safety Issues And Risks

Snow accumulation in excess of building design conditions can result in structural failure and possible collapse. Structural failure due to roof snow loads may be linked to several possible causes, including but not limited to the following:

- ❖ **Unbalanced snow load from drifting and sliding snow.** When snow accumulates at different depths in different locations on a roof, it results in high and concentrated snow loads that can potentially overload the roof structure
- ❖ **Rain-on-snow load.** Heavy rainfall on top of snow may cause snow to melt and become further saturated, significantly increasing the load on the roof structure.
- ❖ **Snow melt between snow events.** If the roof drainage system is blocked, improperly designed or maintained, ice dams may form, which creates a concentrated load at the eaves and reduces the ability of sloped roofs to shed snow. On flat or low slope roof systems, snow melt may accumulate in low areas on roofs, creating a concentrated load.
- ❖ **Roof geometry.** Simple roofs with steep slopes shed snow most easily. Roofs with geometric irregularities and obstructions collect snow drifts in an unbalanced pattern. These roof geometries include flat roofs with parapets, stepped roofs, saw-tooth roofs, and roofs with obstructions such as equipment or chimneys.



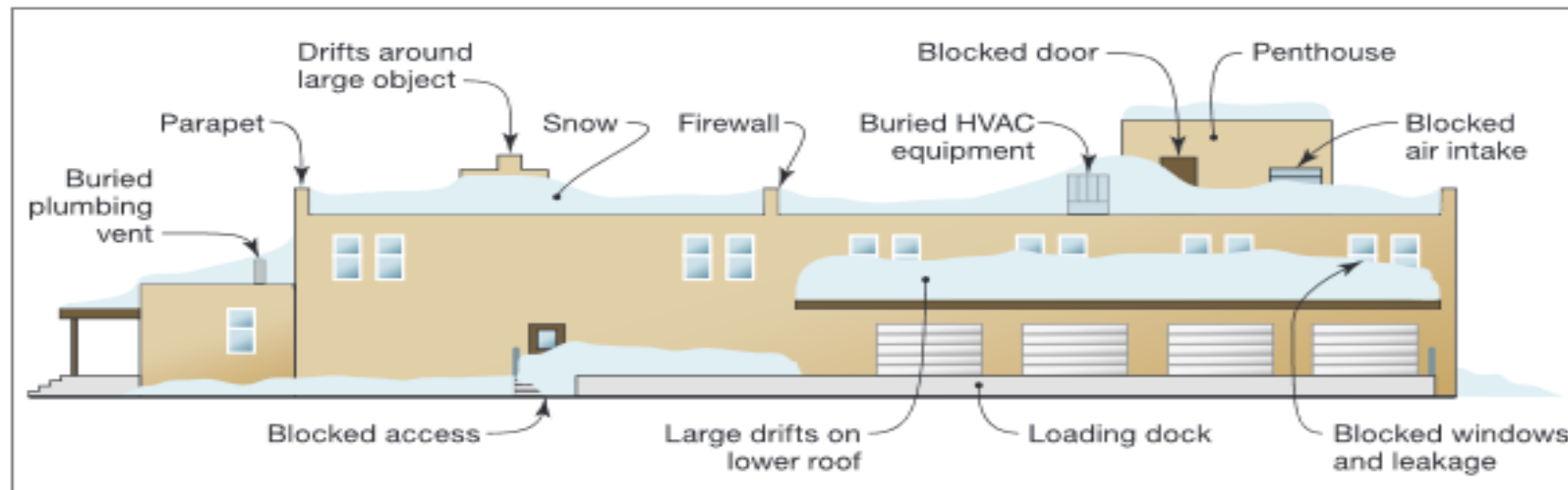


Figure 1a. Unbalanced snow load from drifting and sliding snow on typical commercial or industrial building

Figures 1a and 1b illustrate various unbalanced snow load scenarios resulting from drifting and sliding snow. Notice the snow is deeper at roof protrusions, obstructions, and elevation changes than in more open sections of the roof

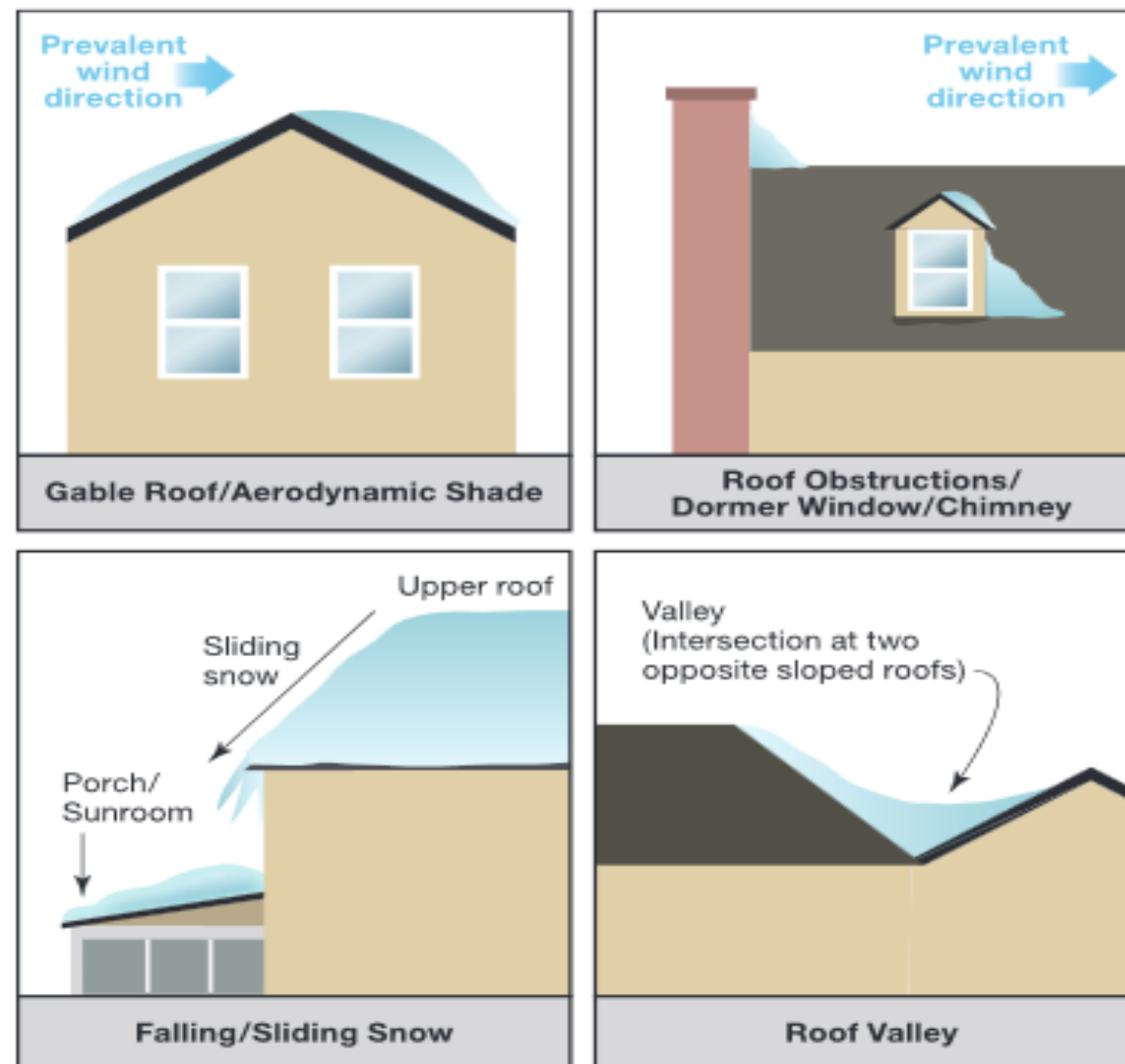


Figure 1b. Unbalanced snow load from drifting and sliding snow on residential structure

Warning Signs Of Overstress Conditions During A Snow Event

Overstressed roofs typically display some warning signs. Wood and steel structures may show noticeable signs of excessive ceiling or roof sagging before failure. The following warning signs are common in wood, metal, and steel constructed buildings:

- ☐ Sagging ceiling tiles or boards, ceiling boards falling out of the ceiling grid, and/or sagging sprinkler lines and sprinkler heads
- ☐ Sprinkler heads deflecting below suspended ceilings
- ☐ Popping, cracking, and creaking noises
- ☐ Sagging roof members, including metal decking or plywood sheathing
- ☐ Bowing truss bottom chords or web members
- ☐ Doors and/or windows that can no longer be opened or closed
- ☐ Cracked or split wood members
- ☐ Cracks in walls or masonry
- ☐ Severe roof leaks
- ☐ Excessive accumulation of water at non-drainage locations on low slope roofs



After A Snowfall - Safety Measures For Snow Removal

Below are some safety measures to take during snow removal to minimize risk of personal injury:

- ☐ Provide safe access to the roof
- ☐ Clearly mark roof edges and provide fall protection where there is a risk of falls
- ☐ Never allow employees to work alone. Institute a buddy system to ensure everyone gets off the roof safely
- ☐ Any roof snow removal should be conducted following proper OSHA protocol for work on rooftops. Use roof fall arrest harnesses where applicable.
- ☐ Always have someone below the roof to keep foot traffic away from locations where falling snow or ice could cause injuries.



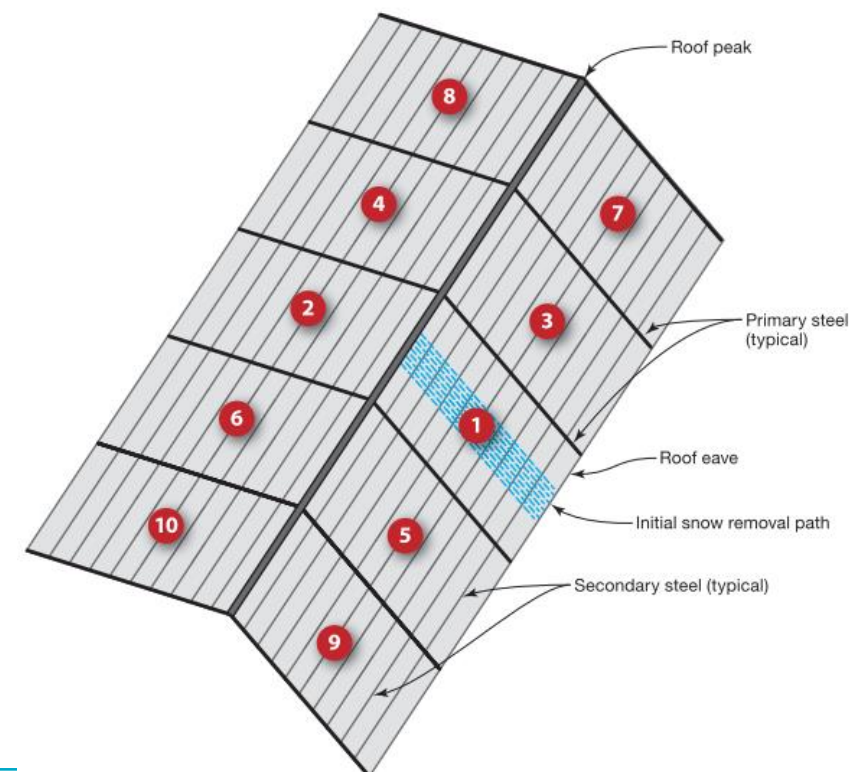
After A Snowfall - Safety Measures For Snow Removal (Continue)

- ❑ Ensure someone confirms that the area below removal site is free of equipment that could be damaged by falling snow or ice.
- ❑ Whenever snow is being removed from a roof, be careful of dislodged icicles. An icicle falling from a short height can still cause damage or injury.
- ❑ When using a non-metallic snow rake, be aware that roof snow can slide at any moment. Keep a safe distance away from the eave to remain outside of the sliding range.
- ❑ Buried skylights pose a high risk to workers on a roof removing snow. Properly mark this hazard as well as other rooftop hazards.



Method Of Snow Removal From The Roof

- ❑ Removing snow completely from a roof surface can result in serious damage to the roof covering and possibly lead to leaks and additional damage. At least 2 inches of snow should be left on the roof.
- ❑ Do not use mechanical snow removal equipment. The risk of damaging the roof membrane or other rooftop items outweighs the advantage of speed.
- ❑ Do not use sharp tools, such as picks, to remove snow. Use plastic rather than metal shovels.
- ❑ Remove drifted snow first at building elevation changes, parapets, and around equipment.
- ❑ Once drifted snow has been removed, start remaining snow removal from the center portion of the roof.
- ❑ Remove snow in the direction of primary structural members. This will prevent unbalanced snow loading.



Method Of Snow Removal From The Roof – (Continue)

- ☐ Do not stockpile snow on the roof.
- ☐ Dispose of removed snow in designated areas on the ground.
- ☐ Keep snow away from building exits, fire escapes, drain downspouts, ventilation openings, and equipment.
- ☐ If possible, remove snow starting at the ridge and moving toward the eave for gable and sloped roofs.
- ☐ Upon completion of snow removal, the roofing material should be inspected for any signs of damage. Additionally, a quick inspection of the structural system may be prudent after particularly large snow events.



WHAT YOU CAN DO TODAY

- **Make sure your members are aware of the risks and your loss prevention plan is up to date:** Assess relative exposures and create tools appropriate to the hazard. Also, factor in the cumulative effect of multiple storms on your property and undertake regular property surveys in advance of storms.
- **Be flexible:** Evaluate each building according to its needs based on importance as well as vulnerability
- **Expand your vision:** Increase your understanding of the risks associated with winter storms and ice as it threatens not only individual buildings, but supply chains, ingress/ egress, and power sources.
- **Clearly identify shut-off valves** for utilities, such as gas, water and electricity.

*If the building is protected by **automatic sprinkler systems** and the system needs to be turned off and drained, due to the potential for imminent roof collapse, it is important to eliminate all possible sources of ignition. Possible sources of ignition could include, but are not limited to: smoking, heating equipment, electric lighting and power systems, and maintenance activities involving cutting, welding, grinding or similar hot work.*

Any questions or queries contact

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