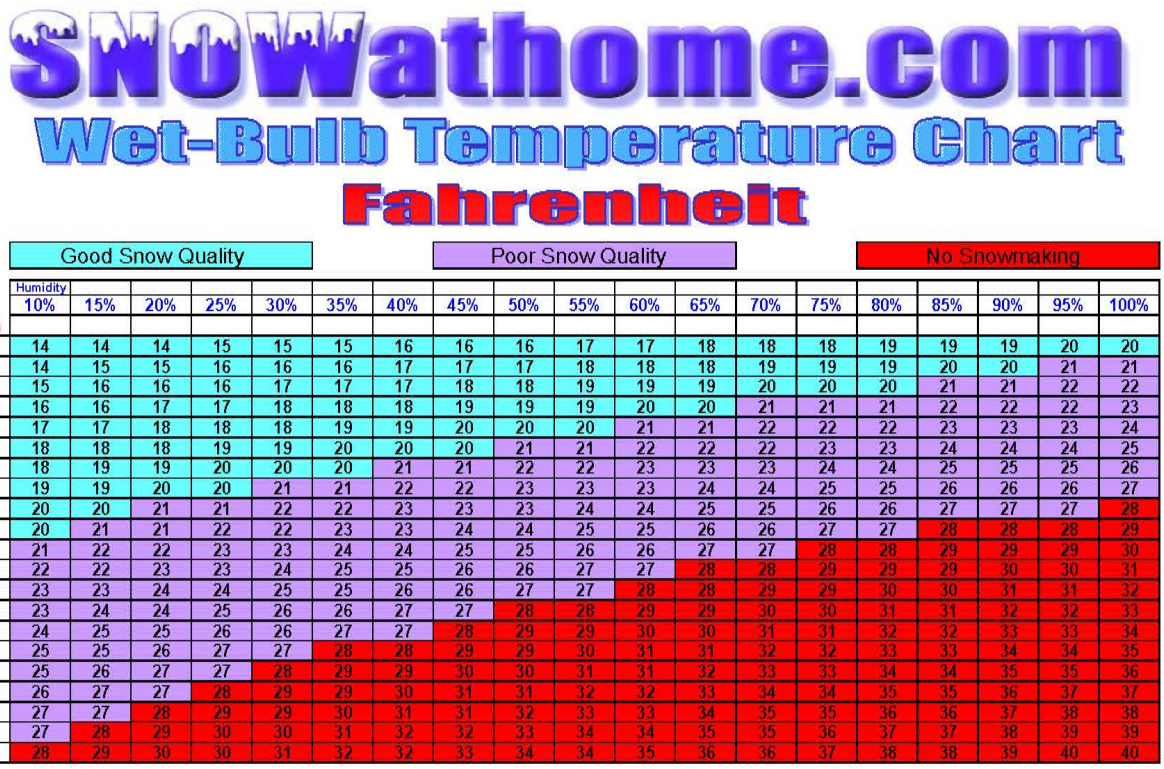
# Quechee Snowmaking Facts

***By Ken Lallier, Property Director***

**<u>Snowmaking Requirements</u>:**

- **Temperature: Maximum of 28 degrees with low humidity**
  - The lower the temperature & humidity, the more snow production
  - Humidity is a very important factor, particularly at higher marginal temps
  - Combined temp & humidity is the "Wet Bulb" temperature (see chart below)
    - 28 degrees with high humidity means **<u>no snowmaking</u>**
    - 28 degrees with low humidity means low production snowmaking
  - There is no temperature too low for snowmaking, but equipment issues and freeze-ups are a factor during extreme cold weather




| Temp (F) \ Humidity | 10% | 15% | 20% | 25% | 30% | 35% | 40% | 45% | 50% | 55% | 60% | 65% | 70% | 75% | 80% | 85% | 90% | 95% | 100% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | 14 | 14 | 14 | 15 | 15 | 15 | 16 | 16 | 16 | 17 | 17 | 18 | 18 | 18 | 19 | 19 | 19 | 20 | 20 |
| 21 | 14 | 15 | 15 | 16 | 16 | 16 | 17 | 17 | 17 | 18 | 18 | 18 | 19 | 19 | 19 | 20 | 20 | 21 | 21 |
| 22 | 15 | 16 | 16 | 16 | 17 | 17 | 17 | 18 | 18 | 19 | 19 | 19 | 20 | 20 | 20 | 21 | 21 | 22 | 22 |
| 23 | 16 | 16 | 17 | 17 | 18 | 18 | 18 | 19 | 19 | 19 | 20 | 20 | 21 | 21 | 21 | 22 | 22 | 22 | 23 |
| 24 | 17 | 17 | 18 | 18 | 18 | 19 | 19 | 20 | 20 | 20 | 21 | 21 | 22 | 22 | 22 | 23 | 23 | 23 | 24 |
| 25 | 18 | 18 | 18 | 19 | 19 | 20 | 20 | 20 | 21 | 21 | 22 | 22 | 22 | 23 | 23 | 24 | 24 | 24 | 25 |
| 26 | 18 | 19 | 19 | 20 | 20 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 23 | 24 | 24 | 25 | 25 | 25 | 26 |
| 27 | 19 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 26 | 26 | 27 |
| 28 | 20 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 27 | 28 |
| 29 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 28 | 29 |
| 30 | 21 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 29 | 30 |
| 31 | 22 | 22 | 23 | 23 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 29 | 30 | 30 | 31 |
| 32 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 30 | 31 | 31 | 32 |
| 33 | 23 | 24 | 24 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 30 | 31 | 31 | 32 | 32 | 33 |
| 34 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 29 | 29 | 30 | 30 | 31 | 31 | 32 | 32 | 33 | 33 | 34 |
| 35 | 25 | 25 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 31 | 31 | 32 | 32 | 33 | 33 | 34 | 34 | 35 |
| 36 | 25 | 26 | 27 | 27 | 28 | 29 | 29 | 30 | 30 | 31 | 31 | 32 | 33 | 33 | 34 | 34 | 35 | 35 | 36 |
| 37 | 26 | 27 | 27 | 28 | 29 | 29 | 30 | 31 | 31 | 32 | 32 | 33 | 34 | 34 | 35 | 35 | 36 | 37 | 37 |
| 38 | 27 | 27 | 28 | 29 | 29 | 30 | 31 | 31 | 32 | 33 | 33 | 34 | 35 | 35 | 36 | 36 | 37 | 38 | 38 |
| 39 | 27 | 28 | 29 | 30 | 30 | 31 | 32 | 32 | 33 | 34 | 34 | 35 | 35 | 36 | 37 | 37 | 38 | 39 | 39 |
| 40 | 28 | 29 | 30 | 30 | 31 | 32 | 32 | 33 | 34 | 34 | 35 | 36 | 36 | 37 | 38 | 38 | 39 | 40 | 40 |

Wet bulb temperature is the lowest temperature that can be obtained by evaporating water into the air at a constant pressure. The term comes from the technique of wrapping a wet cloth around a mercury bulb thermometer and blowing air over the cloth until the water evaporates. The wet bulb temperature is always lower than the dry bulb temperature, but will be identical with 100% relative humidity. This wet bulb temperature is what snowmakers use to know when they can make snow. You can see it is possible to make snow when the temperatures are above freezing but only with very low humidity.

**Plot your current temperature (*red numbers on the left*) to the % of humidity *(blue numbers on the top)* and where they meet the *(black numbers)* is your current wet bulb temp.**
**Any time the wet bulb number is below 20 degrees Fahrenheit (blue shaded area) snowmaking is at its best… nice dry snow. You can make snow from 21 degrees to 27 degrees wet bulb *(purple shaded area)* but the snow will be wet.**

- **Wind:**
  - Calm clear & cold nights yield the best snowmaking conditions
  - High wind makes it difficult to control where the snow lands
  - High winds also coat trees and lift equipment with ice causing damage
  - Varying wind conditions cause fan gun freeze ups if they blow back on themselves.

- **Sun:**
    - Our south facing orientation makes for great cold weather skiing conditions but…
    - Creates warmer conditions at marginal temps making productive snowmaking challenging except on very cold days
- **Mechanical Requirements:**
    - Adequate water & air volume and pressure for efficient snow gun performance
        - Water pressure of 200 PSI & Air pressure of 100 – 120 PSI at each gun
    - On-mountain Electrical service for fan gun operation, requires 480 volt, three phase power cords from hydrant to fan gun
        - Length of cord runs limited due to power loss with distance

**<u>Quechee's Challenging Factors</u>:**

- Low Elevation: Top is 1,260' & Base is 600' (Killington's Main Parking lot is 2,500')
- South Facing slopes
    - Limits our effective daytime snowmaking to only the very coldest days
- Limit of 1,000 Gallons per minute of water and 1,600 CFM of Air
- Original Hydrant layout & limited on-mountain Electrical capacity
    - Labor intensive system design requires lots of gun moves and grooming to get snow where it is needed
    - High voltage electric cords for fan guns have maximum distance limits
    - Electric cords also present a hazard for making snow while ski hill is in operation
- Buried Snowmaking Pipes that cross trails
    - This makes snowmaking & grooming operations clash, particularly when open the next day for skiing
    - Equipment has to be shut down early and moved to facilitate grooming for next day operations
- Generally warmer winters that start later, with less productive snowmaking opportunities

**<u>Positive Factors & Enhancements</u>:**

- Pump station upgrades & larger snowmaking feed line from Pinneo have increased water capacity from 500 GPM to 1,000 GPM (maximizes system output)
- Rental of larger 1,600 CFM air compressor to expand snow gun fleet & maximize output
- Purchase of newer, energy efficient tower guns and newer, more efficient fan guns, bringing Snow gun fleet to 35 guns (up from 8 guns in 1983 when original system was installed)
- Installation of Snowmax injection system to increase production at any given temperature
- Electrical Transformer enlargement to increase capacity and allow for daytime snowmaking during lift operations while open for skiing
- Addition of Inner Loop of snowmaking on Dewey's & Plateau, which facilitates daytime snowmaking on closed inner trails while open for skiing on outer trails
- Large water supply in Lake Pinneo with no current restrictions as to how much water can be used for snowmaking

**Future:**

- Possible addition of another inner loop of snowmaking on Quechee express to facilitate snowmaking on Quechee Express & Mel's
    - Currently have 300+ foot hose runs to make snow under the chairlift on Express & Mel's
    - No power available nearby to run higher production fan guns on these trails
- Continue phasing out older Fan gun technology and purchasing newer, more efficient fan guns, which have a larger production potential than tower guns
- Deploy more fixed tower guns that don't get moved to minimize labor & set-up issues
- Take advantage of any new technology that evolves to improve snowmaking potential at higher temperatures

## Frequently Asked Questions:

***Why don't we make snow during operation more often?***

- Making snow during operation is challenging for several reasons. If temps are marginal, the snow quality is wet and skiing through wet snow piles is challenging and not a great ski experience.
- Our skiing clientele consists of many novice and young skiers who would be hard pressed to negotiate the changing conditions under a snow gun in operation.

***Other ski areas make snow at or above freezing temperatures, why can't we?***

- Larger mountains can make snow at higher marginal temperatures because they generally have less humidity at higher elevations, which yields a higher wet bulb temperature.
- Most larger ski operations have more air capacity so when they are making snow at marginal temps, they can decrease the water flow and increase the air flow to make some snow when we would not be able to.
- Those conditions don't yield great snow or much of it but they are putting on a show that we cannot.

***Why do we see piles of snow left ungroomed on trails that are closed, why can't those piles be spread out and the trail opened for skiing?***

- Because of our labor-intensive system design, we have to make snow with mobile guns that are constantly being moved, which is labor intensive
- Snow left in piles will last longer in warmer weather or rain than after it has been spread out so leaving it in piles until we know there is enough snow to spread it out and open the trail makes the most sense.
- In general, most of the piles you will see are on the inner trails when we are making snow to expand the open terrain while skiing the outer trails
- We also intentionally make snowmaking stockpiles for the groomer to access throughout the winter to fill thin areas or recover from warm weather and traffic.

***Why can't we recover a trail after a meltdown in one night like other ski areas do?***

- Our system design and capacity do not allow us to light up one entire trail at the same time. We have to balance the water draw around the entire mountain to provide adequate air & water pressure for each gun to operate properly.

***What are the deciding factors for making snow or not?***

- First and foremost, temperature and humidity are the most important factors
- Then wind and opening status the next day are also taken into consideration
- Critical need is also a factor, eg; do we have to make snow to be able to open etc.
- If we are considering making snow at marginal temps, are we going to be skiing on that snow the next day, (marginal snowmaking yields poor quality skiing snow that is ok for base snow, but not great for a good skiing experience)
- Is making snow in marginal conditions worth the expense of snowmaking hours
- Can we effectively make snow where it is needed and still have time to move the snowmaking equipment to be able to groom it for safe skiing the next day

***Why can't we start making snow earlier in the season to ensure we can open for the Christmas Vacation period?***

- When we start making snow is all about having consistent cold weather to both make the snow and to preserve it
- Making lots of snow earlier to then watch it melt before we open is a waste of resources
- The prudent thing to do is to wait for winter weather to arrive and ideally the ground to freeze before making snow so it will survive short warming periods

***Why don't we increase our capacities to allow for more snow to be made on shorter notice?***

- To increase our snowmaking capacities would require a significant investment to replace and upsize the current infrastructure
- Several millions of dollars would be needed to increase pumping capacity, increase pipe sizes throughout the system, purchase or rent larger compressors, add snowguns & more hydrants etc.
- Once capacity is increased we would also have to significantly increase the budget to support the higher costs to run the system