Critical Infrastructure Security and Resilience Note: Winter Storms and Critical Infrastructure

December 15, 2014, 1115 EST

SCOPE

The Department of Homeland Security Office of Cyber and Infrastructure Analysis (DHS/OCIA)[1], produces Critical Infrastructure Security and Resilience Notes in response to changes in the infrastructure protection community's risk environment from terrorist attacks, natural hazards, and other events. This product examines the potential impacts to the United States due to annual winter storms.

This product was developed in coordination with the DHS Office of Infrastructure Protection Sector Outreach and Program Division, and the Transportation Security Administration, the Department of Transportation Maritime Administration, the Federal Aviation Administration, and the National Oceanic and Atmospheric Administration (NOAA).

OCIA continues to monitor conditions and will produce additional, incident specific, analysis if significant winter storms occur.

KEY FINDINGS

- **OCIA assesses the Transportation and Energy Sectors are most likely to experience the greatest infrastructure impacts from severe winter storms.**
- **The Transportation and Energy Sectors can expect short-term impacts from heavy snowfall, ice accumulations and strong winds, which could cause transportation delays and closures, and tree and power line damage.**
- **State and local governments generally possess the snow and ice removal equipment and supplies necessary to deal with expected accumulations. When severe winter weather occurs, they may experience difficulty with snow removal. Restoration activities may be delayed 1 to 2 days until roadways and other transportation modes are cleared and operational.**

[1] In February 2014, the DHS National Protection and Programs Directorate (NPPD) created the Office of Cyber and Infrastructure Analysis by integrating analytic resources from across NPPD, including the Homeland Infrastructure Threat and Risk Analysis Center (HITRAC) and the National Infrastructure Simulation and Analysis Center (NISAC).

OVERVIEW

Winter storms usually occur in the United States between late October and mid-April. Snow, ice and blizzard conditions can create hazardous conditions and may cause physical damage to or loss of property. The severity and magnitude of winter storms depends on a variety of factors including: the region's climatological susceptibility to snowstorms (e.g., Northeast vs. the Southwest), rates and amounts of snowfall, wind speeds, temperatures, duration of storm, visibility, topography, time of day, day of week and season of the year.[2] This product focuses on the effects of severe winter storms that do not fit within what is considered "normal" winter weather patterns.

TYPES OF WINTER PRECIPITATION

The three types of winter precipitation are snow, sleet and freezing rain.

- **Snow:** Snowflakes are collections of ice crystals that stick to each other as they fall toward the ground; snow will continue to fall as long as the temperature remains at or below 0 degrees Celsius (32 degrees Fahrenheit) from the cloud base to the ground.
- **Sleet:** Sleet forms when snowflakes partially melt as they fall through a shallow layer of warm air, then refreeze as they fall through a following deep layer of cold air becoming frozen rain drops.
- **Freezing Rain:** Freezing rain forms when snowflakes completely melt as they fall through a deep layer of warm air, fall through a following shallow layer of cold air and then refreeze as they come into contact with anything on the ground that is at or below 0 degrees Celsius; this process creates a glaze of ice on the ground, streets, trees, utility lines and other objects.[3]

WINTER STORM FLOODING

The strong winds generated by severe winter storms can cause tidal flooding and beach erosion in coastal areas. A sudden thaw of snow pack can lead to flooding as the water levels of surrounding streams and rivers rise above normal. Lakes and rivers can experience ice jams when long cold spells cause them to freeze over. When a sudden thaw or rise in the water level occurs, the ice breaks into large chunks and may become jammed on man-made and natural obstacles. Ice jams also can act as a dam and cause flooding.[4]

[2] New York State Division of Homeland Security and Emergency Services, *2014 New York State Hazard Mitigation Plan*, January 2014, www.dhses.ny.gov/oem/mitigation/plan.cfm, accessed October 6, 2014.
[3] National Severe Storms Laboratory, National Oceanic and Atmospheric Administration, "Severe Weather 101," www.nssl.noaa.gov/education/svrwx101/winter/types/, accessed October 3, 2014.
[4] U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, *Winter Storms - The Deceptive Killers A Preparedness Guide*, June 2008, www.nws.noaa.gov/om/winter/resources/Winter_Storms2008.pdf, accessed October 6, 2014.

FORMATION AND TYPES OF WINTER STORMS

Winter storms develop when an optimum combination of cold air, warm air, moisture and lift occurs. Temperatures must be at or below freezing so snow and ice can form. Warm air colliding with cold air or air flowing up a mountain side creates lift which causes moisture to rise creating clouds and precipitation. Water evaporating from the ocean or large lakes can also provide a source of moisture.[5] Figure 1 shows the average annual snowfall in various regions of the United States.

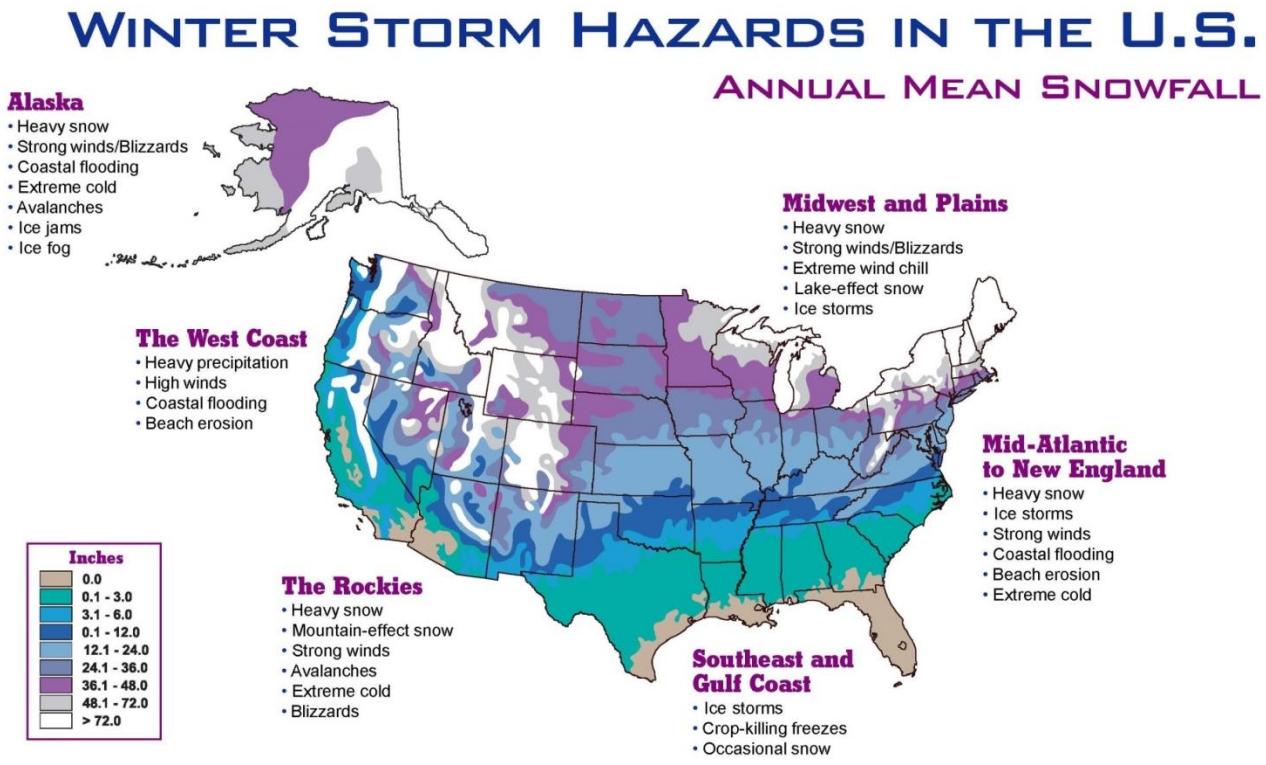

FIGURE 1—Average Snowfall Amounts in the United States (Source: National Weather Service)[6]

There are four main types of severe winter storms:[7]

Blizzard: Winds over 35 miles per hour with blowing snow which reduces visibility to one-quarter of a mile or less for at least 3 hours. Heavy snowfall and severe cold often occur with blizzards, but they are not required; strong winds can pick up snow that already has fallen creating blizzard conditions.

Ice Storm: Freezing rain storms that last several hours or more and result in at least one-quarter inch of ice forming on exposed surfaces.

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[5] U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, *Winter Storms - The Deceptive Killers A Preparedness Guide*, June 2008, www.nws.noaa.gov/om/winter/resources/Winter_Storms2008.pdf, accessed October 6, 2014.
[6] *Ibid.*
[7] National Severe Storms Laboratory, National Oceanic and Atmospheric Administration, "Severe Weather 101," www.nssl.noaa.gov/education/svrwx101/winter/types/, accessed October 3, 2014.

Lake Effect Storm: A cold, dry air mass moves across a lake and picks up moisture; this fills the air with water which is released in the form of snow.

- Lake Effect Storms can form anywhere conditions are right, but they most often occur in the Great Lakes Region between November and February; these storms tend to create heavily localized snowfall. Buffalo, New York is one of the best known and most common locations for this phenomenon.[8]

Snow Squall: Brief and intense snow showers with strong and gusty winds which can result in significant accumulations of snow.

WINTER WEATHER ADVISORIES

To ensure the public knows what to expect when severe winter weather is approaching and to prepare accordingly, the National Weather Service issues various types of winter storm watches, warnings, and advisories:

- **Winter Storm Watch: Severe winter conditions such as heavy snow and ice may occur; issued 12 to 36 hours in advance of expected storm.**
- **Winter Storm Warning: Issued when 4 or more inches of snow or sleet are expected within 12 hours, or 6 or more inches of snow or sleet are expected within 24 hours, or when an ice storm (one-quarter inch or more of ice accretion) is expected.**
- **Winter Weather Advisory: Issued when winter weather conditions such as snow, sleet or freezing rain are predicted to cause significant inconveniences that may be hazardous (e.g., icy roads, downed utility lines).**
- **Blizzard Warning: Issued when blizzard conditions (blowing snow, strong winds, reduced visibility) are expected to occur. [A]**

SOURCE:

[A] U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, *Winter Weather Tip Sheet*, www.nws.noaa.gov/om/winter/winter1.shtml, accessed October 7, 2014.

2014-2015 WINTER SEASON WEATHER OUTLOOK

The National Weather Service predicts above average temperatures for much of the Western U.S., Alaska, Hawaii and New England. Below average temperatures are forecast for the South-central and Southeastern United States. Precipitation outlooks are above average for Southern California, the Southwest, the South-central and Gulf Coast States, Florida, along the eastern seaboard to Maine, Southern Alaska and the Alaskan panhandle. Below average precipitation is predicted for the Pacific Northwest, the Midwest, and Hawaii.[9] Figures 2 and 3 illustrate temperature and precipitation predictions.

[8] U.S. Department of Commerce, National Oceanic and Atmospheric Administration, "Warm Water and Cold Air The Science Behind Lake Effect Snow," www.noaa.gov/features/02_monitoring/lakesnow.html, accessed October 7, 2014.

[9] National Oceanic and Atmospheric Administration, "NOAA: Another warm winter likely for Western U.S., South may see colder weather," October 16, 2014, http://www.noaanews.noaa.gov/stories2014/20141016_winteroutlook.html, accessed October 21, 2014.

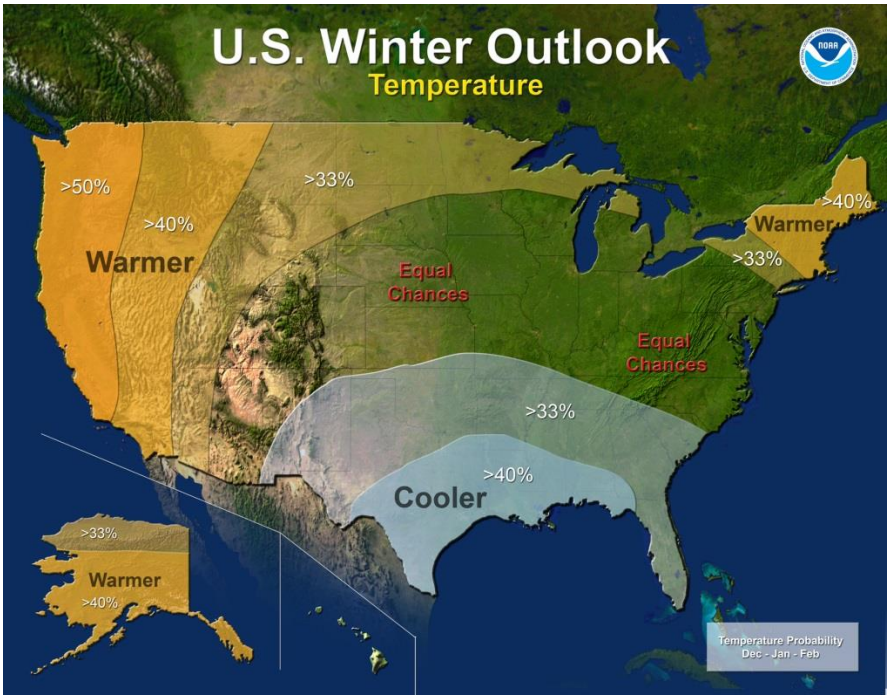

FIGURE 2—U.S. Winter Temperature Outlook (Source: NOAA)[10]

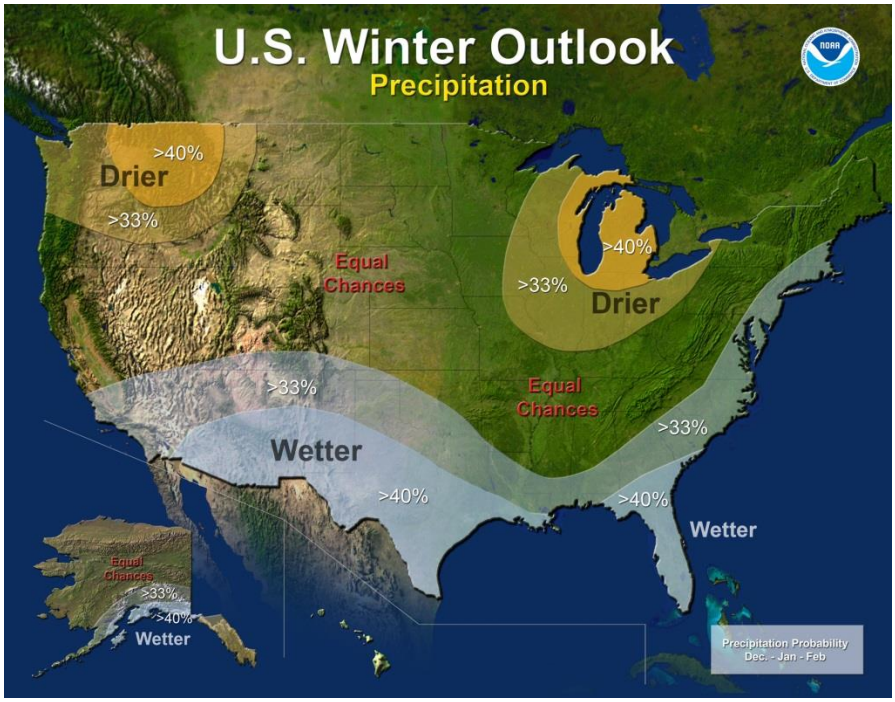

FIGURE 3—U.S. Winter Precipitation Outlook (Source: NOAA)[11]

[10] National Oceanic and Atmospheric Administration (NOAA), "NOAA: Another warm winter likely for western U.S., South may see colder weather," October 16, 2014, http://www.noaanews.noaa.gov/stories2014/20141016_winteroutlook.html, accessed October 21, 2014.
[11] *Ibid.*

ECONOMIC IMPACTS

Economic impacts primarily stem from snow removal and restoration activities. Other direct costs affect primarily the financial and insurance category from property damage. Disruptions to business operations resulting in short-term regional or local impacts may occur. The economic effects of winter storms may be more indirect than hurricanes, flooding, tornadoes, etc.[12]

IMPACTS TO CRITICAL INFRASTRUCTURE

The Transportation and Energy Sectors are most likely to experience the greatest infrastructure impacts from severe winter storms. These sectors could expect short-term impacts from heavy snowfall, ice accumulations and strong winds, which could cause transportation delays and closures, tree and power line damage, roof collapse, and other structural damage. In regions that normally experience winter storms, (e.g., Mid-Atlantic, Northeast, Midwest, and the Rocky Mountains), State and local governments generally possess the snow and ice removal equipment and supplies necessary to deal with expected accumulations. In regions where winter storms are rare (e.g., Southeast, and Gulf Coast), State and local governments generally lack the snow and ice removal equipment and supplies to deal with unusual winter weather and may experience difficulty with snow removal. Restoration activities will likely be delayed 1 to 2 days following a winter storm until roadways and other transportation modes are cleared and operational.

TRANSPORTATION SYSTEMS

Roads, rail systems, ports and waterways, and airports can be disrupted because of the snow, ice, and wind-blown debris caused by winter storms. Disruption of key local transportation nodes can lead to cascading impacts on the larger regional transportation networks. Transportation systems are also important to emergency response and recovery efforts during and following a winter storm.

ROADS

Snow and ice accumulations and wind-blown debris can obstruct roads resulting in traffic delays and road closures. Fog may form when warmer air moves over existing snow cover impairing visibility. Heavy snow can reduce road capacity by 12 to 27 percent.[13,14] Approximately 77 percent of domestic freight shipments (by weight) are transported by truck. Reductions in road capacity can significantly affect the efficiency and timeliness of shipment delivery.[15] It is estimated that weather-related delays cost trucking companies from $2.2 to $3.5 billion

[12] Paul J. Kocin, NOAA, *Some Thoughts on the Societal and Economic Impact of Winter Storms*, sciencepolicy.colorado.edu/socasp/weather1/kocin.html, accessed October 8, 2014.
[13] U.S. Department of Transportation, Federal Highway Administration, *Empirical Studies on Traffic Flow in Inclement Weather*, October 2006, www.ops.fhwa.dot.gov/publications/weatherempirical/weatherempirical.pdf, accessed November 5, 2014, page 2-2. Capacity is defined as the maximum number of vehicles that can pass a point during a specified time period and is a characteristic of the roadway."
[14] U.S. Department of Transportation, Federal Highway Administration, "How Do Weather Events Impact Roads?," February 25, 2014, www.ops.fhwa.dot.gov/weather/q1_roadimpact.htm, accessed November 5, 2014.
[15] American Meteorological Society, "Weather and Highway Safety," 2014, www2.ametsoc.org/ams/index.cfm/policy/studies-analysis/weather-and-highway-safety/, accessed November 5, 2014.

annually.[16] The response times and snow removal efforts of States' departments of transportation can affect the duration of severe winter storm impacts on roadways.[17]

RAIL

Freight rail operations are able to continue in snow conditions as locomotives act as de facto snow plows.[18] Snow drifts on rail tracks could cause short term service interruptions. Snow blown into rail switches may impede the switch action, which could slow overall operations. The railroads typically do not issue speed restrictions for snow, but may cancel or delay services in areas experiencing severe winter weather.[19]

Regional, local, and commuter rail systems can be affected. Commuter rail systems powered using the "third rail" (electrified rail) are likely to see disruptions if snow accumulations are greater than 6 inches due to the inability to receive power from the "third rail." These systems will typically shut down their above-ground operations under these conditions.[20] Amtrak may delay or suspend service in areas affected by winter storm activity.[21]

PORTS AND WATERWAYS

Icing of port infrastructures, vessel superstructures, and ocean structures can occur when the air temperature becomes colder than the freezing point of seawater. Spray that is lifted and carried by the wind (spray) may adversely impact docks, bulkheads, locks, vessel decks, and rigging. Icing increases a vessel's weight and raises the center of gravity thus lowering freeboard and reducing stability. Ice cover formation on inland waterways in the Northern United States and in the Great Lakes can cause impacts to navigation.[22]

AVIATION

Airports may experience disruptions to flight activity. Flight delays and cancellations can impact surrounding regions causing widespread delays and cancellations as air carriers deal with unavailability of equipment and personnel.

[16] U.S. Department of Transportation, Federal Highway Administration, "How Do Weather Events Impact Roads?," February 25, 2014, www.ops.fhwa.dot.gov/weather/q1_roadimpact.htm, accessed November 5, 2014.
[17] OCIA email correspondence with the Department of Transportation, November 4, 2014.
[18] OCIA email correspondence with TSA, February 12, 2014.
[19] OCIA telephone conversation with Federal Railroad Administration, Office of Safety, February 12, 2014.
[20] Examples: the New York City and Washington, DC subway systems are "third rail" systems.
[21] During the February 12-13, 2014 winter storm that impacted the Mid-Atlantic and Northeast, Amtrak suspended service along the Northeast Corridor. U.S. Department of Homeland Security, Office of Cyber and Infrastructure Analysis, "Infrastructure Impact Assessment: Major Winter Storm Impacts to the Mid-Atlantic and Northeastern U.S.," February 12, 2014.
[22] OCIA email correspondence with the Department of Transportation, Maritime Administration, October 24, 2014.

ENERGY

During severe winter weather, wind, cold, snow, and ice can damage Energy Sector assets.

ELECTRICITY

Severe winter storms usually cause extensive electric power outages due to distribution system damage from ice and snow. The amount of damage and the number of repair crews that can be brought to the area have a direct result on electric power restoration. Areas that experience large amounts of snowfall and ice accumulation may experience longer restoration delays due to limited access to repair equipment.

OIL AND NATURAL GAS

Although unlikely, an extended loss of electric power, defined as lasting a week or longer, could impact retail fuel distribution and sales. The hoarding of fuel before a storm may impact the short-term availability of supplies, but it is unlikely to cause any long-term supply issues.

Severe cold can change the properties of oil. When temperatures drop, solids, such as paraffin wax, begin to form and separate from the oil and then crystalize and becomes visible; this is called the cloud point. Certain oils must be maintained at temperatures above the cloud point to prevent clogging of filters. As temperatures drop lower, the fuel continues to thicken or gel until it stops flowing; this is the pour point.[23]

To help prevent clouding and gelling, heating oil is refined so its low temperature properties are optimal for the location and the time of year where it is being used. The temperatures used to assist in determining these regional and seasonal refining processes is based on the 10th percentile minimum temperature scale. This means that the cloud point of the fuel is 42.8°F "above the 10th percentile minimum ambient temperature for the area in which the fuel will be used." This scale is based on historical temperature data for the specific area.[24]

During severe cold weather, fuel blending and additives are commonly used to prevent the oil from reaching its cloud point and to keep it flowing. Additional measures to prevent clouding and gelling include storing fuel oil indoors and insulating storage tanks and pipes.[25] Natural gas pipelines do not freeze. If there is a significant amount of water in the pipeline, it may freeze and cause problems in the pipeline, but the gas itself does not freeze.[26] A common method of water removal is glycol absorption. The gas is passed through a glycol dehydrator device called a

[23] Wai-Lin Litzke, *Guide to Fuel Performance Understanding Heating Oil Properties, Potential Problems and Remedies*, National Oilheat Research Alliance, August 2004, pp. 11, 14, www.hrccc.org/images/nora_fuel_quality_manual.pdf, accessed on October 3, 2014.
[24] Wai-Lin Litzke, *Guide to Fuel Performance Understanding Heating Oil Properties, Potential Problems and Remedies*, National Oilheat Research Alliance, August 2004, p. 15, www.hrccc.org/images/nora_fuel_quality_manual.pdf, accessed on October 3, 2014.
[25] Wai-Lin Litzke, *Guide to Fuel Performance Understanding Heating Oil Properties, Potential Problems and Remedies*, National Oilheat Research Alliance, August 2004, pp. 14, 15, www.hrccc.org/images/nora_fuel_quality_manual.pdf, accessed on October 3, 2014.
[26] U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, "Safe Pipelines: FAQs," phmsa.dot.gov/portal/site/PHMSA/menuitem.6f23687cf7b00b0f22e4c6962d9c8789/?vgnextoid=2c6924cc45ea4110VgnVCM1000009ed07898RCRD&vgnextchannel=f7280665b91ac010VgnVCM1000008049a8c0RCRD&vgnextfmt=print#QA_9, accessed October 3, 2014.

contactor to remove any water vapor present before it is sent down the pipeline. Another method is to inject methanol (an anti-freeze solution) into the gas stream using pumps or methanol drips.[27]

PROPANE

Propane is naturally a gas, but it is stored and transported as a liquid. It is converted back into a gas when accessed for use by consumers.[28] Propane is shipped from its point of production to bulk distribution terminals via pipeline, rail, barge, truck or tanker ship. Propane dealers then use tanker trucks known as "bobtails" to deliver fuel from the terminals to retail fuel distributors and end users.[29,30] Water can enter the propane distribution system at a variety of points. In cold weather, this water may freeze and potentially damage or impair the operation of pipes, valves, pumps and appliances.[31]

Various measures are used to detect and remove moisture from the propane distribution chain. At terminals, propane is tested for its water content. Propane with a water content of 26 parts-per-million is considered water saturated or "wet" and may freeze in cold weather. To remove this moisture, terminals often use the following:

- **Coalescing Filter**: Physically removes the water from the propane.
- **Dryers and Dehydrators**: Salt or a desiccant material such as alumina or silica gel is used to remove the moisture.
- **Particulate Filter**: Removes various particles (e.g., rust, debris) in the propane and also can detect if water is present.
- **Methanol Injection**: Acts as an anti-freeze that prevents the formation of ice crystals when water is present in the propane; it also may be injected into transport trucks and railcars if moisture is detected.[32]

Before being filled for delivery, trucks, railcars and barges can be tested for and purged of moisture in their tanks to prevent water from contaminating the propane. Water also may enter the propane during the transfer process from terminal storage tank to truck or railcar. Freeze valve tests can be used during the transfer to detect if any moisture is being added.[33]

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[27] David J. Fish, "Freeze Protection for Natural Gas Pipeline Systems and Measurement Instrumentation," American School of Gas Measurement Technology,asgmt.com/wp-content/uploads/pdf-docs/2007/1/057.pdf, accessed October 9, 2014.

[28] U.S. Energy Information Administration, "Getting Propane to Consumers," November 26, 2012, www.eia.gov/energyexplained/index.cfm?page=propane_delivery, accessed October 17, 2014.

[29] U.S. Department of Homeland Security, Office of Cyber and Infrastructure Analysis, "Infrastructure Impact Assessment: Propane Supply Issues in the United States," January 13, 2014.

[30] Propane Education and Research Council, *Good Practices for the Care and Custody of Propane in the Supply Chain*, June 2005, p. 17, www.propanecouncil.org/uploadedFiles/Council/Research_and_Development/REP_11352%20Good%20Practices%20Care%20and%20Custody%20of%20Propane.pdf, accessed October 16, 2014.

[31] Propane Education and Research Council, *Good Practices for the Care and Custody of Propane in the Supply Chain*, June 2005, p. 23, www.propanecouncil.org/uploadedFiles/Council/Research_and_Development/REP_11352%20Good%20Practices%20Care%20and%20Custody%20of%20Propane.pdf, accessed October 16, 2014.

[32] Propane Education and Research Council, *Good Practices for the Care and Custody of Propane in the Supply Chain*, June 2005, pp. 8-10, www.propanecouncil.org/uploadedFiles/Council/Research_and_Development/REP_11352%20Good%20Practices%20Care%20and%20Custody%20of%20Propane.pdf, accessed October 16, 2014.

[33] American Society for Testing Materials (ASTM), "ASTM D2713-13 Standard Test Method for Dryness of Propane (Valve Freeze Method)," portal.astm.org/download/D2713.31526.pdf, accessed October 20, 2014. As the liquid propane flows through the test valve, the time required for the valve to freeze is noted. Short freeze-off times indicate high water content in the propane.

At the consumer's end, the liquid propane is converted into gas for use in propane-fueled heating and appliances by being released from its storage tank at temperatures above -44°F. Extreme cold (i.e., below -44°F) can cause the propane in these tanks to remain in its liquid state and potentially freeze. To prevent this, consumers can take various steps. Insulating the storage tank and any pipes and valves connected to it may help prevent the propane and the lines from freezing up. Enclosing the tank in a shelter or even burying it underground provides added protection and insulation from severely cold weather.[34]

NUCLEAR

If a storm causes electric power outages that directs offsite power to nuclear power plants, the affected plants would likely implement relevant regulations and licensing conditions and go into controlled shutdown, as appropriate.

COMMUNICATIONS AND INFORMATION TECHNOLOGY

Localized communications outages may occur due to wind and ice damage to pole-mounted communications systems or cellular towers. Communications facilities have varying levels of backup power capabilities to ensure resilience to power failures; widespread communications network failure is unlikely. Communications systems are important to response and recovery efforts following a winter storm and repairs can be expected to proceed quickly once the storm abates and transportation routes are cleared of snow. Wireless telecommunications switching centers can be expected to continue operation in the absence of an extended power outage.

EMERGENCY SERVICES

Police stations, fire stations, and emergency operations centers rely on communications systems and electrical power. Emergency response delays are only expected if significant disruptions occur to transportation, electrical power, and communications systems.

HEALTHCARE AND PUBLIC HEALTH

Hospitals and other healthcare facilities can potentially be impacted by winter storms. Short delays to emergency response may occur because of transportation and electrical power impacts.

PREPAREDNESS MEASURES

Various measures can be taken to prepare for and survive winter storms. Before a storm strikes, create emergency kits for both home and vehicles and add winter storm-specific items. Suggested items include:

- Rock salt for use in melting ice on walkways;
- Sand for help in gaining traction;

[34] University of Alaska Fairbanks Cooperative Extension Service, "Keeping Your House Operating During a Cold Alaskan Winter," June 2011, www.uaf.edu/files/ces/publications-db/catalog/eeh/EEM-04955.pdf, accessed October 17, 2014.

- Snow shovels, ice scrapers and other snow removal equipment; and
- Extra cold weather clothing (e.g., hats, coats, gloves, boots, sweaters) and blankets.[35]

Check to see if vehicles have the requisite amount of antifreeze to operate in cold weather and keep the gas tank near full to prevent fuel lines from freezing. Winterizing homes with storm windows, wall and attic insulation, and weather-stripping on doors and windows will help to keep the heat in, the cold out and extend the heating fuel supply. Ensure there is sufficient heating fuel in the storage tank before the storm hits; after the storm, fuel carriers could be delayed until roads are cleared.[36]

The National Weather Service created the Wind Chill Temperature Index to describe how the blowing, cold winds of winter storms make the air feel much colder on the skin than its actual temperature (i.e., perceived air temperature vs. actual air temperature). Donning a hat and mittens, dressing in layers of loose fitting, light weight, warm clothing, and wearing hooded, water repellent, tightly woven outer garments can protect against this "wind chill factor" and help prevent frostbite and hypothermia. The National Weather Service releases Wind Chill Advisories when wind chill temperatures are potentially hazardous, and Wind Chill Warnings when wind chill temperatures are life threatening.[37] The chart in Figure 4 shows wind chill temperatures based on the combination of wind speed and actual air temperature.

[35] Federal Emergency Management Agency, "Winter Storms & Extreme Cold," www.ready.gov/winter-weather, accessed October 6, 2014 and American Red Cross, "Winter Storm Preparedness," www.redcross.org/prepare/disaster/winter-storm, accessed October 6, 2014. Both of these websites contain extensive information on winter storm preparedness actions and emergency kit items.

[36] Federal Emergency Management Agency, "Winter Storms & Extreme Cold," www.ready.gov/winter-weather, accessed October 6, 2014 and American Red Cross, "Winter Storm Preparedness," www.redcross.org/prepare/disaster/winter-storm, accessed October 6, 2014.

[37] National Oceanic and Atmospheric Administration, National Weather Service, *Wind Chill Temperature Index*, http://www.nws.noaa.gov/om/windchill/wind-chill-brochure.pdf, accessed October 6, 2014.

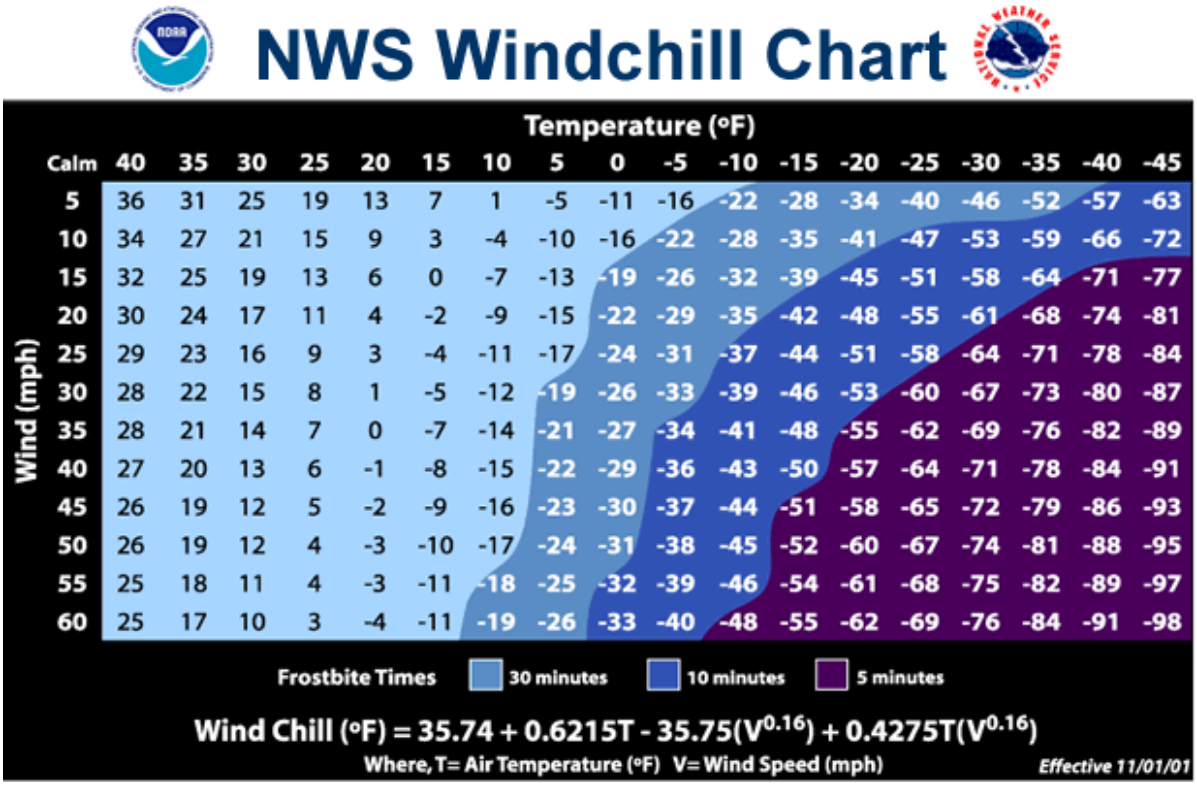

FIGURE 4—Wind Chill Temperature Chart (Source: National Weather Service)[38]

The Office of Cyber and Infrastructure Analysis (OCIA) produces Critical Infrastructure Security and Resilience Notes to address emerging risks to critical infrastructure and provide increased awareness of the implications of those risks to the Homeland. The information is provided to support the activities of DHS, and to inform the strategies and capabilities of Federal, State, local, and private sector partners. For more information, contact OCIA@hq.dhs.gov or visit our Website: www.dhs.gov/office-cyber-infrastructure-analysis.

[38] National Oceanic and Atmospheric Administration, National Weather Service, *Wind Chill Temperature Index*, www.nws.noaa.gov/om/windchill/wind-chill-brochure.pdf, accessed October 6, 2014.