



MINNESOTA DEPARTMENT OF TRANSPORTATION
Engineering Services Division
Technical Memorandum No. 14-10-MAT-02
October 7, 2014

To: Electronic Distribution Recipients

From: Jon M. Chiglo, P.E. *ASJ*
for Division Director, Engineering Services

Subject: Process for Seasonal Load Limit Starting and Ending Dates

Expiration

This Technical Memorandum supersedes Technical Memorandum No. 09-09-MAT-02 and will continue in force until October 7, 2019, unless superseded prior to that date.

Implementation

This procedure is effective immediately.

Introduction

This Technical Memorandum updates the process for setting Seasonal Load Limits, including Spring Load Restrictions and Winter Load Increases, in accordance with Minnesota Statute 169.87.

Purpose

The purpose of this technical memorandum is to update the procedure for the placement, removal, and other administration of Seasonal Load Limits. This includes the starting and ending dates for spring load restrictions, winter load increases, middle-range overweight permits and full-summer overweight permits. These procedures apply to Minnesota Trunk Highways and the County, Municipal, and Township Highway Systems.

Guidelines

Spring Load Restrictions

1. The Districts will submit their restricted roadway segments and any exceptions or changes to the Director of the Office of Materials and Road Research. Restricted Roadway segments for the annual ROAD RESTRICTION MAP are to be submitted, each year, by November 30.
2. The spring load restriction **start and end dates** for each frost zone will be announced **with at least a 3-day advance notice**. **Advance notice is available on the Internet at http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/sllindex.asp** and via recorded messages at (651) 366-5400 or toll free at 1-800-723-6543.
3. The annual ROAD RESTRICTION MAP is available using the web site listed above. The annual ROAD RESTRICTION MAP is updated for the current year on the Internet by January 31.
4. The **start date** of the load restriction period for each frost zone is determined using measured and forecast daily air temperatures for several locations within each frost zone. **Load restrictions will be scheduled** (and the advance notice released) when the 3-day weather forecast indicates that the cumulative thawing index (CTI) for a zone will exceed **25 F degree-days** and longer-range forecasts predict continued warmth. Forecast temperatures are used to schedule the restrictions (as opposed to daily measurements) in order to ensure that the **beginning of the thaw** coincides with the end of the 3-day public notice period.

-MORE-

The cumulative thawing index (CTI) is the running total of each day's thawing index starting from a value of 0 F degree-days during the winter freeze. The daily thawing index is the amount the daily average temperature is above the reference temperature for that day's date as shown in Table 1. For example, the daily thawing index would be 2 F degree-days if the average temperature was 25°F on March 22nd.

For days in which freezing occurs the CTI is reduced by one half of that day's freezing index (the CTI may be reduced to a minimum value of zero). The daily freezing index is the amount the daily average temperature is below freezing. There is no reference temperature for the daily freezing indices.

Because each day is either a thawing day or a freezing day; when the daily thawing index is a positive number the daily freezing index is set to zero, when the daily freezing index is a positive number the daily thawing index is set to zero.

The equations for calculating the cumulative thawing index (CTI) are shown below.

$$CTI_n = \sum_{i=1}^n \left(\text{Daily Thawing Index} - 0.5 \times \text{Daily Freezing Index} \right) \quad (\text{Equation 1})$$

- When $\left(\frac{T_{\text{maximum}} + T_{\text{minimum}}}{2} - T_{\text{reference}} \right) < 0^\circ\text{F}$

And $CTI_{n-1} \leq 0.5 \times \left(32^\circ\text{F} - \frac{T_{\text{maximum}} + T_{\text{minimum}}}{2} \right)$, *(Significant thawing has not yet occurred)*

Daily Thawing Index = 0°F-day and

Daily Freezing Index = 0°F-day.

- When $\left(\frac{T_{\text{maximum}} + T_{\text{minimum}}}{2} - T_{\text{reference}} \right) > 0^\circ\text{F}$, *(The pavement structure is thawing)*

Daily Thawing Index = $\left(\frac{T_{\text{maximum}} + T_{\text{minimum}}}{2} - T_{\text{reference}} \right)$ and

Daily Freezing Index = 0°F-day.

- When $\left(\frac{T_{\text{maximum}} + T_{\text{minimum}}}{2} - T_{\text{reference}} \right) < 0^\circ\text{F}$

And $CTI_{n-1} > 0.5 \times \left(32^\circ\text{F} - \frac{T_{\text{maximum}} + T_{\text{minimum}}}{2} \right)$, *(The pavement structure is refreezing)*

Daily Thawing Index = 0°F-day and

Daily Freezing Index = $\left(32^\circ\text{F} - \frac{T_{\text{maximum}} + T_{\text{minimum}}}{2} \right)$

Where: CTI_n = cumulative thawing index calculated over 'n' days (°F-day),
 CTI_{n-1} = cumulative thawing index for the previous day,
 T_{maximum} = Maximum daily air temperature (°F),
 T_{minimum} = Minimum daily air temperature (°F), and
 T_{reference} = Reference air temperature (see Table 1) (°F).
 (CTI resets to zero on January 1).

-MORE-

Please note the following:

- To calculate the CTI the freezing index is multiplied by a refreeze factor of 0.5. This is used to account for the partial phase change of water from a liquid to a semi-solid during temporary refreeze events.
- A reference temperature is used to account for the increasing intensity of the sun during the spring thaw period. As the sun's daily duration and intensity increases the air temperature at which thawing may occur in the pavement's structure reduces. As shown in Table 1, the increase in solar intensity is adjusted for by using a freezing temperature depression of **2.7 °F** during the first seven days of February and a depression of **0.9 °F** per week from then until the end of the season.

Table 1.
Reference temperature used when calculating the cumulative thawing and freezing index.

Date*	Reference Temperature (°F)
January 1 – January 31	32.0
February 1 – February 7	29.3
February 8 – February 14	28.4
February 15 – February 21	27.5
February 22 – February 28	26.6
March 1 – March 7	25.7
March 8 – March 14	24.8
March 15 – March 21	23.9
March 22 – March 28	23.0
March 29 – April 4	22.1
April 5 – April 11	21.2
April 12 – April 18	20.3
April 19 – April 25	19.4
April 26 – May 2	18.5
May 3 – May 9	17.6
May 10 – May 16	16.7
May 17 – May 23	15.8
May 24 – May 30	14.9
June 1 – December 31	32.0

A statewide graph of the cumulative thawing index is updated daily on the Internet at http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/slindex.asp. This graph can be manipulated to show both the current year's data and forecasted trends.

5. The **end date** of the load restriction period for each frost zone is determined using measured frost depths, forecast daily air temperatures, and other key indicators at several locations within each frost zone. The speed with which the soil thaws is dependent upon a number of variables including maximum frost depth, soil moisture content, and spring weather patterns. Therefore, the duration of the spring load restrictions will **vary** from year to year. However, it is MnDOT's intent that the spring load restrictions last **no more than 8 weeks** unless extraordinary conditions exist that require additional time or route specific signage.

-MORE-

Winter Load Increases

1. The winter load increase **start and end dates** for each frost zone will be announced with at least a **3-day advance notice**. Advance notice is available on the Internet at http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/sllindex.asp and via recorded messages at (651) 366-5400 or toll free at 1-800-723-6543.
2. The **start date** of the winter load increase period for each frost zone is determined using measured and forecast daily air temperatures at several locations within each frost zone. **The winter load increase will be scheduled** (and the advance notice released) when the 3-day weather forecast indicates that the cumulative freezing index (CFI) for a zone will exceed **280 F degree-days** and extended forecasts predict continued freezing temperatures. Forecast temperatures are used to schedule the increases (as opposed to daily measurements) in order to ensure that a thawing event is not likely and that roads will be open to larger loads as soon as they are able to carry the weight.

The cumulative freezing index is calculated using equation 2:

$$CFI_n = \sum_{i=1}^n (\text{Daily Freezing Index}) \quad (\text{Equation 2})$$

- When $CFI_{n-1} + \left(32^\circ F - \frac{T_{\text{maximum}} + T_{\text{minimum}}}{2} \right) \geq 0^\circ F$

$$\text{Daily Freezing Index} = \left(32^\circ F - \frac{T_{\text{maximum}} + T_{\text{minimum}}}{2} \right)$$

- When $CFI_{n-1} + \left(32^\circ F - \frac{T_{\text{maximum}} + T_{\text{minimum}}}{2} \right) < 0^\circ F$

$$CFI_n = 0^\circ F$$

Where: CFI_n = cumulative freezing index calculated over 'n' days (°F-day),
 CFI_{n-1} = cumulative freezing index for the previous day,
 T_{maximum} = Maximum daily air temperature (°F), and
 T_{minimum} = Minimum daily air temperature (°F).
(CFI resets to zero on July 1).

3. The **end date** of the winter load increase period for each frost zone is determined when forecast air temperatures predict daily thawing, as indicated by the cumulative thawing index, and the impending placement of spring load restrictions. The end date of winter load increases is **not** tied to the starting date of spring load restrictions and winter load increases may be removed prior to the placement of spring load restrictions. Winter load increases are not removed during temporary thaw events that are followed by extended freezing periods during the months of December and January, and therefore, are not typically removed prior to February 1st

Middle-Range and Full-Summer Overweight Permits

1. The **starting and ending dates** of middle-range and full-summer overweight permits for each frost zone are preceded by at least a **3-day advance notice**. Advance notice is available at http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/sllindex.asp and via recorded messages at (651) 366-5400 or toll free at 1-800-723-6543.

-MORE-

2. Middle-range overweight permits are available within each frost zone **starting** when spring load restrictions are removed.
3. Full-summer overweight permits are available within each frost zone **starting** 2-3 weeks after spring load restrictions are removed.
4. Use of middle-range and full-summer overweight permits **ends** when winter load increases are removed the following year.

Questions

Any questions regarding the technical provisions of this Technical Memorandum can be addressed to either of the following:

- **Tim Andersen**, Pavement Design Engineer, at **(651) 366-5455**
- materialslab.dot@state.mn.us

Any questions regarding publication of this Technical Memorandum should be referred to the Design Standards Unit, DesignStandards.DOT@state.mn.us. A link to all active and historical Technical Memoranda can be found at <http://techmemos.dot.state.mn.us/techmemo.aspx>.

To add, remove, or change your name on the Technical Memoranda mailing list, please visit the web page <http://techmemos.dot.state.mn.us/subscribe.aspx>

