



# **Update of Ongoing Binder Activities Fall Binder ETG 2016**





# **Binder Activities**

- **REOB round robin characterization**
- **WRI/ARC Field Validation Sites**
- **Binder QC Tester Update**
  
- **Delta Tc Range and Magnitude**





# Background.....

- **Binders have changed**
  - High crude oil prices
  - **New Blends, modifications, materials**
    - REOB
    - RAP
    - Hybrid (CRM+Elastomer)
    - Waxes and other polymers
    - PPA
  - **New methods for extracting crudes**





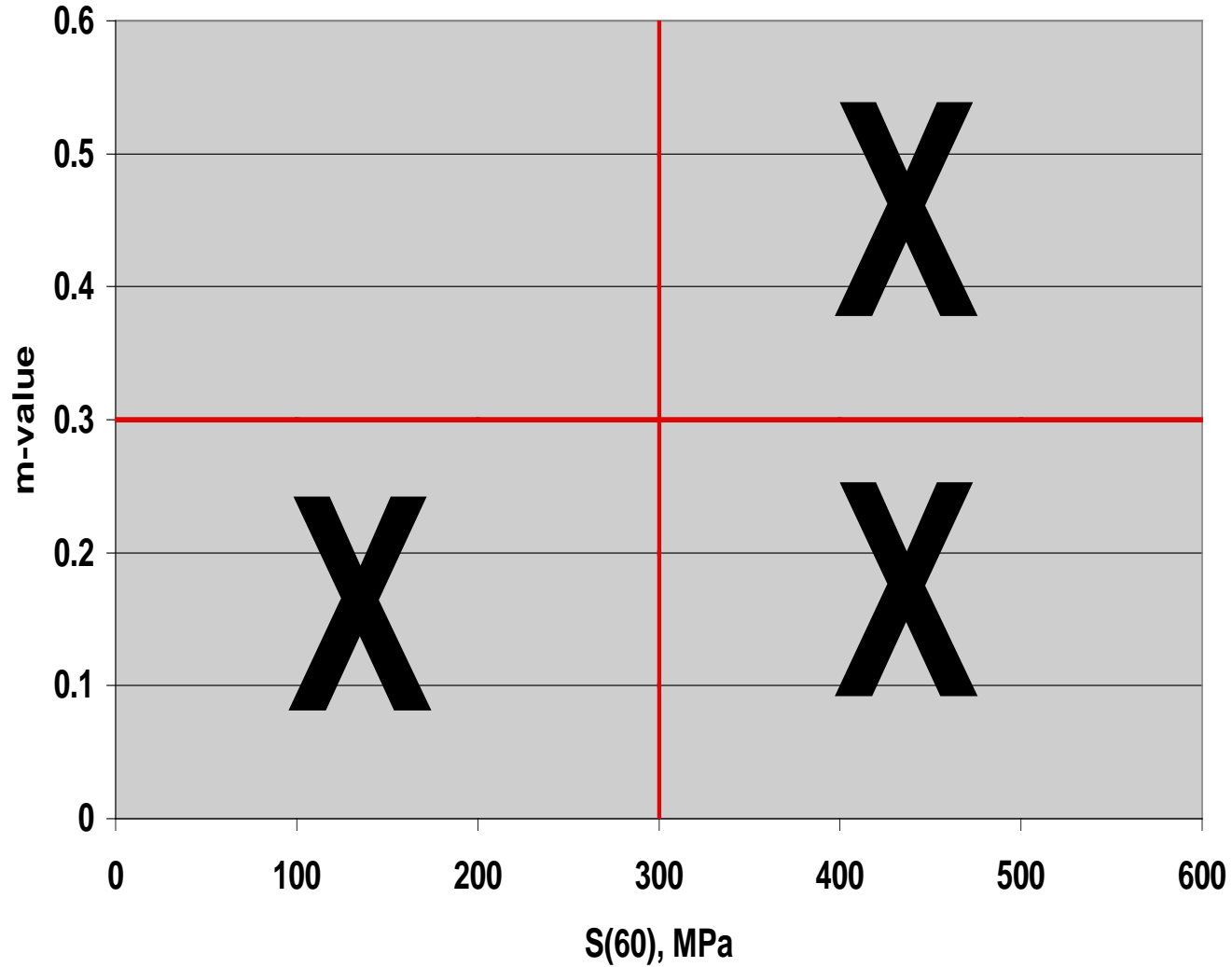
# Background

- **SHRP Premise**
  - No lower limit to  $S(60s)$  value – 0 to 300 MPa allowed
  - A minimum of 0.300 m-value is required as long as  $S$  is lower than or equal to 300 Mpa
  - $\Delta T_c = T_c (S = 300) - T_c (m = 0.3)$  was not considered
    - $\Delta T_c = \text{Positive}$  indicates  $\rightarrow S$  – controlled binders
    - $\Delta T_c = \text{Negative}$  indicates  $\rightarrow m$  – controlled binders





## Low Temperature Specification M320 - Table 1





# Background – Where are we today?

- **How is the Issue being addressed? – At present – FHWA, ETG etc**
  - **S and m-value based approach**
    - It was observed in the past that the delta Tc value is an indicator of Performance
      - G. Reinke during MnRoads evaluation
    - REOB and other softening additives affect S value more than m-value creating a difference in critical value of temperature (Delta Tc)
    - Suggestion: Specify that m-value is met at a certain S value
    - Advantage: If it works – no new tests need to be performed – just a calculation!



# Approach

- **Collect State DOT Low Temperature BBR Verification Data**
- **Calculate Delta Tc using Data Mining Techniques**
- **Get performance data if available**
  
- **Provide Data => Recommendations**
  - Perhaps an acceptable Delta Tc?
  - Specify S where m-value is 0.3?





- **Calculate Delta Tc using Data Mining Techniques**
  - Challenge – State validation data contains BBR info. at only one temperature!
  - To calculate Delta Tc – Need BBR S and m-value data at two temperatures!
  - Approach – Determine prediction algorithms to calculate Delta Tc.
- **Delta Tc Prediction from single point BBR data**
  - Rule of Thumb
  - PG specific changes in S and m-values
  - Average of all PG specific changes in S and m-value





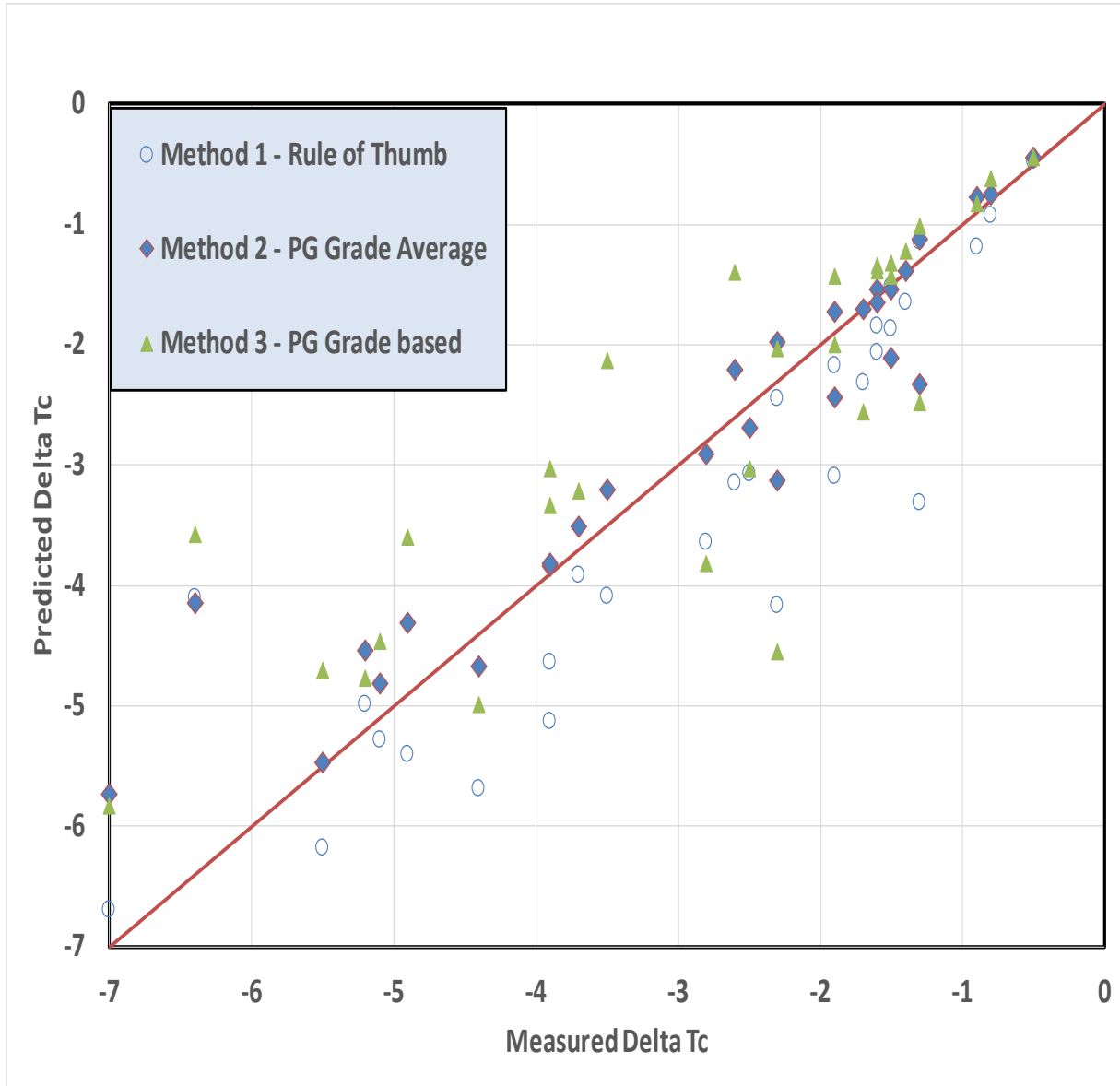
# Delta Tc Prediction from single point BBR data

- Rule of Thumb (Method 1)
  - **S value at 60s doubles every 6°C**
    - e.g. If  $S = 120$  at  $-18\text{C}$ ;  $S = 240$  at  $-24\text{C}$  and  $S = 60$  at  $-12\text{C}$
  - **m-value changes by 0.036 every 6°C**
    - e.g. If  $m = 0.303$  at  $-18\text{C}$ ;  $m = 0.267$  at  $-24\text{C}$  and  $m = 0.339$  at  $-12\text{C}$



# Delta Tc Prediction from single point BBR data

- **PG Specific prediction rules (Method 2)**
  - **Collect a robust database of BBR S and m-values for different PG grades**
    - Multiple sources of binder for each PG grade
  - **Calculate PG grade specific prediction rules for S and m-value**
  - Validate using independent database of S and m-value
- **PG Averaging prediction rules (Method 3)**
  - **Predict Delta Tc based on PG specific changes in S and m-value**

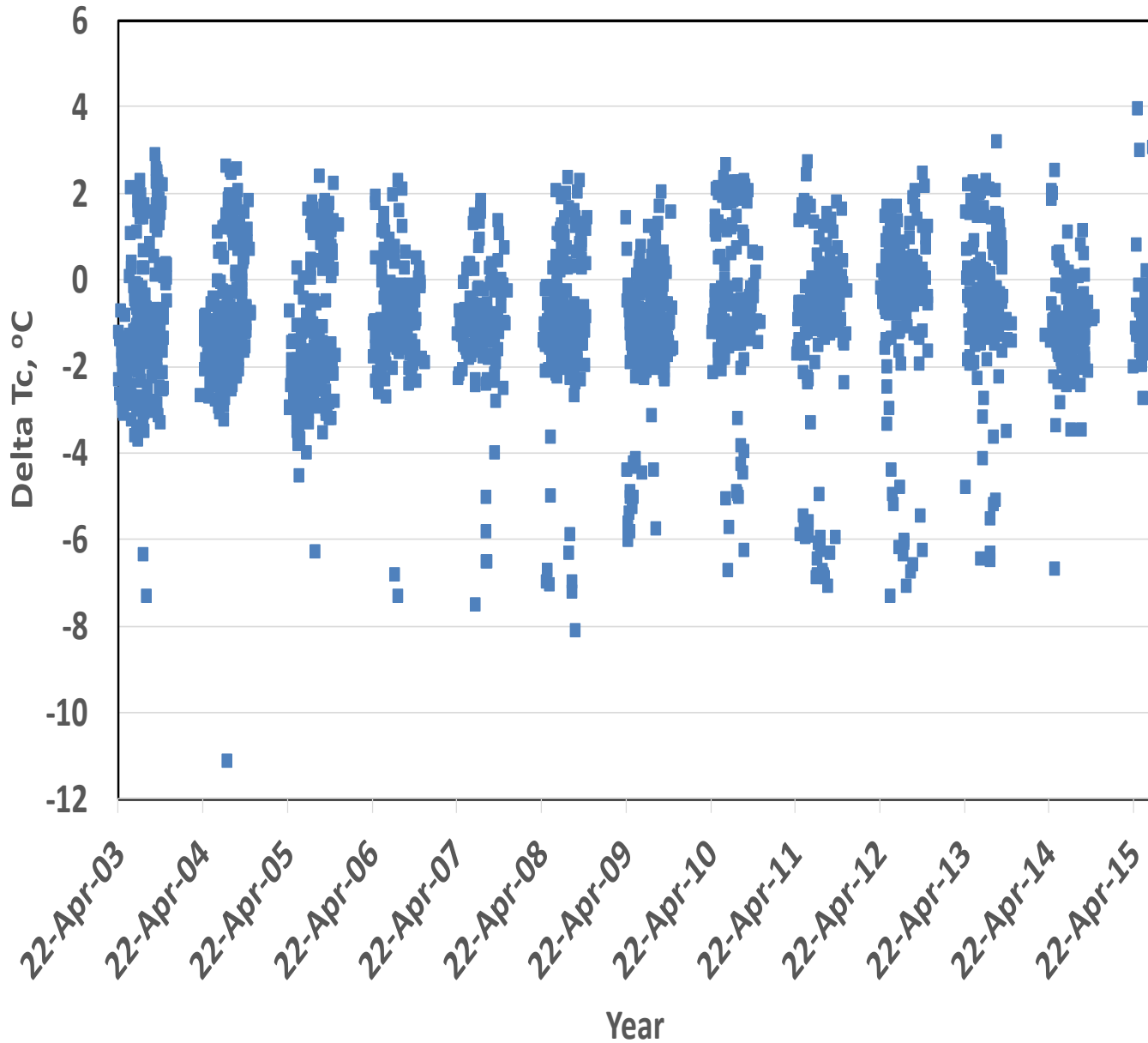




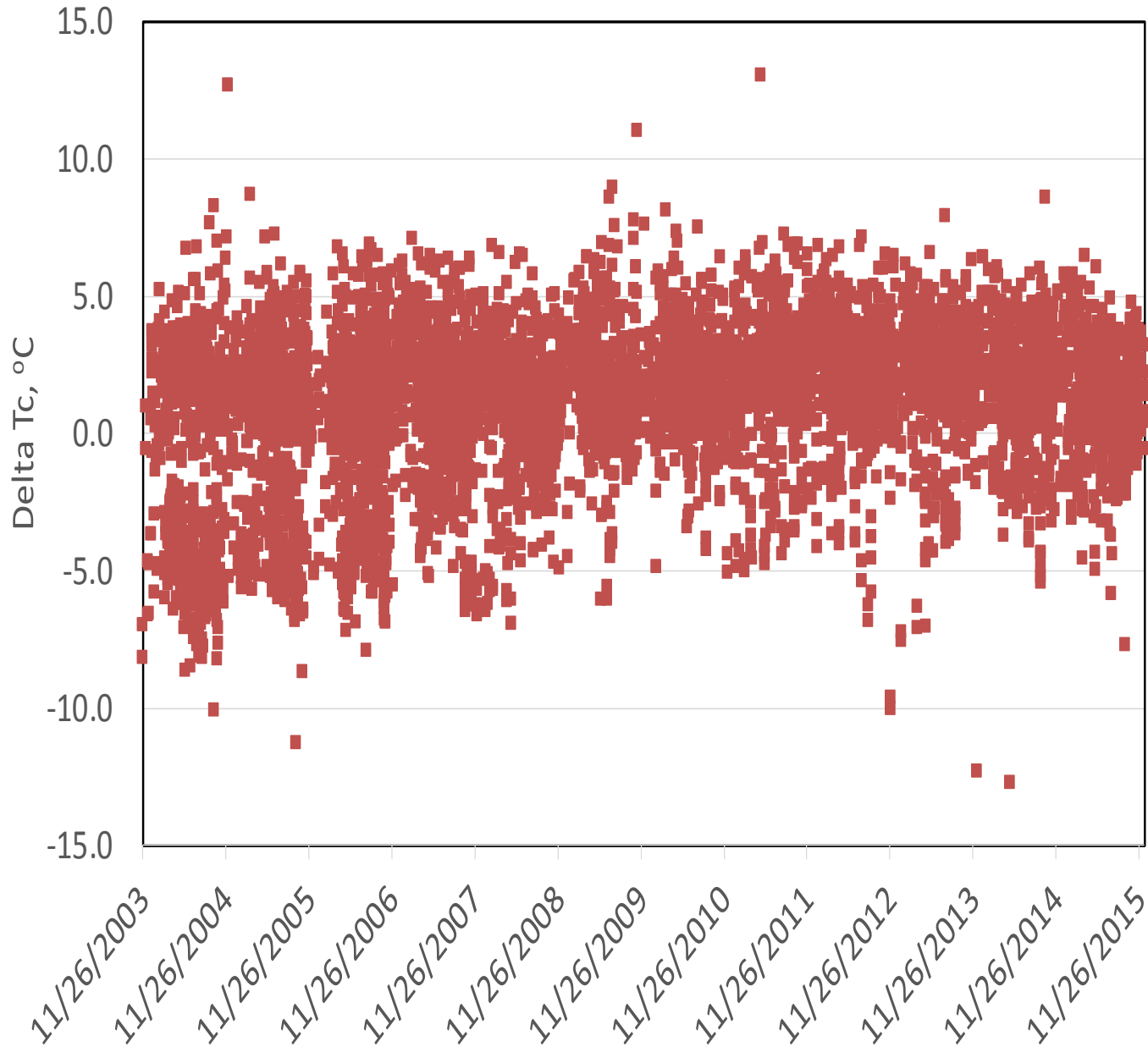
# **State DOT - BBR S and m-value Database**

- **Requested BBR validation data from all state DOTs**
  - Received data from over 20 State DOTs.
  - Analyzed data from Six States DOTs so far.
    - Used Method 2 – PG Average to predict Delta Tc
- **Data Analysis Approach**
  - Discrete Statistics
  - Data Mining using Probability Distribution Fitting

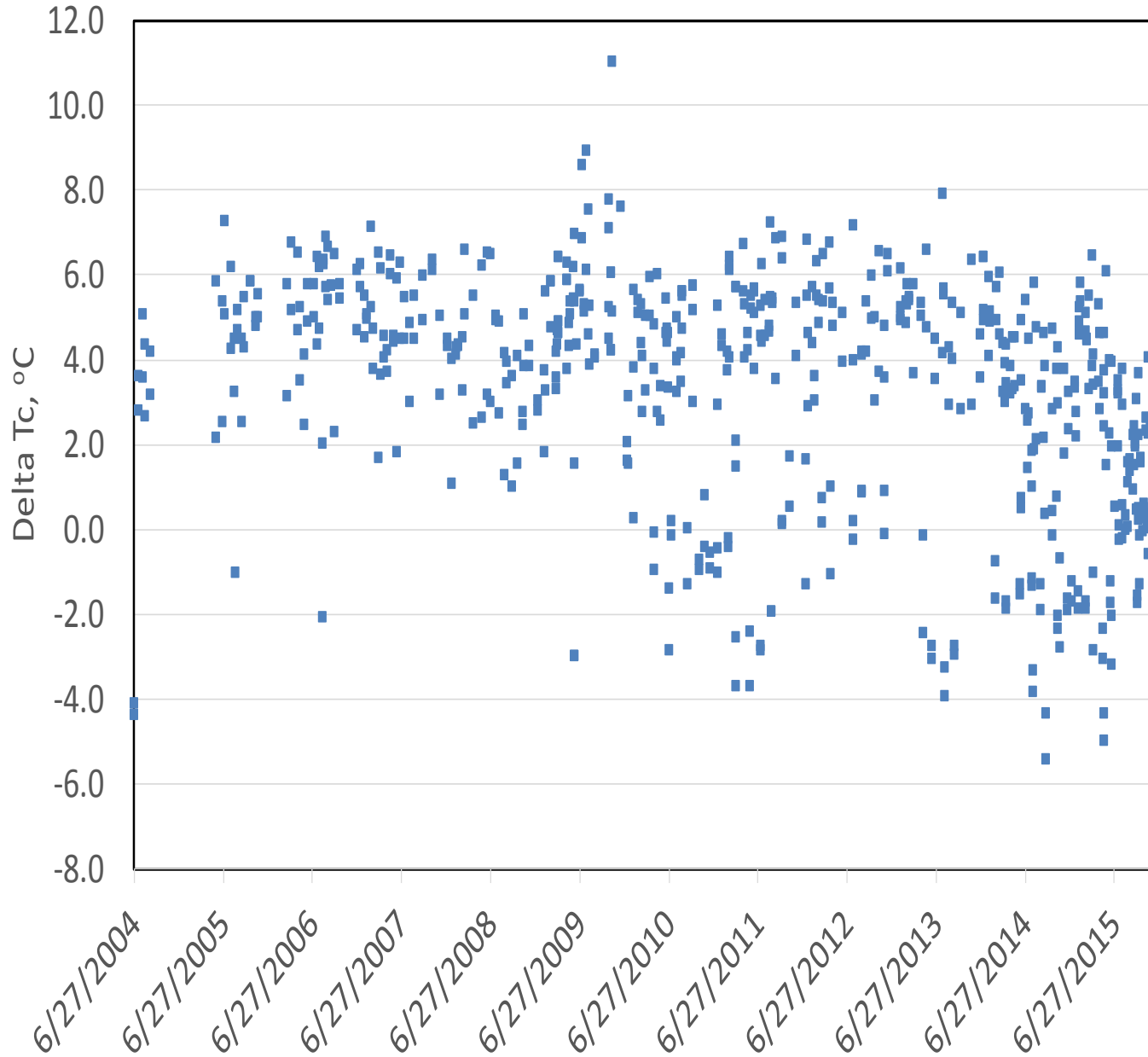
# MAINE DOT - All PG Grades



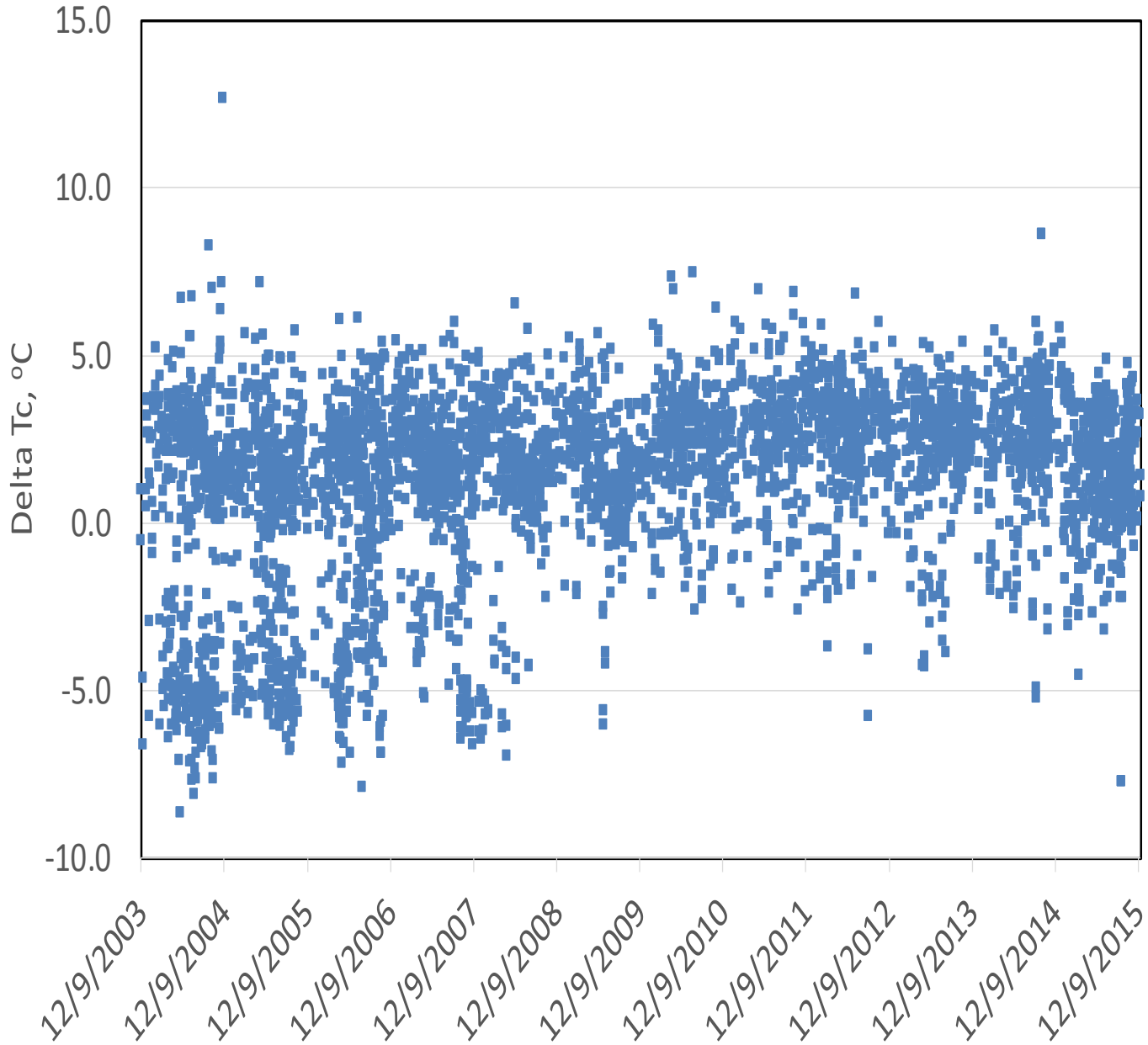
# DELAWARE DOT - All PG Grades



DELAWARE DOT - PG 58-28



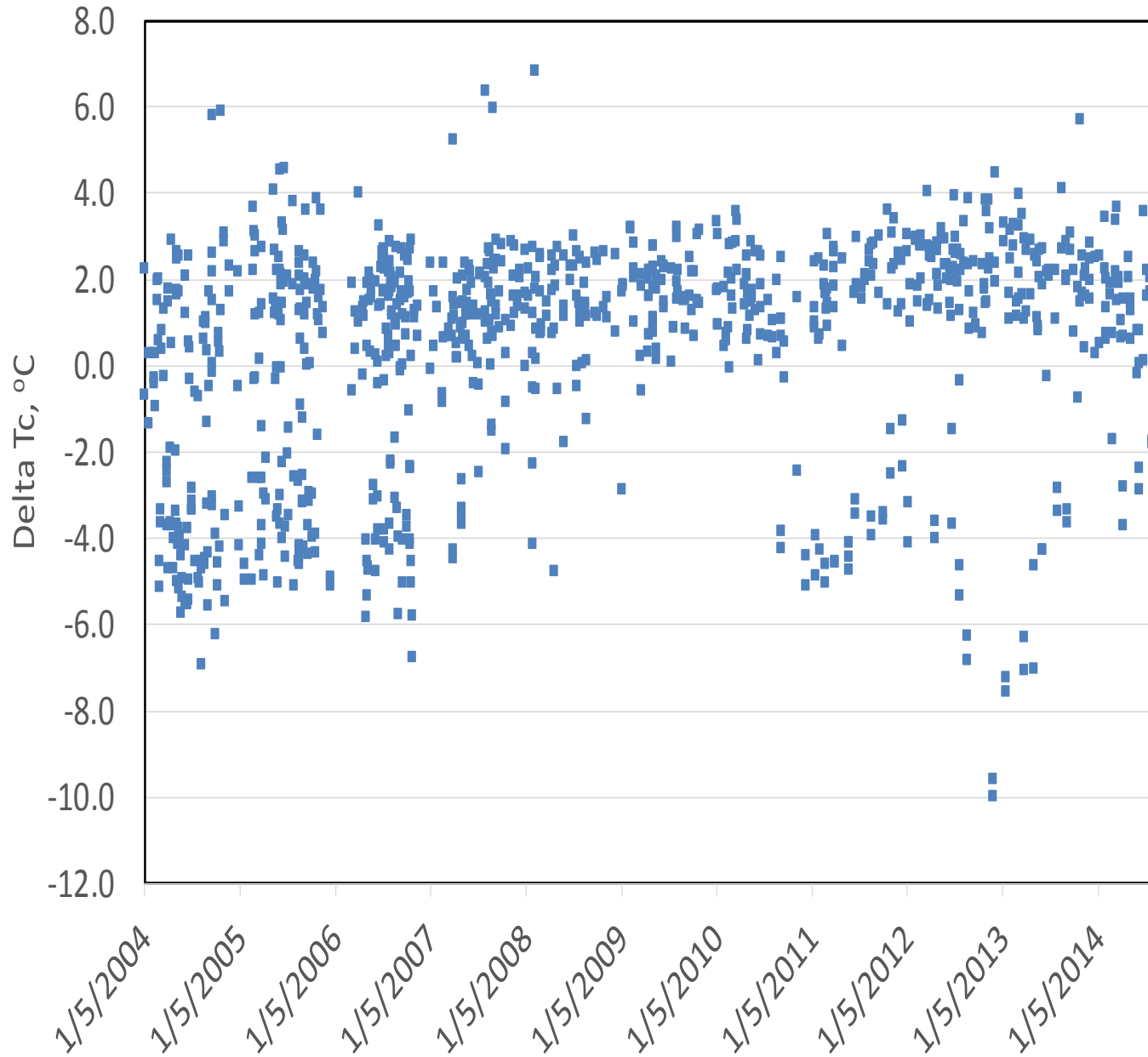
DELAWARE DOT - PG 64-22



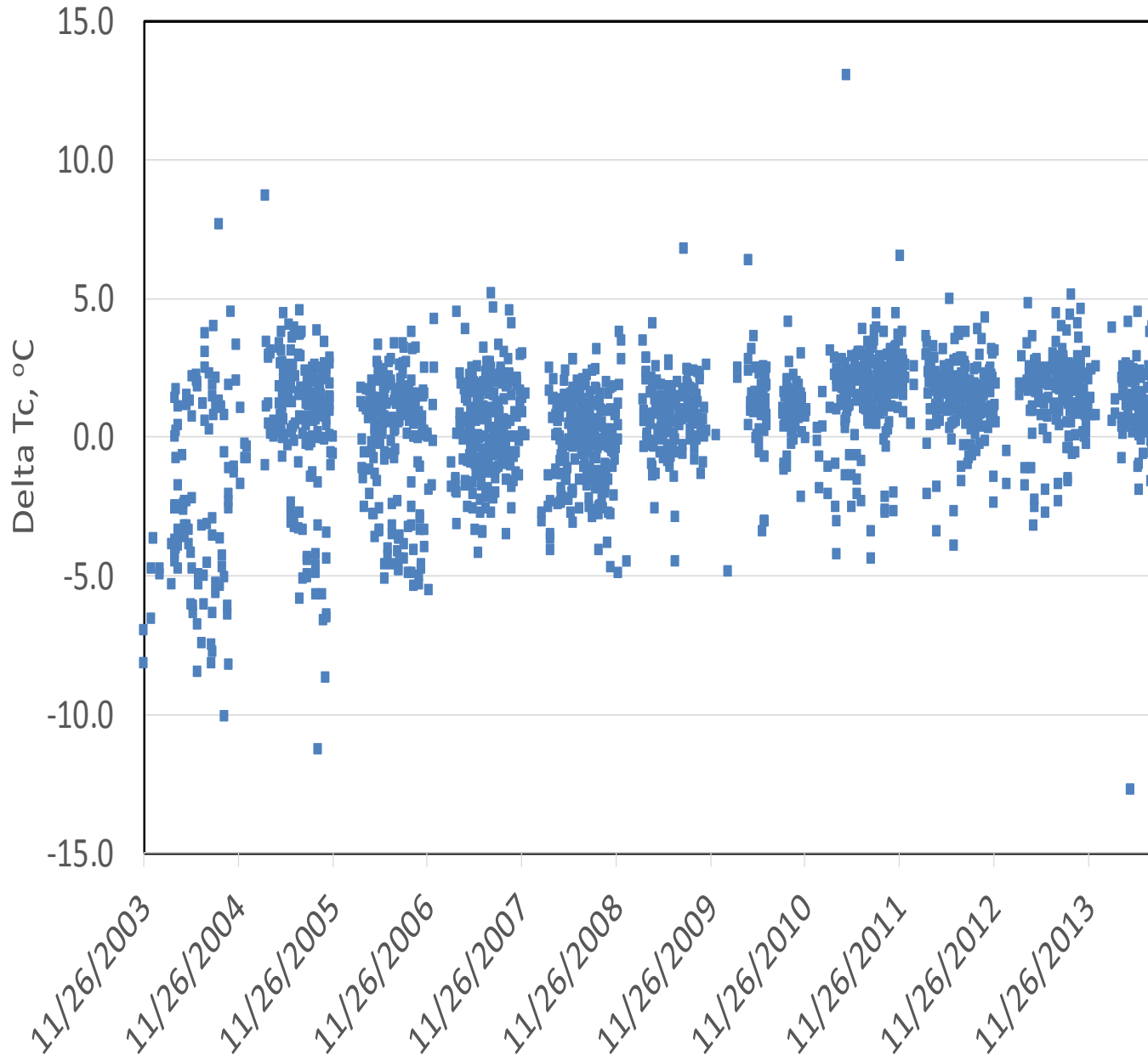




# DELAWARE DOT - PG 70-22

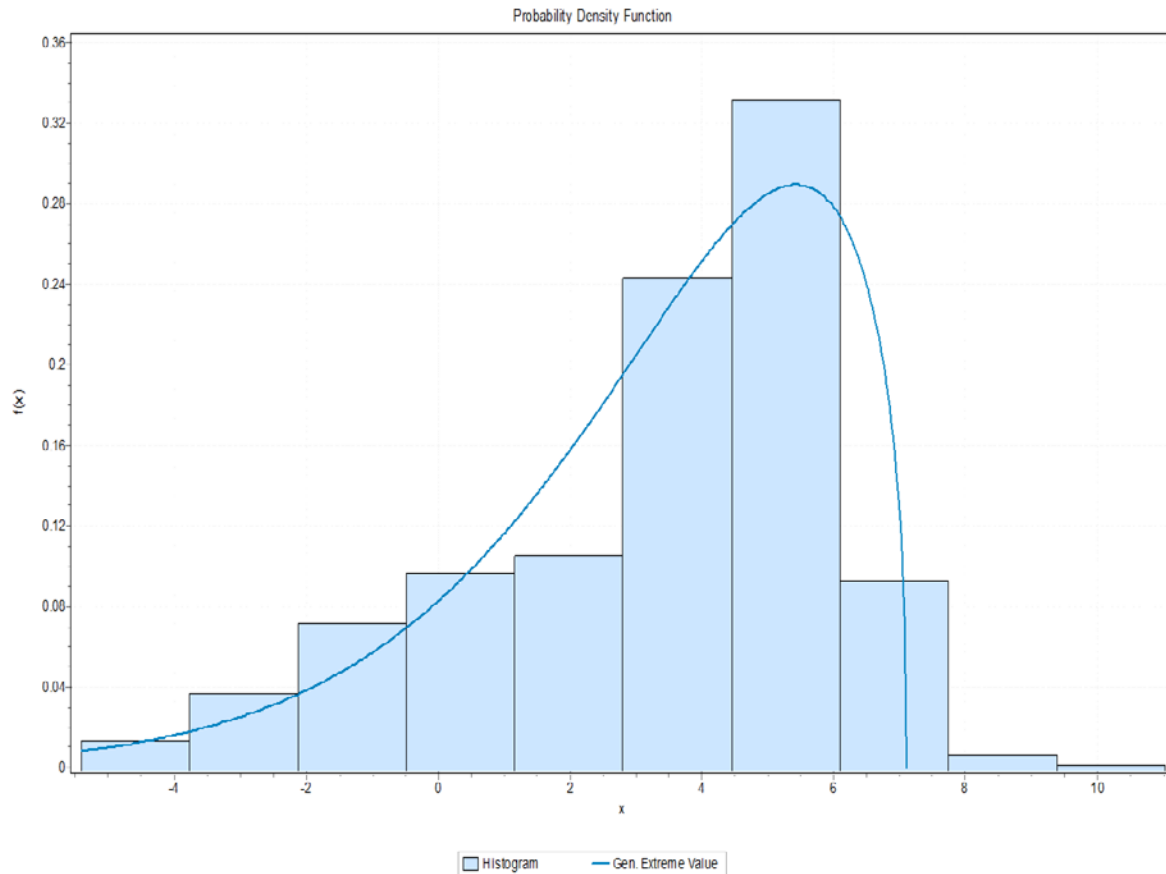


# DELAWARE DOT - PG 76-22



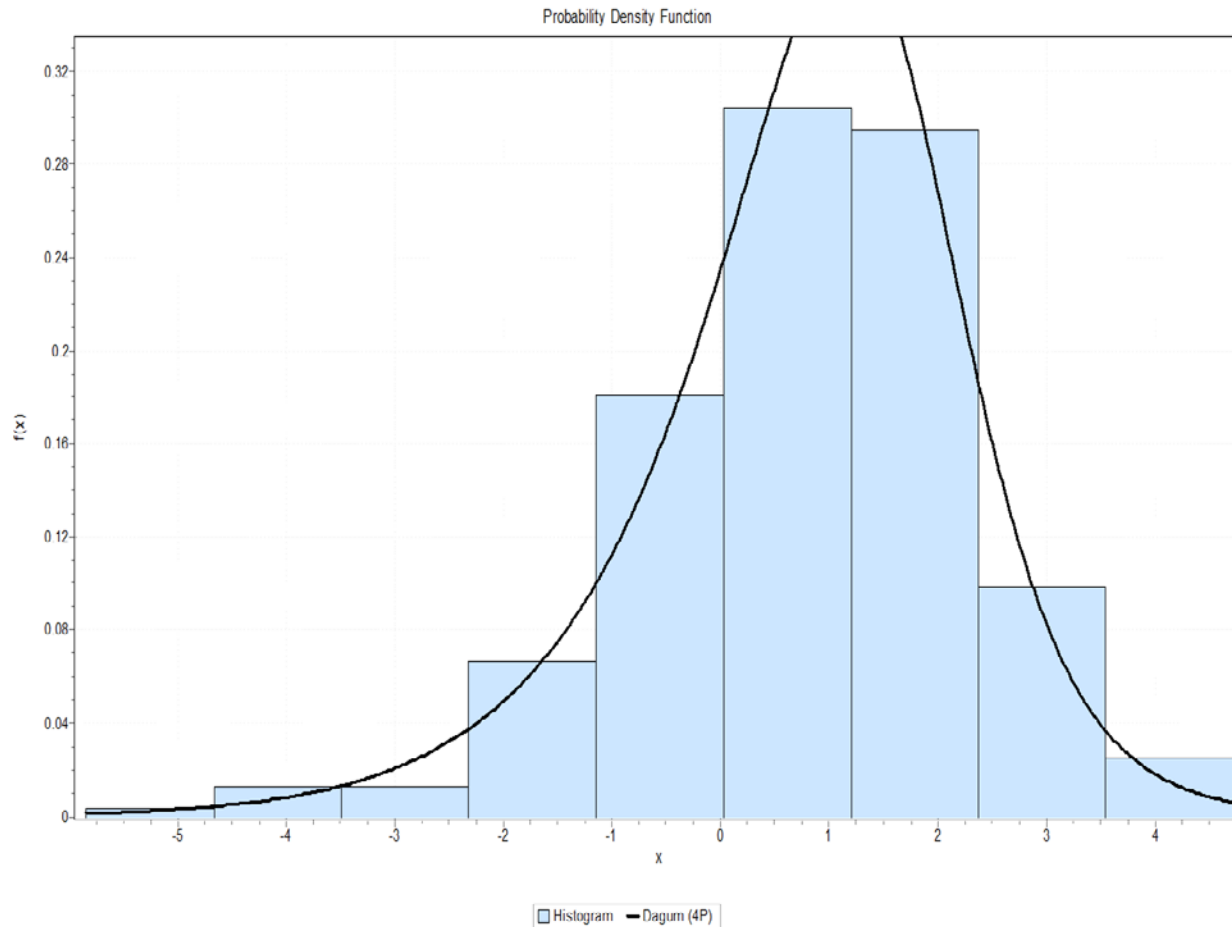


# DELAWARE PG 58-28 PDF



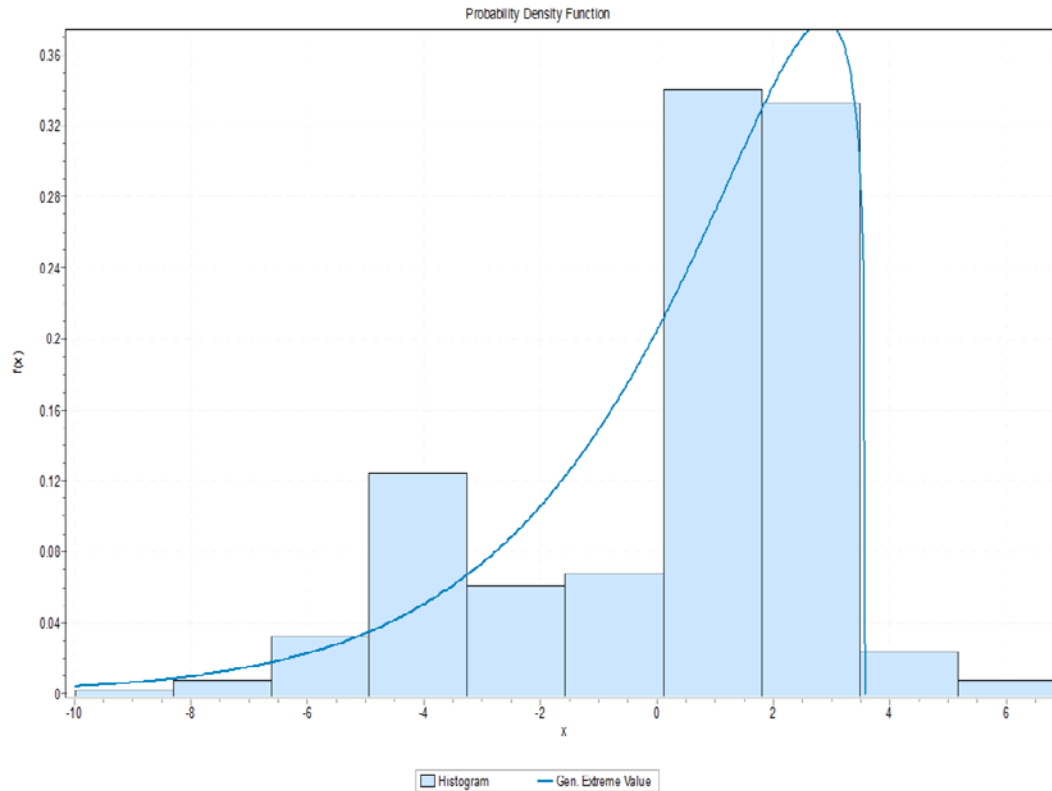


# DELAWARE PG 64E-22 PDF



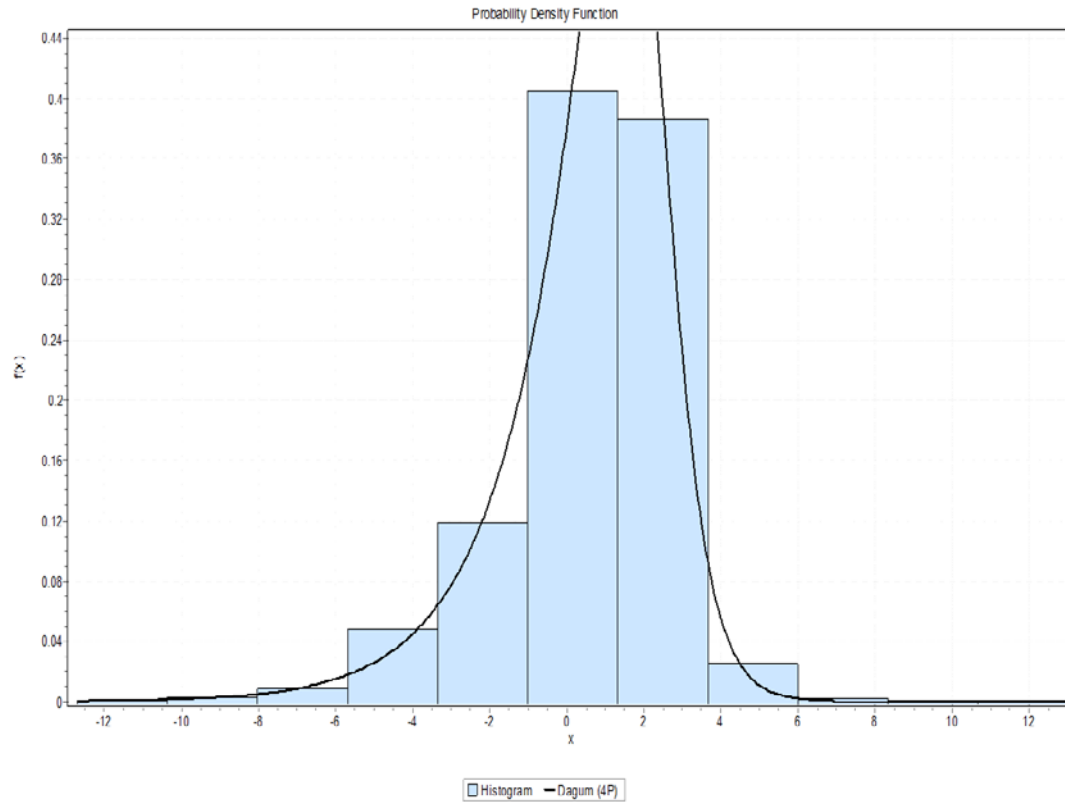


# DELAWARE PG 70-22 PDF





# DELAWARE – PG 76-22 PDF





State ID	State	Sample Size	Delta Tc, degrees C		
			Median	Minimum	Maximum
1	AR	417	-3.5	-12.4	3.6
2	CO	4275	-1.1	-14.6	12.4
3	DE (PG 58-28)	600	4.1	-5.4	11
3	DE (PG 64-22E)	315	0.9	-5.8	4.7
3	DE (PG 64-22)	3657	1.9	-8.6	12.7
3	DE (PG 70-22)	949	1.3	-10	6.8
3	DE (PG 76-22)	1961	1	-12.7	13
4	ME	2308	-1	-11.1	3.9
5	NCDOT	12,116	-0.3	-13.6	8.4
6	NE	926	2	-5.1	6.5





# Findings to date

- **Findings**

- **Delta Tc may be predicted using simple rules based on PG Averages**
- **Error in prediction is within +/- 1 degree C for most grades and binders**
- **Data Mining effort**
  - **Delta Tc is mostly skewed to negative Delta Tc (m-controlled) for the six State DOTs analyzed**
  - **Delta Tc can range from as low as 3.6 to as high as -14.6 for the six State DOTs analyzed**





# Next Steps

- **Complete analyses**
- **Send report back to participants**
- **Request field performance**
- **Share final analysis with ETG and SOM**





# Future Plan

- **Collect more datasets from researchers where S and m-value data for both temperatures for BBR are available**
  - Fine tune Delta Tc prediction method and improve on PG based method error
- **Collect performance data from State DOTs**
  - Especially for State DOTs showing high values of Delta Tc
- **Recommend possible Delta Tc limits for binder specification**





# Any Questions?

**Contact: [Jack.youtcheff@dot.gov](mailto:Jack.youtcheff@dot.gov)**

