

# NONRESIDENTIAL ~~ACM MANUAL~~ APPENDIX ~~NA6~~ (Formerly ~~NRACM NH~~)

## Appendix ~~NA6~~ - Alternate Default Fenestration Thermal Properties<sup>1</sup>

### Scope

This appendix ~~applies~~ provides default ~~to a~~ procedure for determining ~~fenestration~~ performance data (product SHGC and U-factor) for skylights and site built fenestration less than 10,000 ft<sup>2</sup> in area, as excepted from Section 116 (a) 2 and Section 116 (a) 3 of the Standard.

~~“EXCEPTION to Section 116 (a) 2: If the fenestration product is site-built fenestration in a building covered by the nonresidential standards with less than 10,000 square feet of site-built fenestration or is a skylight, the default U-factor may be the applicable U-factor as set forth in the Nonresidential ACM Manual.”~~

~~“EXCEPTION to Section 116 (a) 3: If the fenestration product is site-built fenestration in a building covered by the nonresidential standards with less than 10,000 square feet of site-built fenestration or is a skylight, the default SHGC may be calculated according to Equation 116-A.”~~

### Purpose

To present alternate default U-factors and the calculation method for determining an alternate default SHGC, and to describe the responsibilities of energy consultants, designers, architects, builders, installers, and building departments when an alternate default value is used for determining compliance.

### ~~NA6-I.1~~ Solar Heat Gain CoefficientU-factor

The U-factor shall be determined using the following equation:

$$U_T = c_1 + c_2 \times U_C$$

where

U<sub>T</sub> The fenestration product U-factor

C<sub>1</sub> coefficient selected from Table NA-1

C<sub>2</sub> coefficient selected from Table NA-1

U<sub>C</sub> center of glass U-factor

Table NA-1 –U-factor Coefficients

<u>Product</u>	<u>Frame Type</u>	<u>C1</u>	<u>C2</u>
<u>Site-Built Vertical Fenestration</u>	<u>Metal Frame</u>	<u>0.311</u>	<u>0.872</u>
	<u>Thermal Break or Non-Metalic Frame</u>	<u>0.202</u>	<u>0.86/</u>
<u>Skylights with a Curb</u>	<u>Metal Frame</u>	<u>0.711</u>	<u>1.065</u>
	<u>Thermal Break or Non-Metalic Frame</u>	<u>0.437</u>	<u>1.229</u>
<u>Skylights with no Curb</u>	<u>Metal Frame</u>	<u>0.195</u>	<u>0.882</u>
	<u>Thermal Break or Non-Metalic Frame</u>	<u>0.310</u>	<u>0.878</u>

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## NA6-2 Solar Heat Gain Coefficient

The SHGC of the fenestration product shall be calculated using the following equation:

$$\text{SHGC}_T = 0.08 + 0.86 \times \text{SHGC}_c$$

Where:

$\text{SHGC}_{\text{fen}}$  where

$\text{SHGC}_T$  is the SHGC for the fenestration including glass and frame.

$\text{SHGC}_c$  is the SHGC for the center of glass alone, and

### NA6-1.2.3 Responsibilities for SHGC Compliance

This section describes the responsibilities of energy consultants, designers, architects, builders, installers, and building departments when using the procedures of this alternative calculation method is used for determining compliance with SHGC requirements appendix.

#### NA6-1.23.1 Energy Consultants, Designers, Architects

##### Site-Built Fenestration Products without SHGC Rated Using NFRC Procedures

The procedure described below applies only to skylights and to site-built fenestration in buildings with less than 10,000 ft<sup>2</sup> of site-built fenestration.

To determine compliance with the efficiency standards, the center of glass SHGC from the manufacturer's documentation for the proposed glazing must be converted to an  $\text{SHGC}_{\text{fen}}$   $\text{SHGC}_T$  for the fenestration that includes the framing effect. The person with responsibility for preparing the compliance documentation shall establish the inputs to the procedure according to the following:

- The center of glass U-factor and SHGC shall be taken from manufacturers' literature and determined using methods consistent with to NFRC standards [CE2].
- The frame type (thermal break, non-metallic or metal) shall be verified from manufacturers' literature and through observations of frame sections provided by the manufacturer.

For the Prescriptive compliance method, the  $U_T$ ,  $\text{SHGC}_{\text{fen}}$ ,  $\text{SHGC}_T$ ,  $U_C$  and  $\text{SHGC}_C$  determined through this procedure shall be entered into the prescriptive ENV-1/ENV-1-C form, Part 2 of 2 and must appear on the building plans.

For the Performance compliance method, the  $\text{SHGC}_{\text{fen}}$ ,  $U_T$ ,  $\text{SHGC}_T$ ,  $U_C$  and  $\text{SHGC}_C$  determined through this procedure shall be documented on the  $\text{SHGC}_T$  output information printed on the Performance ENV-1/ENV-1-C form must be listed on the building plans. The PERF-1 and Performance ENV-1/ENV-1-C forms must appear on the plans. The building plan window schedule list must indicate the proposed total  $\text{SHGC}_{\text{fen}}$ ,  $\text{SHGC}_T$  values for each fenestration assembly, and these values must be equal to the SHGCs listed on the Performance ENV-1/ENV-1-C computer form. (Note: an under-calculation of space conditioning energy can result from entering either too low or too high an  $\text{SHGC}_{\text{fen}}$ ,  $\text{SHGC}_T$  for the product.)

For both the Prescriptive and Performance compliance method, the building plans shall contain a window schedule that lists the  $U_T$  and  $\text{SHGC}_T$  determined through this procedure and the specifications

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of the windows shall be consistent with the values used in this procedure, e.g. frame type glazing product, etc.

Permit applications must include heat gain fenestration U-factor documentation for the Building Plan Checker. This documentation must include a copy of the manufacturer's documentation showing the SHGC<sub>g</sub>, Glazing Type information (-center of glass ~~alone and the calculation~~ U-factor, number of panes, and coatings) and the Frame Type (frame material type, presence of thermal breaks, and identification of structural glazing (glazing with no frame)) that is used to determine U<sub>T</sub> and SHGC<sub>T</sub> the SHGC<sub>fen</sub> SHGC<sub>i</sub>. If the proposed design uses multiple fenestration products or site-assembled built fenestration products, a calculation, manufacturer's documentation for each different U-factor for each glass unit shall be attached to the plans. Manufacturer's documentation must be provided for each unique combination of glazing and frame used for compliance.

Building plans shall identify all site-built fenestration with U-factors or SHGC values not without U-factors rated using NFRC procedures.

If mixed fenestration is included in the compliance analysis, then the compliance submittal must show which are certified fenestration products, and which are non-certified fenestration products (site-built less than 10,000 ft<sup>2</sup> or skylights). The manufacturer's documentation and calculations for each product must be included in the submittal, and either the ENV-1-C or PERF-1 form must be included on the building plans.

### **NA6-3.2 Builder and Installer Responsibilities<sup>ii</sup>**

The builder must ensure that the fenestration (glass and frame) documentation showing the U-factor used for determining compliance is provided to the installer. The builder also is responsible for ensuring that the persons preparing compliance documentation are specifying products the builder intends to install. The builder is responsible for ensuring that the installer installs glass with U-factors equal to or lower than the U-factors used for compliance and that the frame type installed is the same as that used for compliance. The builder also must ensure that the field inspector for the building department is provided with manufacturer's documentation showing the U-factor and method of determining U-factor for the actual fenestration product installed. The builder should verify that these fenestration products are clearly shown on the building plans before fenestration products are purchased and installed.

### **NA6-3.3 Building Department Responsibilities**

#### Plan Checker

The building department plan checker is responsible for ensuring that the plans identify all site-built fenestration.

The plan checker shall ensure that for skylights and site-built fenestration using alternate default U-factors:

1. U-factors and SHGC values are shown on the window schedules on the plans,
2. the Glazing Type and Frame Type and which are the basis of this procedure are properly documented,
3. manufacturer documentation of the Glazing Type and Frame Type has been provided for the each of the fenestration products using the procedure of this appendix, and
4. the building has less than 10,000 ft<sup>2</sup> of site-built fenestration.

Plans should be consistent with the compliance documentation, the Glazing Type and Frame Type and U-factor and SHGC values developed through this procedure

#### Building Inspector

The building department field inspector is responsible for ensuring that the building using the procedure in this appendix has less than 10,000 ft<sup>2</sup> of site-built fenestration.

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The building department field inspector is responsible for ensuring that manufacturer's documentation has been provided for the installed fenestration. The field inspector is responsible for ensuring that the U-factor for the installed fenestration is consistent with the plans, the Prescriptive ENV-1/ENV-1-C Part 2 of 2 or the Performance PERF-1, and Performance ENV-1/ENV-1-C, and that manufacturer documentation is consistent with the product installed in the building.

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### **NA6-1.2 Responsibilities for SHGC Compliance**

This section describes the responsibilities of energy consultants, designers, architects, builders, installers, and building departments when this alternative calculation method is used for determining compliance with SHGC requirements.

#### **NA6-1.2.1 Energy Consultants, Designers, Architects**

##### *Site-Built Fenestration Products without SHGC Rated Using NFRC Procedures*

The procedure described below applies only to skylights and to site-built fenestration in buildings with less than 10,000 ft<sup>2</sup> of site-built fenestration.

To determine compliance with the efficiency standards, the center of glass SHGC from the manufacturer's documentation for the proposed glazing must be converted to an SHGC<sub>t</sub> for the fenestration that includes the framing effect.

For the Prescriptive compliance method, the SHGC<sub>t</sub> is then entered into the prescriptive ENV-1-C form, Part 2 of 2 and must appear on the building plans.

For the Performance compliance method, the SHGC<sub>t</sub> output information printed on the Performance ENV-1-C form must be listed on the building plans. The PERF-1 and Performance ENV-1-C forms must appear on the plans. The building plan window schedule list must indicate the proposed total SHGC<sub>t</sub> values for each fenestration assembly, and these values must be equal to the SHGCs listed on the Performance ENV-1-C computer form. (Note: an under-calculation of space conditioning energy can result from entering either too low or too high an SHGC<sub>t</sub> for the product.)

Permit applications must include heat gain documentation for the Building Plan Checker. This documentation must include a copy of the manufacturer's documentation showing the SHGC<sub>g</sub> center of glass alone and the calculation used to determine the SHGC<sub>t</sub>. If the proposed design uses multiple fenestration products or site-built fenestration products, a calculation for each different SHGC<sub>fen</sub> SHGC<sub>t</sub> must be attached to the plans along with each glass unit manufacturer's documentation.

Building plans shall identify all site-built fenestration and all site-built fenestration without SHGCs rated using NFRC procedures.

##### *Mixed Fenestration Types*

If mixed fenestration is included in the compliance analysis, then the compliance submittal must demonstrate which are certified fenestration products and which are non-certified fenestration or site-built fenestration products. The manufacturer's documentation and calculations for each product must be included in the submittal, and either the **ENV-4/ENV-1-C** or PERF-1 form must be included on the building plans.

#### **NA6-1.2.2 Builder and Installer Responsibilities**

The builder is responsible for obtaining a Site-Built Label Certificate for site-built products. When the certificate is provided by the installer, the builder is responsible for ensuring that the glass documentation showing the SHGC used for determining compliance is provided to the installer. The builder is responsible for obtaining an NFRC Label Certificate for Site-Built Products for the building's site-built fenestration if the building has 10,000 ft<sup>2</sup> or more of site-built fenestration.<sup>iii</sup>

The builder is also responsible for ensuring that the persons preparing compliance documentation are specifying products that the builder intends to install. The builder must ensure that the glazing

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contractor installs the glass with the same  $SHGC_c$  as used for compliance and that the building inspector is provided with manufacturers' documentation showing the  $SHGC_c$  for the actual glass product installed. The builder should verify that these fenestration products are clearly shown on the building plans before fenestration products are purchased and installed.

### **NA6-1.2.3 Building Department Responsibilities**

#### *Plan Checker*

The building department plan checker is responsible for ensuring that the plans identify all site-built fenestration.

The plan-checker is responsible for verifying that for skylights and site-built fenestration using the alternate default SHGC calculation:

1. the  $SHGC_{fen}$ ,  $SHGC_t$  and  $SHGC_c$  are identified on the plans,
2. calculations have been provided showing the conversion from  $SHGC_c$  to  $SHGC_{fen}$ ,  $SHGC_t$ ,
3. manufacturer documentation of the  $SHGC_c$  has been provided for each of the fenestration products using alternate default SHGC calculations, and
4. the building has less than 10,000 ft<sup>2</sup> of site-built fenestration.

Plans should be consistent with the compliance documentation, the calculations showing the conversion from  $SHGC_c$  to  $SHGC_{fen}$ ,  $SHGC_t$ , and Prescriptive ENV-1ENV-1-C Part 2 of 2 or Performance ENV-1ENV-1-C.

#### *Building Inspector*

The building department field inspector is responsible for ensuring that the building using an alternate default SHGC calculation has less than 10,000 ft<sup>2</sup> of site-built fenestration.

The field inspector is responsible for ensuring that the  $SHGC_c$  and  $SHGC_{fen}$ ,  $SHGC_t$  for the installed fenestration is consistent with the plans, the Prescriptive ENV-1ENV-1-C Part 2 of 2 or the Performance PERF-1 and Performance ENV-1ENV-1-C, and that manufacturer documentation is consistent with the product installed in the building.

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## **NA6-1.2 Thermal Transmittance (U-Factor)**

~~Table NA6-1~~<sup>iv</sup>~~Table NA6-1~~ and ~~Table NA6-2~~ provides provide default U-factors for skylights and for site-built fenestration in buildings with less than 10,000 ft<sup>2</sup> of site-built fenestration.

The default ~~Table NA6-1~~<sup>iv</sup>~~Table NA6-1~~ and ~~Table NA6-2~~ are is consistent with default U-factors published in Table 4, Chapter 3031, ASHRAE Fundamentals Handbook, 20012005, which is referenced in the Energy Standards. Fenestration products fitting the two descriptions above may still use U-factors obtained through NFRC if available.

### **NA6-1.2.1 Responsibilities for U-factor Compliance**

This section describes the responsibilities of energy consultants, designers, architects, builders, installers, and building departments when ~~Table NA6-1~~<sup>iv</sup>~~Table NA6-1~~ and ~~Table(s) NA6-1 and NA6-2~~ are is used for determining compliance with the U-factor requirements of the Efficiency Standards.

#### **NA6-1.2.1.1 Energy Consultants, Designers, Architects**

##### *Site-Built Fenestration without U-factor Rated Using NFRC Procedures*

The procedure described below applies only to skylights and to site-built fenestration in buildings with less than 10,000 ft<sup>2</sup> of site-built fenestration. To determine compliance with the efficiency standards, the Glazing Type and Frame Type shown in ~~Table NA6-1~~<sup>iv</sup>~~Table NA6-1~~ (Vertical Installation) or

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Table NA6-2 (Sloped Installation) must be identified from the manufacturer's documentation for the proposed glazing.

For the Prescriptive compliance method, the U-factor must be selected from Table NA6-1 ~~Table NA6-1~~ pr Table NA6-2 for this Glazing Type and Frame Type and entered into the prescriptive ENV-4ENV-1-C form, Part 2 of 2, and must appear on the building plans.

For the Performance compliance method, the U-factor output information printed on the Performance ENV-4ENV-1-C form must be listed on the building plans. The PERF-1 and Performance ENV-4ENV-1-C forms must appear on the plans. The building plan window schedule list must indicate the proposed total U-factors for each fenestration assembly, and these values must be equal to or less than the U-factors listed on the Performance ENV-4ENV-1-C computer form.

Permit applications must include fenestration U-factor documentation for the Building Plan Checker. This documentation must include a copy of the manufacturer's documentation showing the Glazing Type information – center of glass U-factor, number of panes, spacing of panes, glass type, gas fill type, coating emissivity and location – and the Frame Type – frame material type, presence of thermal breaks, and identification of structural glazing (glazing with no frame) that is used to determine the U-factor. If the proposed design uses multiple fenestration products or site-assembledbuilt fenestration products, manufacturer's documentation for each different U-factor for each glass unit must be attached to the plans. Manufacturer's documentation must be provided for each U-factor used for compliance.

Building plans shall identify all site-built fenestration and all site-built fenestration without U-factors rated using NFRC procedures.

#### Mixed Fenestration Types

If mixed fenestration is included in the compliance analysis, then the compliance submittal must demonstrate which are certified fenestration products and which are non-certified fenestration or site-assembledbuilt fenestration products. The manufacturer's documentation and calculations for each product must be included in the submittal, and either the ENV-4ENV-1-C or PERF-1 form must be included on the building plans.

#### **NA6-I.2.1.2 Builder and Installer Responsibilities<sup>v</sup>**

The builder ~~is responsible for~~ must ensure that the glass-fenestration (glass and frame) documentation showing the U-factor used for determining compliance is provided to the installer. The builder also is responsible for ensuring that the persons preparing compliance documentation are specifying products the builder intends to install. The builder is responsible for ensuring that the installer installs glass with U-factors equal to or lower than the U-factors used for compliance and that the frame type installed is the same as that used for compliance. The builder also must ensure that the field inspector for the building department is provided with manufacturer's documentation showing the U-factor and method of determining U-factor for the actual fenestration product installed. The builder is responsible for ensuring that the persons preparing compliance documentation are specifying products that the builder intends to install. The builder is also responsible for ensuring that the installer installs glass with U-factors the same or lower than the U-factors used for compliance and ensuring that the field inspector for the building department is provided with manufacturer's documentation showing the U-factor and method of determining U-factor for the actual fenestration product installed.<sup>vi</sup> The builder should verify that these fenestration products are clearly shown on the building plans before fenestration products are purchased and installed.

#### **NA6-I.2.1.3 Building Department Responsibilities**

##### *Plan Checker*

The building department plan checker is responsible for ensuring that the plans identify all site-built fenestration.

The plan checker shall ensure that for skylights and site-built fenestration using alternate default U-factors:

1. U-factors are identified on the plans,
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2. the Glazing Type and Frame Type and ~~Table NA6-1~~~~Table NA6-1~~ Table NA6-1 and Table NA6-2 have been provided documenting the method of determining the U-factor,
  3. manufacturer documentation of the Glazing Type and Frame Type has been provided for the each of the fenestration products using alternate default U-factors, and
  4. the building has less than 10,000 ft<sup>2</sup> of site-built fenestration.

Plans should be consistent with the compliance documentation, the Glazing Type and Frame Type and ~~Table NA6-1~~~~Table NA6-1~~ Table NA6-1 and Table NA6-2 -values, and Prescriptive ENV-1ENV-1-C Part 2 of 2 or Performance ENV-1ENV-1-C.

#### *Building Inspector*

The building department field inspector is responsible for ensuring that the building using an alternate default U-factor has less than 10,000 ft<sup>2</sup> of site-built fenestration.

The building department field inspector is responsible for ensuring that manufacturer's documentation has been provided for the installed fenestration. The field inspector is responsible for ensuring that the U-factor for the installed fenestration is consistent with the plans, the Prescriptive ENV-1ENV-1-C Part 2 of 2 or the Performance PERF-1, and Performance ENV-1ENV-1-C, and that manufacturer documentation is consistent with the product installed in the building.

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[Table NA6-1. U-Factors for Various Vertical Fenestration Products in Btu/h-ft<sup>2</sup>-°F<sup>vii</sup>](#)

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## **End Notes**

The following notes are an explanation of the changes that have been made. These notes are not part of the Standard.

<sup>i</sup> This document was part of the 2005 Nonresidential ACM Manual (NACM Appendix NI). This will be part of a new document, the Nonresidential Appendices, Appendix NA7.

<sup>ii</sup> [The changes were made to clarify responsibilities and to include framing materials in the requirement.](#)

<sup>iii</sup> Language clarification. The builder is responsible for all fenestration irrespective of the glazing area.

<sup>iv</sup> Former Table NI-1 has been revised and split into Table NA6-1 (Vertical Installation) and Table NA6-2 (Sloped Installation). See full comments with tables.

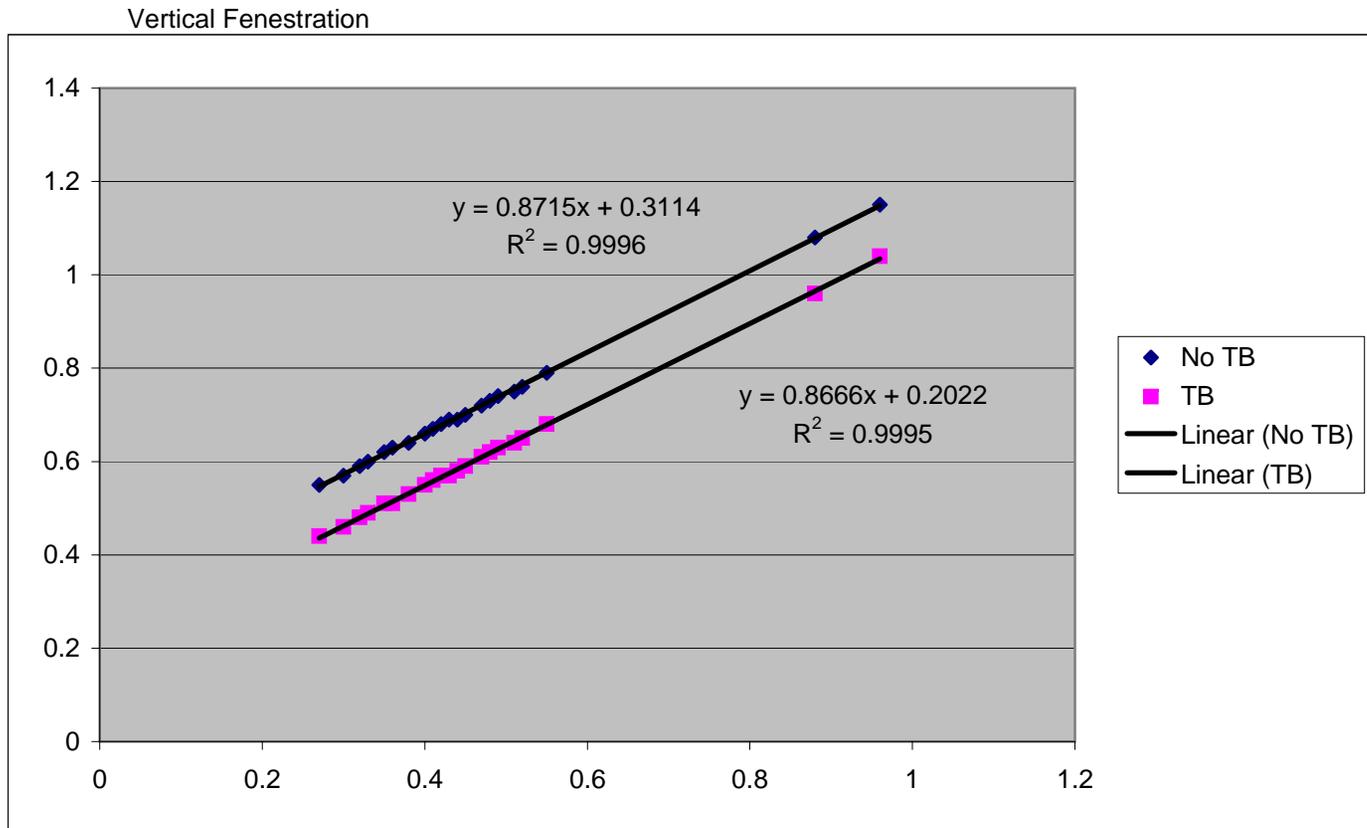
<sup>v</sup> The changes were made to clarify responsibilities and to include framing materials in the requirement.

<sup>vi</sup> The changes were made to clarify responsibilities and to include framing materials in the requirement.

<sup>vii</sup> The revisions to Tables NA6-1 and NA6-2 were made in order to make Table NI-1 less confusing. The table data source is the 2005 ASHRAE Handbook of Fundamentals (Table 4).

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No TB	TB
1.15	1.04
1.08	0.96
0.79	0.68
0.76	0.65
0.75	0.64
0.74	0.63
0.73	0.62
0.72	0.61
0.7	0.59
0.69	0.58
0.69	0.57
0.68	0.57
0.67	0.56
0.66	0.55
0.64	0.53
0.63	0.51
0.62	0.51
0.6	0.49
0.59	0.48
0.57	0.46
0.55	0.44



Curb no TE	Curb TB	No Curb No	No Curb TB
1.9	1.81	1.29	1.18
1.82	1.73	1.21	1.1
1.31	1.11	0.82	0.7
1.3	1.1	0.81	0.69
1.27	1.08	0.78	0.67
1.27	1.07	0.77	0.66
1.25	1.05	0.76	0.64
1.24	1.04	0.75	0.64
1.23	1.03	0.74	0.63
1.2	1	0.71	0.6
1.18	0.99	0.7	0.58
1.15	0.95	0.66	0.55
1.14	0.94	0.65	0.54
1.13	0.93	0.65	0.53
1.11	0.91	0.63	0.52

