

# Aluminum 6063-T5

Component	Wt. %	Component	Wt. %	Component	Wt. %
Al	Max 97.5	Mg	0.45 - 0.9	Si	0.2 - 0.6
Cr	Max 0.1	Mn	Max 0.1	Ti	Max 0.1
Cu	Max 0.1	Other, each	Max 0.05	Zn	Max 0.1
Fe	Max 0.35	Other, total	Max 0.15		

## Physical Properties

Physical Properties	Metric	English	Comments
Density	<a href="#">2.7 g/cc</a>	0.0975 lb/in <sup>3</sup>	AA; Typical

## Mechanical Properties

Hardness, Brinell	60	60	AA; Typical; 500 g load; 10 mm ball
Ultimate Tensile Strength	<a href="#">186 MPa</a>	27000 psi	AA; Typical
Tensile Yield Strength	<a href="#">145 MPa</a>	21000 psi	AA; Typical
Elongation at Break	12 %	12 %	AA; Typical; 1/16 in. (1.6 mm) Thickness
Modulus of Elasticity	<a href="#">68.9 GPa</a>	10000 ksi	AA; Typical; Average of tension and compression. Compression modulus is about 2% greater than tensile modulus.
Poisson's Ratio	0.33	0.33	
Fatigue Strength	<a href="#">68.9 MPa</a>	10000 psi	AA; 500,000,000 cycles completely reversed stress; RR Moore machine/specimen
Shear Modulus	<a href="#">25.8 GPa</a>	3740 ksi	
Shear Strength	<a href="#">117 MPa</a>	17000 psi	AA; Typical

## Electrical Properties

Electrical Resistivity	<a href="#">3.16e-006 ohm-cm</a>	3.49e-006 ohm-cm	AA; Typical at 68°F
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## Thermal Properties

CTE, linear 68°F	<a href="#">23.4 μm/m-°C</a>	13 μin/in-°F	AA; Typical; Average over 68-212°F range.
CTE, linear 250°C	<a href="#">25.6 μm/m-°C</a>	14.2 μin/in-°F	Average over the range 20-300°C
Heat Capacity	<a href="#">0.9 J/g-°C</a>	0.215 BTU/lb-°F	
Thermal Conductivity	<a href="#">209 W/m-K</a>	1450 BTU-in/hr-ft <sup>2</sup> -°F	AA; Typical at 77°F
Melting Point	616 - 654 °C	1140 - 1210 °F	AA; Typical range based on typical composition for wrought products 1/4 inch thickness or greater
Solidus	<a href="#">616 °C</a>	1140 °F	AA; Typical
Liquidus	<a href="#">654 °C</a>	1210 °F	AA; Typical

## Processing Properties

Annealing Temperature	<a href="#">413 °C</a>	775 °F	hold at temperature for 2 to 3 hr; cool at 50 °F per hour from 775 to 500 °F
Solution Temperature	<a href="#">521 °C</a>	970 °F	
Aging Temperature	<a href="#">182 °C</a>	360 °F	hold at temperature for 1 hr



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## *Certificate of Conformance*

APEL Extrusions, Inc. certifies that the raw material log used to manufacture product for their customer, meets the Aluminum Standard for Chemical and Physical properties for Aluminum Alloy 6063.

Manufactured lots are traceable to cast certification per ASTM standards.

APEL Extrusions, Inc.

Leah Ishaug, Quality Manager

Company Representative & Title

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June 22, 2017

**SUPERNEUTRAL® SERIES**

# SNX 51/23 & SNX 62/27

**MORE NATURAL LIGHT. LESS HEAT GAIN.  
GREATER ENERGY SAVINGS.**

**SUNGUARD SNX 51/23**

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Kickstand Photography

Triple-silver low-E technology.  
The best in high-performance glass.

## **SNX 51/23**

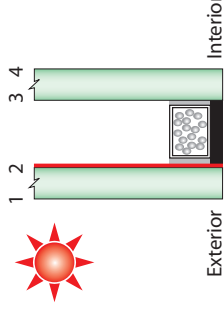
- Attractive neutral/blue reflected color.
- Low solar heat gain coefficient: 0.23
- Best combination of visible light transmission and solar heat gain.
- Highest visible light transmission in its class.
- Developed to meet the most stringent energy codes in North America.

## **SNX 62/27**

- High visible light transmission: 62%
- Neutral reflected & transmitted color.
- SunGuard's highest light-to-solar-gain ratio: LSG 2.31
- Excellent solar control: 0.27 SHGC

Both SNX products help projects qualify for LEED credits. SunGuard products are produced at multiple U.S. locations and are distributed through Guardian's independent network of Select Fabricators. To locate a Select Fabricator, visit [www.SunGuardGlass.com](http://www.SunGuardGlass.com).

To learn more, call us at  
**1-866-GuardSG (482-7374)** or visit us  
online [www.SunGuardGlass.com](http://www.SunGuardGlass.com)



## SNX Performance Data - Insulating Glass Units

Product	Outboard - Inboard Substrate	Appearance	Transmittance			Reflectance			U-Value		Relative Heat Gain Coefficient	Solar Heat Gain Coefficient	Light to Solar Gain (LSG)
			Visible Light %	Ultra-violet %	Solar Energy %	Visible Light Out %	Visible Light In %	Solar Energy Out %	Winter Nighttime	Argon			
<b>Coating #2 Surface</b>													
<b>SNX 62/27</b>	UltraClear - UltraClear	Ultra Clear	<b>64</b>	8	24	11	13	51	0.29	0.24	65	<b>0.27</b>	2.40
	Clear - Clear	Clear	<b>62</b>	6	23	11	12	39	0.29	0.24	65	<b>0.27</b>	2.31
	Green - Clear	Green	<b>52</b>	3	18	9	12	10	0.29	0.24	59	<b>0.24</b>	2.13
	TwilightGreen - Clear	Dark Green	<b>46</b>	2	16	8	11	8	0.29	0.24	54	<b>0.22</b>	2.08
	CrystalGray - Clear	Light Gray	<b>44</b>	3	16	8	11	19	0.29	0.24	54	<b>0.22</b>	1.98
<b>SNX 51/23</b>	Gray - Clear	Gray	<b>31</b>	3	12	6	11	19	0.29	0.24	45	<b>0.18</b>	1.71
	CrystalBlue - Clear	Blue	<b>40</b>	4	15	7	11	25	0.29	0.24	51	<b>0.21</b>	1.91
	UltraClear - UltraClear	Light Blue	<b>53</b>	14	20	14	14	46	0.29	0.24	57	<b>0.23</b>	2.28
	Clear - Clear	Light Blue	<b>51</b>	11	19	14	14	36	0.29	0.24	57	<b>0.23</b>	2.19
	Green - Clear	Blue-Green	<b>43</b>	5	15	11	13	10	0.29	0.24	52	<b>0.22</b>	1.99
<b>Coating #3 Surface*</b>	TwilightGreen - Clear	Dark Green	<b>38</b>	3	13	10	13	8	0.29	0.24	49	<b>0.20</b>	1.93
	CrystalGray - Clear	Light Gray	<b>36</b>	6	14	9	13	18	0.29	0.24	48	<b>0.20</b>	1.85
	Gray - Clear	Gray	<b>26</b>	5	10	7	13	17	0.29	0.24	41	<b>0.16</b>	1.57
	CrystalBlue - Clear	Blue	<b>33</b>	7	13	9	13	23	0.29	0.24	46	<b>0.19</b>	1.78
	<b>SNX 62/27 (#3)</b>	Bronze - Clear	Bronze	<b>37</b>	2	14	7	10	17	0.29	0.24	64	<b>0.26</b>
Green - Clear		Green	<b>52</b>	3	18	10	10	11	0.29	0.24	75	<b>0.31</b>	1.66
TwilightGreen - Clear		Dark Green	<b>46</b>	2	16	9	10	8	0.29	0.24	67	<b>0.28</b>	1.66
CrystalGray - Clear		Light Gray	<b>44</b>	3	16	8	10	20	0.29	0.24	72	<b>0.30</b>	1.48
Gray - Clear		Gray	<b>31</b>	3	12	7	10	20	0.29	0.24	59	<b>0.24</b>	1.27
CrystalBlue - Clear	Blue	<b>40</b>	4	15	8	10	26	0.29	0.24	69	<b>0.29</b>	1.39	

SN 68 or Neutral 78/65 may also be used on the #3 surface with a tinted or coated outboard lite.

- The performance values shown are nominal and subject to variations due to manufacturing tolerances.
- Guardian performance data are calculated for center-of-glass only (no spacer or framing) in accordance with LBNL Window 7 program.
- Glass may require heat strengthening or tempering to resist potential thermal stresses. SNR 43 must be heat-treated.
- A slight shift in visible light reflectance or transmission may be noticed after heat-treatment.
- Relative Heat Gain, Shading Coefficient, Solar Heat Gain Coefficient and/or LSG may change slightly when using argon gas fill.
- Guardian reserves the right to change product performance characteristics without notice or obligation.

### \* NOTES RELATED TO COATINGS DESIGNED FOR #3 SURFACE APPLICATIONS:

- The SunGuard coatings that can be used on the #3 surface are SN 68, SNX 62/27 and Neutral 78/65. Guardian recommends a tinted or coated outboard lite when these coatings (except Neutral 78/65) are used on the #3 surface. All other SunGuard coatings are not recommended for use on the #3 surface.



TO REQUEST SAMPLES  
visit [SunGuardGlass.com](http://SunGuardGlass.com) or call 1-866-GuardSG  
482-7374

## Quality Standards

GG 002—2015-02-23

Glass products fabricated by Trulite Glass & Aluminum Solutions™ meet the following standards and specifications:

**Primary Float Glass**—Meets the requirements of ASTM C 1036, *Standard Specification for Flat Glass*, including: Type 1, Class 1, Quality q3 for clear glass; and Type 1, Class 2, Quality q3 for tinted glass. The primary float glass manufacturer will be one of the following: PPG, Guardian, Pilkington.

**Heat Treated Glass**—Meets the requirements of ASTM C 1048, *Standard Specification for Heat-Treated Flat Glass*, for Condition A, B, or C; Quality q3, and Kind FT (Fully Tempered) or Kind HS (heat-strengthened). Unless otherwise noted, all fully tempered glass meets the safety glazing requirements of ANSI Z97.1, Class A; and CPSC 16 CFR 1201 Category II. Trulite's tempered products are certified through the Safety Glazing Certification Council (SGCC), which serves as a third party independent sponsor for overseeing of safety glazing certification and product testing. Heat treated products have a Limited Warranty from Trulite for a period of ten (10) years.

**Coated Glass**—Meets the requirements of ASTM C 1376, *Standard Specification for Pyrolytic and Vacuum Deposition Coatings*. Coated glass has a Limited Warranty for a period of ten (10) years, provided by the coating supplier. These include PPG, Guardian, Pilkington.

**Insulating Glass**—Meets the requirement of ASTM E2190 (supersedes ASTM E774, level CBA). In the case of argon filled IG units, meets ASTM E2190 with tested results of 90% before, 80% after accelerated testing. Insulating glass units are comprised of two lites of glass, separated by a dehydrated airspace, with a primary seal of poly isobutylene (PIB), and a secondary seal of silicone. Most Trulite plants carry certification to the PPG Certified Fabricator® program and the Guardian Select™ Fabricator program. Insulating glass products have a Limited Warranty for a period of (10) Years.

**Spandrel Glass**—Meets the requirement of ASTM C1048 for Condition B, Kind HS (Heat Strengthened) or Kind FT (Fully Tempered) for ceramic fritted coating. Spandrel glass is also available with Opaci-Coat® 300. Both products have a Limited Warranty for a period of Five (5) Years. Neither coating is recommended for 2<sup>nd</sup> or 3<sup>rd</sup> surface application in an insulating glass unit.

**Laminated Glass**—Meets the requirement of ASTM C 1172 *Standard Specification for Laminated Architectural Flat Glass*. When comprised of two plies of glass and a 0.030" or thicker Interlayer, Trulite's laminated glass also meets the safety criteria of CPSC 16 CFR 1201, Category II; and ANSI Z97.1, Class A. Laminated glass also complies with ASTM C 1036, and when heat-treated, with ASTM C 1048. A Limited Warranty for a period of Five (5) Years is available for laminated glass with a PVB interlayer.

## Laminated Guidelines

LG 001—2015-03-12

### Sloped IG laminated constructions

Overall Thickness (nominal)	Construction	Lami Treatment	Max Area (Sq. Feet)
1"	(1/4" HS  1/2 "AS  1/8"/.030/1/8")	Annealed	12
1-1/16"	(1/4"HS  1/2" AS  1/8"/.060/1/8")	Annealed	12
		Heat Strengthened	20
1-1/8"	(1/4"HS  1/2"AS  3/16"/.030/3/16")	Annealed	18
1-3/16"	(1/4"HS  1/2"AS  3/16"/.060/3/16")	Annealed	18
		Heat Strengthened	30
1-1/4"	(1/4"HS  1/2"AS  1/4"/.030/1/4")	Annealed	24
1-5/16"	(1/4"HS  1/2"AS  1/4"/.060/1/4")	Annealed	24
		Heat Strengthened	40

(Note: A heat-strengthened exterior lite is recommended for sloped glazing IG.)

### Single Lite laminated constructions

Overall Thickness (nominal)	Construction	Lami Treatment	Sloped Max Area (Sq. Feet)	Vertical Max Area (Sq. Feet)
1/4"	1/8"/.030/1/8"	Annealed	12	20-25
5/16"	1/8"/.060/1/8"	Annealed	12	20-25
		Heat Strengthened	20	20-25
3/8"	3/16"/.030/3/16"	Annealed	18	35
7/16"	3/16"/.060/3/16"	Annealed	18	35
		Heat Strengthened	30	35-40
1/2"	1/4"/.030/1/4"	Annealed	24	50
9/16"	1/4"/.060/1/4"	Annealed	24	50
		Heat Strengthened	40	65



**Designation: C 1036 – 91 (Reapproved 1997)**

AMERICAN SOCIETY FOR TESTING AND MATERIALS  
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## Standard Specification for Flat Glass<sup>1</sup>

This standard is issued under the fixed designation C 1036; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

### 1. Scope

1.1 This specification covers the quality requirements for cut sizes of flat, transparent, clear glass having glossy, apparently plane and smooth surfaces for glazing, mirrors, and general architectural or similar uses.

1.2 This specification covers the quality requirements for cut sizes of flat transparent tinted heat-absorbing or light-reducing glass, or both, having glossy, apparently plane and smooth surfaces. The glass is intended to be used primarily for building construction to control the transmission of light, heat, or solar radiation, or combination thereof.

1.3 This specification covers the quality requirements for cut sizes of patterned and wired glasses for decorative and general glazing applications.

1.4 The dimensional values stated in inch-pound units, except for thickness designations, are to be regarded as the standard.

1.5 The following safety hazards caveat pertains only to the test method portion, Section 7, of this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*<sup>2</sup>

### 2. Referenced Documents

#### 2.1 ASTM Standards:

C 162 Terminology of Glass and Glass Products<sup>3</sup>

E 308 Test Method for Computing the Colors of Objects by Using the CIE System<sup>4</sup>

E 903 Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres<sup>5</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C-14 on Glass and Glass Products and is the direct responsibility of Subcommittee C14.08 on Flat Glass.

Current edition approved Nov. 15, 1991. Published January 1992. Originally published as C 1036 – 85. Last previous edition C 1036 – 90<sup>1</sup>.

<sup>2</sup> Latest issue, unless otherwise specified by the agency applying Specification C 1036.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 15.02.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 06.01.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 12.02.

### 3. Terminology

3.1 *Definitions*—For additional definitions of terms, refer to Terminology C 162.

3.1.1 *blemishes in flat glass*:

NOTE 1—These definitions do not apply to in-service damage.

3.1.1.1 *crush*—a lightly pitted area resulting in a dull gray or white appearance over the region.

3.1.1.2 *digs*—deep, short scratches.

3.1.1.3 *dirt*—a small particle of foreign matter imbedded in the glass surface.

3.1.1.4 *gaseous inclusions*—round or elongated bubbles in the glass.

3.1.1.5 *knot*—a transparent area of incompletely assimilated glass.

3.1.1.6 *lines*—fine cords or strings, usually on the surface of sheet glass.

3.1.1.7 *open gaseous inclusions*—bubbles at the surface of glass that are open, leaving a cavity in the surface.

3.1.1.8 *process surface blemishes*—slight surface blemishes that originated in the process that can be small particles of foreign materials on either surface or surface irregularities.

3.1.1.9 *ream*—inclusions within the glass or layers or strings of glass that are not homogeneous with the main body of the glass.

3.1.1.10 *rub*—abrasion of the glass surfaces producing a frosted appearance. A rub differs from a scratch in having appreciable width.

3.1.1.11 *scratch*—any marking or tearing of the surface produced in manufacturing or handling, appearing as though it were done by a sharp or rough instrument.

3.1.1.12 *smoke*—streaked areas appearing as slight discoloration.

3.1.1.13 *stone*—any crystalline inclusion imbedded in the glass.

3.1.1.14 *string*—transparent line appearing as though a thread of glass had been incorporated into the sheet.

3.1.1.15 *wave*—blemishes resulting from irregularities of the surfaces of glass, making objects viewed at varying angles appear wavy or bent.

3.1.2 *vision interference angle*—the acute angle included

between the plane of the glass and the vertical plane perpendicular to the wall, such plane including the observer when the glass is examined in accordance with 7.1.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *heat-absorbing glass*—glass for absorbing appreciable portions of radiant energy, especially solar energy.

3.2.2 *illuminant C*—as defined in Test Method E 308, an approximate representation of average daylight. Standard illuminant C (CIE 1931) (Commission Internationale de l'Éclairage) is a gas-filled lamp of color temperature 2848 K used in conjunction with a liquid filter (Davis-Gibson filter) for converting color temperature 2856 to 6670 K.

3.2.3 *light-reducing glass*—glass which is formulated to reduce the transmission of light.

3.2.4 *light transmittance*—that fraction of the incident light of a given wavelength which is not reflected or absorbed but passes through a substance.

3.2.5 *patterned glass*—rolled flat glass having a pattern on one or both surfaces.

3.2.6 *shading coefficient*—for any fenestration, the ratio of the rate of total solar heat gain through that type of fenestration to the total solar heat gain that would be admitted through a standard single pane of 3-mm (0.12-in.) thick clear glass in the same situation, the standard pane having a total solar transmittance value of 0.87.

3.2.7 *wired glass*—rolled glass having a layer of meshed or standard wire completely imbedded in the sheet.

4. Classification and Intended Use

4.1 *Types, Classes, Styles, Forms, Qualities, and Finishes*—Glass shall be of the following types, classes, styles, forms, qualities, and finishes, as specified (see Section 5):

4.1.1 *Type I—Transparent Glass, Flat:*

4.1.1.1 *Class 1—Clear:*

- q<sup>1</sup>—Mirror select Quality
- q<sup>2</sup>—Mirror
- q<sup>3</sup>—Glazing select
- q<sup>4</sup>—Glazing A
- q<sup>5</sup>—Glazing B
- q<sup>6</sup>—Greenhouse

4.1.1.2 *Class 2—Tinted, Heat-Absorbing and Light-Reducing:*

- q<sup>3</sup>—Glazing select Quality
- q<sup>4</sup>—Glazing A
- q<sup>5</sup>—Glazing B
- Style A—Higher light transmittance
- Style B—Lower light transmittance

4.1.1.3 *Class 3—Tinted, Light-Reducing:*

- q<sup>3</sup>—Glazing select Quality
- q<sup>4</sup>—Glazing A
- q<sup>5</sup>—Glazing B

4.1.2 *Type II—Patterned and Wired Glass, Flat:*

- 1—Clear Class
- 2—Tinted, heat-absorbing and light-reducing (A and B applies to Class 2 only)
  - Style A—Higher light transmittance
  - Style B—Lower light transmittance
- 3—Tinted, light reducing

- Form (Classes 1, 2, and 3)
  - 1—Wired, polished both sides
  - 2—Patterned and wired
  - 3—Patterned
- Quality
  - q<sup>7</sup>—Decorative
  - q<sup>8</sup>—Glazing
- Finish
  - f<sup>1</sup>—Patterned one side
  - f<sup>2</sup>—Patterned both sides
- Mesh (Forms 1 and 2)
  - m<sup>1</sup>—Diamond
  - m<sup>2</sup>—Square
  - m<sup>3</sup>—Parallel strand
  - m<sup>4</sup>—Special
- Pattern (Forms 2 and 3)
  - p<sup>1</sup>—Linear
  - p<sup>2</sup>—Geometric
  - p<sup>3</sup>—Random
  - p<sup>4</sup>—Special

4.2 *Intended Use of Transparent Flat Glass:*

4.2.1 *Mirror Select Quality, q<sup>1</sup>*—Intended to be coated for premium mirrors.

4.2.2 *Mirror Quality, q<sup>2</sup>*—Intended to be coated for general use mirrors.

4.2.3 *Glazing Select Quality, q<sup>3</sup>*—Intended for architectural fenestrations or other applications where distant objects are viewed through the glass by the observer.

4.2.4 *Glazing A Quality, q<sup>4</sup>*—Intended for selected glazing applications such as appliances or show cases where the observer views near objects through the glass.

4.2.5 *Glazing B Quality, q<sup>5</sup>*—Intended for general glazing applications that have lesser aesthetic demands than a q<sup>3</sup> or q<sup>4</sup> quality grade.

4.2.6 *Greenhouse Quality, q<sup>6</sup>*—Intended for greenhouses or other applications where restrictions on aesthetic conditions are not required.

4.3 *Intended Use of Patterned and Wired Flat Glasses:*

4.3.1 *Decorative Quality, q<sup>7</sup>*—Intended for use where design and aesthetic characteristics are major considerations.

4.3.2 *Glazing Quality, q<sup>8</sup>*—Intended for general glazing where functional or aesthetic characteristics are a consideration and where surface blemishes are not a major concern.

4.3.3 *Wired Glass*—Intended for skylights and general glazing where fire retardation or glass retention in the frame are a consideration.

5. Ordering Information

5.1 Purchasers should select the preferred options permitted in this specification, and include the following information in procurement documents:

- 5.1.1 Title, number, and date of this specification,
- 5.1.2 Type, class, quality, style, and form, as requested (see 4.1),
- 5.1.3 Edges (see 6.1),
- 5.1.4 Length and width of cut size (see 6.3, 6.8.1.1, and 6.8.2.1), and
- 5.1.5 Glass thickness (see 6.3, 6.8.1.1, and 6.8.2.1).
- 5.1.6 *Samples*—If for any particular purpose samples with bids are necessary, they should be specifically asked for in the invitation for bids and the particular purpose to be served by the bid sample should be definitely stated.

5.2 Additional information to be specified for tinted, heat-absorbing or light-reducing flat glass, or both:

- 5.2.1 *Heat-Absorbing Glass*—Style and tint.
- 5.2.2 *Light-Reducing Glass*—Transmittance and tint.
- 5.2.3 *Availability*—Heat-absorbing glass is available in a variety of styles and tints, but within limitations. Combinations of all styles and tints are not possible. It is advisable that before referencing glass to this specification, the authority applying this specification should consult with suppliers.

5.3 Additional information to be specified for patterned or wired glass, or both.

- 5.3.1 For patterned glass, pattern description, whether one or both sides.
- 5.3.2 For wired glass, surface finish, wire mesh, and pattern description, if any.
- 5.3.3 *Samples*—If for any particular purpose samples with bids are necessary, such as wired glass that may contain numerous gaseous inclusions along the wire, they should be specifically asked for in the invitation for bids and the particular purpose to be served by the bid sample should be definitely stated.

**6. Requirements**

6.1 *Edge*—An edge shall be cut, ground, sanded to remove sharp edges only, seamed, ground and polished, beveled, or mitered, as specified.

6.2 *Marking*—Each package of glass shall bear a label, affixed by the manufacturer, giving the manufacturer’s name or trademark, the quality of glass, nominal thickness, and place of manufacture.

6.3 *Dimensional Tolerances for Type I (Transparent Glass, Flat)*—Tolerances for length, width, and thickness shall be in accordance with Table 1.

6.4 *Blemishes for Type I (Transparent Glass, Flat)*—Blemishes shall be not greater than those listed in Table 2, Table 3, and Table 4.

6.5 *Quality q<sup>6</sup> (Greenhouse)*—Glass may contain visual blemishes that are suitable for greenhouse glazing.

6.6 *Additional Requirements for Type I, Class 2 (Tinted, Heat-Absorbing and Light-Reducing Flat Glass)*:

6.6.1 *Transmittance, Styles A and B*—The illuminant C (daylight) and solar transmittance shall be in accordance with Table 5.

6.6.2 *Blemishes for Type I, Class 2 (Tinted, Heat-Absorbing and Light-Reducing Flat Glass)*—The type and number of blemishes shall be not greater than those specified in Table 3 and Table 4.

6.6.3 *Tint*—The tint of each class, style, and quality shall be as specified. Note that the color of tinted heat-absorbing glass is a major consideration for either design and aesthetic reasons or for color matching requirements. Tinted heat-absorbing glass should be viewed as installed for color comparison. Colors may vary considerably among different manufacturers and from run to run.

6.7 *Additional Requirements for Type I, Class 3 (Tinted, Light-Reducing, Flat Glass)*:

6.7.1 *Luminous Transmittance*—Light-reducing glass may be produced in a wide range of luminous transmittance values. The transmittance shall be as specified.

6.7.2 *Blemishes for Type I, Class 3 (Tinted, Light-Reducing, Flat Glass)*—The type and number of blemishes shall be as specified in Table 3 and Table 4.

6.7.3 *Color*—The color of tinted glass is a major consideration for either design and aesthetic reasons or color matching requirements. Tinted glass should be viewed as installed for color comparison. Colors may vary considerably among different manufacturers and from run to run.

6.8 *Additional Requirements for Type II (Patterned and Wired Flat Glass)*:

6.8.1 *Wired (Forms 1 and 2)*:

**TABLE 1 Dimensional Tolerance for Rectangular Shapes of Type 1 Transparent, Flat Glass**

Designation, mm	Thickness Traditional Designation	Nominal Decimal, in.	Tolerance				Length and Width for Cut Sizes, plus or minus, mm (in.)	Generally Available in the Following Qualities
			Thickness Range,					
			mm		in.			
1.0	micro-slide	0.04	0.79	1.24	0.031	0.049	1.6 (1/16)	q <sup>4</sup> , q <sup>5</sup>
1.5	photo	0.06	1.27	1.78	0.050	0.070	1.6 (1/16)	q <sup>4</sup> , q <sup>5</sup>
2.0	picture	0.08	1.80	2.13	0.071	0.084	1.6 (1/16)	q <sup>4</sup> , q <sup>5</sup>
2.5	single	0.09	2.16	2.57	0.085	0.101	1.6 (1/16)	q <sup>1</sup> , q <sup>2</sup> , q <sup>4</sup> , q <sup>5</sup>
2.7	lami	0.11	2.59	2.90	0.102	0.114	1.6 (1/16)	q <sup>4</sup> , q <sup>5</sup>
3.0	double-1/8 in.	0.12	2.92	3.40	0.115	0.134	1.6 (1/16)	q <sup>1</sup> , q <sup>2</sup> , q <sup>3</sup> , q <sup>4</sup> , q <sup>5</sup> , q <sup>6</sup>
4.0	5/32 in.	0.16	3.78	4.19	0.149	0.165	1.6 (1/16)	q <sup>3</sup> , q <sup>4</sup> , q <sup>5</sup>
5.0	3/16 in.	0.19	4.57	5.05	0.180	0.199	1.6 (1/16)	q <sup>1</sup> , q <sup>2</sup> , q <sup>3</sup> , q <sup>4</sup> , q <sup>5</sup>
5.5	7/32 in.	0.21	5.08	5.54	0.200	0.218	1.6 (1/16)	q <sup>3</sup> , q <sup>4</sup> , q <sup>5</sup>
6.0	1/4 in.	0.23	5.56	6.20	0.219	0.244	1.6 (1/16)	q <sup>1</sup> , q <sup>2</sup> , q <sup>3</sup>
8.0	5/16 in.	0.32	7.42	8.43	0.292	0.332	2.0 (5/64)	q <sup>3</sup>
10.0	3/8 in.	0.39	9.02	10.31	0.355	0.406	2.4 (3/32)	q <sup>3</sup>
12.0	1/2 in.	0.49	11.91	13.49	0.469	0.531	3.2 (1/8)	q <sup>3</sup>
16.0	5/8 in.	0.63	15.09	16.66	0.595	0.656	4.0 (5/32)	q <sup>3</sup>
19.0	3/4 in.	0.75	18.26	19.84	0.719	0.781	4.8 (3/16)	q <sup>3</sup>
22.0	7/8 in.	0.87	21.44	23.01	0.844	0.906	5.6 (7/32)	q <sup>3</sup>
25.0	1 in.	1.00	24.61	26.19	0.969	1.031	6.4 (1/4)	q <sup>3</sup>
32.0	1 1/4 in.	1.23	28.58	34.93	1.125	1.375	7.9 (5/16)	q <sup>3</sup>

TABLE 2 Glass Qualities q<sup>1</sup> and q<sup>2</sup>, Maximum Allowable Blemishes for Thicknesses 6.0 mm (1/4 in.) or Less<sup>A</sup>

Blemishes	q <sup>1</sup> , Mirror Select Quality				q <sup>2</sup> , Mirror Quality	
	Up to 2.5 m <sup>2</sup> (25 ft <sup>2</sup> )		Over 2.5 m <sup>2</sup> (25 ft <sup>2</sup> )		Central <sup>B</sup>	Outer <sup>B</sup>
	Central <sup>B</sup>	Outer <sup>B</sup>	Central <sup>B</sup>	Outer <sup>B</sup>		
Gaseous inclusions, maximum size <sup>C</sup>	0.8 mm (1/32 in.) <sup>D,E</sup>	1.2 mm (3/64 in.) <sup>D,E</sup>	1.2 mm (3/64 in.) <sup>D,E</sup>	1.6 mm (1/16 in.) <sup>D,E</sup>	6.4 mm (1/4 in.) <sup>E,F</sup>	6.4 mm (1/4 in.) <sup>E,F</sup>
Open or translucent gaseous inclusions, maximum size <sup>C</sup>	none	0.4 mm (1/64 in.) <sup>D,E</sup>	0.4 mm (1/64 in.) <sup>D,E</sup>	0.8 mm (1/32 in.) <sup>D,E</sup>	6.4 mm (1/4 in.) <sup>E,F</sup>	6.4 mm (1/4 in.) <sup>E,F</sup>
Knots, dirt, and stones, maximum size <sup>C</sup>	none	0.4 mm (1/64 in.) <sup>D,E</sup>	0.4 mm (1/64 in.) <sup>D,E</sup>	0.8 mm (1/32 in.) <sup>D,E</sup>	0.8 mm (1/32 in.) <sup>E,F</sup>	0.8 mm (1/32 in.) <sup>E,F</sup>
Scratches and rubs (intensity, maximum length)	faint, <150 mm (<6 in.) <sup>G</sup>	light, <150 mm (<6 in.) <sup>G</sup>	faint <sup>G</sup>	light <sup>G</sup>	light, <150 mm (<6 in.) <sup>G</sup>	medium, <150 mm (<6 in.) <sup>G</sup>
Crush (intensity, maximum length)	none	none	faint, <12.7 mm (<1/2 in.) <sup>F,G</sup>	faint, <19.0 mm (<3/4 in.) <sup>F,G</sup>	light, <0.4 mm (<1/64 in.) <sup>F,G</sup>	medium, <0.8 mm (<1/32 in.) <sup>F,G</sup>
Digs, maximum length	none	none	0.4 mm (1/64 in.) <sup>F</sup>	0.8 mm (1/32 in.) <sup>F</sup>	6.4 mm (1/4 in.) <sup>F</sup>	6.4 mm (1/4 in.) <sup>F</sup>
Ream, strings, lines and other linear distortion (maximum angle or intensity)	30° <sup>H</sup> or light <sup>I</sup>		30° <sup>H</sup> or light <sup>I</sup>		45° <sup>H</sup> or medium <sup>I</sup>	
Wave (intensity)	medium <sup>J</sup>	medium <sup>J</sup>	medium <sup>J</sup>	medium <sup>J</sup>	medium <sup>J</sup>	medium <sup>J</sup>
Process surface blemishes (intensity)	faint <sup>K</sup>	light <sup>K</sup>	faint <sup>K</sup>	light <sup>K</sup>	light <sup>K</sup>	medium <sup>K</sup>

<sup>A</sup> Glass greater than 6.0 mm (1/4 in.) in thickness may contain proportionally more and larger blemishes.

<sup>B</sup> The central area is considered to form an oval or circle centered on the lite whose axes or diameters do not exceed 80 % of the overall dimension. The remaining area is considered the outer area.

<sup>C</sup> Gaseous inclusions, knots, dirt, and stones may be round or elongated. For elongated blemishes of this type(s) the maximum size specified shall be determined by adding the length and width of the blemish and dividing by two, for example (L + W)/2.

<sup>D</sup> Separated by at least 305 mm (12 in.).

<sup>E</sup> For blemishes of a smaller size or of less intensity, the minimum separation shall be proportionately less. The larger of the two blemishes shall govern the separation. Blemishes not specifically mentioned shall be compared to the blemish they most closely resemble.

<sup>F</sup> Separated by at least 610 mm (24 in.).

<sup>G</sup> Intensity (scratches, rubs, and crush)—When looking through the glass and perpendicular to it using daylight without direct sunlight or with background light suitable for observing each type of blemish, the blemishes shall not be detectable at distances greater than the following, except for heavy intensity (see 7.3):

Intensity	Distance
Faint	203 mm (8 in.)
Light	914 mm (36 in.)
Medium	3.3 m (132 in.)
Heavy	detected at distances greater than 3.3 m (132 in.)

<sup>H</sup> Vision interference angle (see 3.1.1 and 7.1).

<sup>I</sup> Intensity (ream, strings, lines, and other linear distortion)—When evaluated using the shadowgraph, the intensities of these blemishes are defined as having a shadowgraph readout at distances greater than or equal to the following (see 7.2):

Intensity	Minimum Distance, mm (in.)
Light	76 (3)
Medium	51 (2)
Heavy	25 (1)

<sup>J</sup> Intensity (wave)—When evaluated using the shadowgraph, the intensities of wave are defined as having shadowgraph readouts at distances greater than or equal to the following (see 7.2):

Intensity	Minimum Distance, mm (in.)
Medium	254 (10)
Heavy	152 (6)

<sup>K</sup> Intensity (process surface blemishes)—When viewed in normal reflected light, the blemishes are classified as follows: faint—visible only to the trained eye; light—just noticeable; medium—visible as a slight grayish haze; and heavy—readily visible as a cloudy surface.

6.8.1.1 *Thickness and Dimensional Tolerances*—The allowable tolerances for rectangular shapes shall be ±1.6 mm (±1/16 in.) for each 3.2 mm (1/8 in.) of nominal thickness. Thickness, and tolerance on thickness, shall be in accordance with Table 6.

6.8.1.2 *Wire and Mesh*—Diameter of wires shall be from 0.43 to 0.64 mm (0.017 to 0.025 in.). Discoloration and slight distortion of wire is permissible.

(a) Mesh m<sup>1</sup>, diamond, shall be welded. Openings in the mesh shall not exceed 31.8 mm (1 1/4 in.) between wire intersection measured across diagonal corners of the diamond.

(b) Mesh m<sup>2</sup>, square, shall be welded. Openings in the mesh shall not exceed 15.9 mm (5/8 in.) between wire intersections measured along a side of the square.

(c) Mesh m<sup>3</sup>, parallel strand, spacing shall be as specified.

6.8.1.3 *Wired Glass (Polished or Patterned)*:

(a) *Form 1 (Polished Both Sides)*—Glass may contain

waviness that does not interfere with vision normal to the surface.

(b) *Form 2 (Patterned One or Both Sides)*—Glass shall not contain fire cracks, exposed wire, or stones that can cause spontaneous breakage in annealed glass.

6.8.2 *Patterned (Form 3)*:

6.8.2.1 *Thickness and Dimensional Tolerances*—Finishes f<sup>1</sup> and f<sup>2</sup>, patterns p<sup>1</sup>, p<sup>2</sup>, and p<sup>3</sup>. Tolerances for length, width, and thickness shall be in accordance with Table 7.

6.8.2.2 *Glass*—Patterned glass shall not contain fire cracks and stones that can cause spontaneous breakage in annealed glass.

6.8.2.3 *Surface Pattern*:

NOTE 2—Patterned glass can vary slightly in both configuration and color from run to run.

TABLE 3 Glass Quality q<sup>3</sup>, Maximum Allowable Blemishes for Thicknesses 6.0 mm (¼ in.) or Less<sup>A</sup>

Blemishes	q <sup>3</sup> , Glazing Select Quality					
	Up to 2.5 m <sup>2</sup> (25 ft <sup>2</sup> )		2.5 to 7.0 m <sup>2</sup> (25 to 75 ft <sup>2</sup> )		Over 7.0 m <sup>2</sup> (75 ft <sup>2</sup> )	
	Central <sup>B</sup>	Outer <sup>B</sup>	Central <sup>B</sup>	Outer <sup>B</sup>	Central <sup>B</sup>	Outer <sup>B</sup>
Gaseous inclusions, maximum size <sup>C</sup>	1.6 mm (⅙ in.) <sup>D,E</sup>	2.4 mm (⅜ in.) <sup>D,E</sup>	3.2 mm (⅙ in.) <sup>D,E</sup>	4.8 mm (⅜ in.) <sup>D,E</sup>	6.4 mm (¼ in.) <sup>D,E</sup>	6.4 mm (¼ in.) <sup>D,E</sup>
Open or translucent gaseous inclusions, maximum size <sup>C</sup>	1.2 mm (⅜ in.) <sup>D,E</sup>	1.6 mm (⅙ in.) <sup>D,E</sup>	1.2 mm (⅜ in.) <sup>D,E</sup>	1.6 mm (⅙ in.) <sup>D,E</sup>	6.4 mm (¼ in.) <sup>D,E</sup>	6.4 mm (¼ in.) <sup>D,E</sup>
Knots, dirt, and stones, maximum size <sup>C</sup>	0.4 mm (⅙ in.) <sup>D</sup>	0.8 mm (⅓ in.) <sup>D</sup>	1.6 mm (⅙ in.) <sup>D</sup>	1.6 mm (⅙ in.) <sup>D</sup>	3.2 mm (⅙ in.) <sup>D</sup>	3.2 mm (⅙ in.) <sup>D</sup>
Scratches and rubs (intensity)	medium <sup>F</sup>	medium <sup>F</sup>	medium <sup>F</sup>	heavy <sup>F</sup>	heavy <sup>F</sup>	heavy <sup>F</sup>
Crush (intensity, maximum length)	medium <sup>F</sup> <1.6 mm (<⅙ in.) <sup>G</sup>	medium <sup>F</sup> <2.4 mm (<⅜ in.) <sup>G</sup>	medium <sup>F</sup> <3.2 mm (<⅙ in.) <sup>G</sup>	heavy <sup>F</sup> <4.8 mm (<⅜ in.) <sup>G</sup>	heavy <sup>F</sup> <6.4 mm (<¼ in.) <sup>G</sup>	heavy <6.4 mm (<¼ in.) <sup>G</sup>
Digs, maximum length	1.6 mm (⅙ in.) <sup>G</sup>	2.4 mm (⅜ in.) <sup>G</sup>	3.2 mm (⅙ in.) <sup>D</sup>	4.8 mm (⅜ in.) <sup>D</sup>	6.4 mm (¼ in.) <sup>D</sup>	6.4 mm (¼ in.) <sup>D</sup>
Ream, strings, lines, and other linear distortion (maximum angle or intensity)	45° <sup>H</sup> or medium <sup>I</sup>		90° <sup>H</sup> or heavy		90° <sup>H</sup> or heavy	
Wave (intensity)	medium <sup>J</sup>	medium <sup>J</sup>	medium <sup>J</sup>	heavy <sup>J</sup>	heavy <sup>J</sup>	heavy <sup>J</sup>
Process surface blemishes (intensity)	medium <sup>K</sup>	medium <sup>K</sup>	medium <sup>K</sup>	heavy <sup>K</sup>	heavy <sup>K</sup>	heavy <sup>K</sup>

<sup>A</sup> Glass greater than 6.0 mm (¼ in.) in thickness may contain proportionally more and larger blemishes.

<sup>B</sup> The central area is considered to form an oval or circle centered on the lite whose axes or diameters do not exceed 80 % of the overall dimension. The remaining area is considered the outer area.

<sup>C</sup> Gaseous inclusions, knots, dirt, and stones may be round or elongated. For elongated blemishes of this type(s) the maximum size specified shall be determined by adding the length and width of the blemish and dividing by two, for example (L + W)/2.

<sup>D</sup> Separated by at least 305 mm (12 in.).

<sup>E</sup> For blemishes of a smaller size or of less intensity, the minimum separation shall be proportionately less. The larger of the two blemishes shall govern the separation. Blemishes not specifically mentioned shall be compared to the blemish they most closely resemble.

<sup>F</sup> Intensity (scratches, rubs, and crush)—When looking through the glass and perpendicular to it using daylight without direct sunlight or with background light suitable for observing each type of blemish, the blemishes shall not be detectable at distances greater than the following, except for heavy intensity (see 7.3):

Intensity	Distance
Faint	203 mm (8 in.)
Light	914 mm (36 in.)
Medium	3.3 m (132 in.)
Heavy	detected at distances greater than 3.3 m (132 in.)

<sup>G</sup> Separated by at least 610 mm (24 in.).

<sup>H</sup> Vision interference angle (see 4.1 and 7.1).

<sup>I</sup> Intensity (ream, strings, lines, and other linear distortion)—When evaluated using the shadowgraph, the intensities of these blemishes are defined as having a shadowgraph readout at distances greater than or equal to the following (see 7.2):

Intensity	Minimum Distance, mm (in.)
Light	76 (3)
Medium	51 (2)
Heavy	25 (1)

<sup>J</sup> Intensity (wave)—When evaluated using the shadowgraph, the intensities of wave are defined as having shadowgraph readouts at distances greater than or equal to the following (see 7.2):

Intensity	Minimum Distance, mm (in.)
Medium	254 (10)
Heavy	152 (6)

<sup>K</sup> Intensity (process surface blemishes)—When viewed in normal reflected light, the blemishes are classified as follows: faint—visible only to the trained eye; light—just noticeable; medium—visible as a slight grayish haze; and heavy—readily visible as a cloudy surface.

(a) *Quality q<sup>7</sup> (Decorative)*—Surface pattern shall be clear, sharp, and defined and free of disfiguration that affects the appearance of the pattern. The smooth sides shall be free of open gaseous inclusions greater than 2.4 mm (⅜ in.) or equivalent elliptical open inclusions up to 15.9 mm (⅝ in.) long with no more than three of the maximum size in each 4.64 m<sup>2</sup> (50 ft<sup>2</sup>) of each cut sheet.

(b) *Quality q<sup>8</sup> (Glazing)*—Surface pattern shall be free of large areas of blemishes. Scattered areas of nonuniform surface and scattered surface blemishes are permissible. The smooth side shall be free of imbedded foreign materials and shall be free of open gaseous inclusions greater than 3.2 mm (⅙ in.) or equivalent elliptical open inclusions up to 19 mm (¾ in.) long with no more than three of the maximum size in each 4.64 m<sup>2</sup> (50 ft<sup>2</sup>) of each cut sheet.

## 7. Test Methods

7.1 *Ream, Strings, and Distortion (Test Method A)*—Place specimen in a vertical position at a distance of approximately 914 mm (36 in.) from a brick wall or similar background showing straight lines. The viewer shall look through the sample at a distance of 914 mm from the sample using daylight without direct sunlight or with background light suitable for observing each type of blemish. View the sample at an angle to the surface of not less than vision interference angle in Table 2, Table 3, and Table 4, for the applicable glass. The line of vision shall be perpendicular to the wall.

7.2 *Ream, Strings, Lines, and Wave (Test Method B, Shadowgraph)*—Focus a light projector with a 500-W lamp, or equivalent, and an objective lens with an approximate 51-mm

**TABLE 4 Glass Qualities q<sup>4</sup>, q<sup>5</sup>, and q<sup>6</sup>, Maximum Allowable Blemishes for Thicknesses 6.0 mm (¼ in.) or Less<sup>A</sup>**

Blemishes	q <sup>4</sup> Glazing A		q <sup>5</sup> Glazing B		q <sup>6</sup> Greenhouse
	Central <sup>B</sup>	Outer <sup>B</sup>	Central <sup>B</sup>	Outer <sup>B</sup>	Total
Gaseous inclusions, maximum size <sup>C</sup>	6.4 mm (¼ in.) <sup>DE</sup>	12.7 mm (½ in.) <sup>DE</sup>	12.7 mm (½ in.) <sup>DE</sup>	19.0 mm (¾ in.) <sup>DE</sup>	>19.0 mm (>¾ in.) <sup>DE</sup>
Open or translucent gaseous inclusions, maximum size <sup>C</sup>	6.4 mm (¼ in.) <sup>EF</sup>	6.4 mm (¼ in.) <sup>EF</sup>	6.4 mm (¼ in.) <sup>EF</sup>	6.4 mm (¼ in.) <sup>EF</sup>	≥6.4 mm (≥¼ in.) <sup>EF</sup>
Knots, dirt, and stones, maximum size <sup>C</sup>	0.8 mm (⅓ in.) <sup>EF</sup>	1.6 mm (⅓ in.) <sup>EF</sup>	1.6 mm (⅓ in.) <sup>EF</sup>	3.2 mm (⅓ in.) <sup>EF</sup>	≥3.2 mm (≥⅓ in.) <sup>EF</sup>
Scratches and rubs (intensity)	light <sup>G</sup>	light <sup>G</sup>	medium <sup>G</sup>	medium <sup>G</sup>	≥medium <sup>G</sup>
Crush (intensity, maximum length)	light <sup>G</sup> <6.4 mm (<¼ in.) <sup>E</sup>	light <sup>G</sup> <12.7 mm (<½ in.) <sup>E</sup>	medium <sup>G</sup> <12.7 mm (<½ in.) <sup>E</sup>	medium <sup>G</sup> <19.0 mm (<¾ in.) <sup>E</sup>	≥medium <sup>G</sup> ≥19.0 mm (≥¾ in.)
Digs, maximum length	6.4 mm (¼ in.) <sup>E</sup>	12.7 mm (½ in.) <sup>E</sup>	12.7 mm (½ in.) <sup>E</sup>	19.0 mm (¾ in.) <sup>E</sup>	>19.0 mm (>¾ in.) <sup>E</sup>
Ream, strings, lines, and other linear distortion (maximum angle or intensity)		30° <sup>H</sup> or light <sup>I</sup>		90° <sup>H</sup> or heavy <sup>I</sup>	90° <sup>H</sup> or heavy <sup>I</sup>
Wave (intensity)	medium <sup>J</sup>	medium <sup>J</sup>	heavy <sup>J</sup>	heavy <sup>J</sup>	heavy <sup>J</sup>
Process surface blemishes (intensity)	medium <sup>K</sup>	medium <sup>K</sup>	heavy <sup>K</sup>	heavy <sup>K</sup>	heavy <sup>K</sup>

<sup>A</sup> Glass greater than 6.0 mm (¼ in.) in thickness may contain proportionally more and larger blemishes.

<sup>B</sup> The central area is considered to form an oval or circle centered on the lite whose axes or diameters do not exceed 50 % of the overall dimension. The remaining area is considered the outer area.

<sup>C</sup> Gaseous inclusions, knots, dirt, and stones may be round or elongated. For elongated blemishes of this type(s) the maximum size specified shall be determined by adding the length and width of the blemish and dividing by two, for example  $(L + W)/2$ .

<sup>D</sup> Separated by at least 305 mm (12 in.)

<sup>E</sup> For blemishes of a smaller size or of less intensity, the minimum separation shall be proportionately less. The larger of the two blemishes shall govern the separation. Blemishes not specifically mentioned shall be compared to the blemish they most closely resemble.

<sup>F</sup> Separated by at least 610 mm (24 in.)

<sup>G</sup> *Intensity (scratches, rubs, and crush)*—When looking through the glass and perpendicular to it using daylight without direct sunlight or with background light suitable for observing each type of blemish, the blemishes shall not be detectable at distances greater than the following, except for heavy intensity (see 7.3):

Intensity	Distance
Faint	203 mm (8 in.)
Light	914 mm (36 in.)
Medium	3.3 m (132 in.)
Heavy	detected at distances greater than 3.3 m (132 in.)

<sup>H</sup> Vision interference angle (see 4.1 and 7.1).

<sup>I</sup> *Intensity (ream, strings, lines and other linear distortion)*—When evaluated using the shadowgraph, the intensities of these blemishes are defined as having a shadowgraph readout at distances greater than or equal to the following (see 7.2):

Intensity	Minimum Distance, mm (in.)
Light	76 (3)
Medium	51 (2)
Heavy	25 (1)

<sup>J</sup> *Intensity (wave)*—When evaluated using the shadowgraph, the intensities of wave are defined as having shadowgraph readouts at distances greater than or equal to the following (see 7.2):

Intensity	Minimum Distance, mm (in.)
Medium	254 (10)
Heavy	152 (6)

<sup>K</sup> *Intensity (process surface blemishes)*—When viewed in normal reflected light, the blemishes are classified as follows: faint—visible to the trained eye; light—just noticeable; medium—visible as a slight grayish haze; and heavy—readily visible as a cloudy surface.

(2-in.) aperture and an approximate 305-mm (12-in.) focal length on a flat white projection screen positioned 8 m (25 ft) from the light source in a dark room. Place the glass in a vertical position parallel to the screen between the light and the screen. Move the glass slowly toward the screen with a circulating motion in the plane perpendicular to the light beam. The shadowgraph readout is the distance at which the distortion just blends with the general shadow of the glass on the screen.

**7.3 Scratches, Rubs, Stones, and Gaseous Inclusions**—Place samples in a vertical position approximately 1 m (36 in.) from the viewer’s position for initial blemish detection. The viewer shall look through the sample using daylight without direct sunlight or with background light suitable for observing each type of blemish. Refer to Table 2, Table 3, and Table 4 for evaluation criteria.

**7.4 Cut Sizes**—Measure length and width from edge to edge including flares.

### 7.5 Additional Procedures for Type I, Class 2 (Tinted, Heat-Absorbing or Light-Reducing Flat Glass, or Both):

#### 7.5.1 Transmittance:

**7.5.1.1 Specimens**—Select two specimens, one each from two samples.

**7.5.1.2 Color or Tint**—Place the specimen in a vertical position in an area illuminated either by daylight (without direct sunlight) or a background light suitable for observing blemishes. View the glass at an angle of 90° perpendicular to the surface from a distance of 1 m.

**7.5.1.3 Luminous Transmittance**—Using Practice E 308, measure transmittance by illuminating each specimen at normal incidence with light having the spectral composition of ICI illuminant C. Measure the ratio of transmittance to incident luminous flux by calculation from the spectral distribution of illuminant C as defined by Practice E 308.

**7.5.1.4 Solar Transmittance**—Use Test Method E 903. Calculate transmittance for solar energy from the measured

**TABLE 5 Transmittance Values for Style A and Style B Heat-Absorbing Glass**

Thickness, mm (in.)	ICI Illuminant C Transmittance	Solar Transmittance, total max, % <sup>A</sup>
Style A, min, % <sup>A</sup>		
2.5 (0.090)	83	74
3.0 (0.118)	80	67
5.0 (0.197)	75	56
6.0 (0.236)	70	52
8.0 (0.315)	65	45
10.0 (0.394)	60	39
12.0 (0.472)	50	36
Style B, max, % <sup>A</sup>		
2.5 (0.090)	83	74
3.0 (0.118)	80	67
5.0 (0.197)	75	56
6.0 (0.236)	70	52
8.0 (0.315)	65	45
10.0 (0.394)	60	39
12.0 (0.472)	50	36

<sup>A</sup> Straight line interpolation may be used for intermediate thickness, as an approximation.

**TABLE 6 Thickness and Tolerance for Wired Glass**

Thickness Designation, mm (in.)	Tolerance, Thickness, mm (in.)	
	max	min
5.6 (7/32) <sup>A</sup>	6.4 (0.250)	5.1 (0.203)
6.4 (1/4)	7.6 (0.297)	6.4 (0.250)
9.5 (3/8)	9.9 (0.391)	8.3 (0.328)

<sup>A</sup> Never approved by Underwriter's Laboratories for fire resistance.

spectral transmittance of the glass using the values for spectral distribution of solar energy received at sea level by a surface perpendicular to the sun's rays through an air mass of 1.5.

#### 7.6 Additional Procedure for Type II (Patterned and Wired Flat Glass):

7.6.1 *Transmittance Samples for Classes 2 and 3*—For specimens with patterned surfaces, grind and polish surfaces to a smooth finish.

**TABLE 7 Thickness and Tolerance for Patterned Glass Patterns p<sup>1</sup> to p<sup>3</sup>**

Thickness Designation, mm (in.)	Tolerance, Thickness, mm (in.)		Cut Size Tolerance, Length and Width, plus or minus, mm (in.)
	max	min	
2.5 (SS)	2.8 (0.110)	2.2 (0.085)	1.6 (1/16)
3.0 (DS)	3.4 (0.134)	2.8 (0.110)	1.6 (1/16)
3.2 (InI)	4.4 (0.172)	2.8 (0.110)	1.6 (1/16)
4.0 (5/32)	4.4 (0.172)	3.6 (0.142)	1.6 (1/16)
4.8 (3/16)	5.6 (0.219)	4.4 (0.172)	1.6 (1/16)
5.6 (7/32)	6.8 (0.266)	5.2 (0.203)	2.4 (3/32)
6.4 (1/4)	7.6 (0.297)	6.0 (0.234)	3.2 (1/8)
7.9 (5/16)	9.1 (0.359)	7.1 (0.281)	4.0 (5/32)
9.5 (In#)	10.7 (0.422)	8.7 (0.344)	4.8 (3/16)

*The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 100 Barr Harbor Drive, West Conshohocken, PA 19428.*



# Standard Specification for Heat-Treated Flat Glass—Kind HS, Kind FT Coated and Uncoated Glass<sup>1</sup>

This standard is issued under the fixed designation C 1048; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope

1.1 This specification covers the requirements for flat heat-strengthened and flat fully tempered coated and uncoated glass used in general building construction.

1.2 The dimensional values stated in SI units are to be regarded as the standard. The units given in parentheses are for information only.

1.3 The following safety hazards caveat pertains only to the test method portion, Section 11, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*<sup>2</sup>

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>3</sup>

- C 162 Terminology of Glass and Glass Products
- C 346 Test Method for 45-deg Specular Gloss of Ceramic Materials
- C 724 Test Methods for Acid Resistance of Ceramic Decorations on Architectural-Type Glass
- C 978 Test Method for Photoelastic Determination of Residual Stress in a Transparent Glass Matrix Using a Polarizing Microscope and Optical Retardation Compensation Procedures
- C 1036 Specification for Flat Glass
- C 1203 Test Method for Quantitative Determination of Alkali Resistance of a Ceramic-Glass Enamel

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C14 on Glass and Glass Products and is the direct responsibility of Subcommittee C14.08 on Flat Glass.

Current edition approved Jan. 1, 2004. Published March 2004. Originally approved in 1985. Last previous edition approved in 1997 as C 1048 – 97b.

<sup>2</sup> Reference to these documents shall be the latest issue unless otherwise specified by the authority applying this specification.

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

C 1279 Test Method for Non-Destructive Photoelastic Measurement of Edge and Surface Stresses in Annealed, Heat-Strengthened, and Fully Tempered Flat Glass

### 2.2 ANSI Standard:

Z97.1 Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings<sup>4</sup>

### 2.3 Other Documents:

CPSC 16 CFR 1201 Safety Standard for Architectural Glazing Materials<sup>5</sup>

## 3. Terminology

3.1 *Definitions:* For definitions of terms used in this specification, refer to Terminology C 162 and Specification C 1036.

## 4. Classification

4.1 *Kinds*—Flat glass furnished under this specification shall be of the following kinds, as specified (see Section 6):

4.1.1 *Kind HS*—Heat-strengthened glass shall be flat glass, either transparent or patterned, in accordance with the applicable requirements of Specification C 1036 as further processed to conform with the requirements hereinafter specified for heat-strengthened glass.

4.1.2 *Kind FT*—Fully tempered glass shall be flat glass, either transparent or patterned in accordance with the applicable requirements of Specification C 1036 as further processed to conform with the requirements hereinafter specified for fully tempered glass.

4.2 *Conditions*—Glass furnished under this specification shall be of the following conditions, as specified (see Section 6):

4.2.1 *Condition A*—Uncoated surfaces.

4.2.2 *Condition B*—Spandrel glass, one surface ceramic coated.

4.2.3 *Condition C*—Other coated glass.

<sup>4</sup> Available from American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.

<sup>5</sup> Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

4.3 *Types, Classes, Forms, Qualities, and Finishes*—these are described in Specification C 1036.

## 5. Intended Use

5.1 *Kind HS*—Heat-strengthened glass is generally twice as strong as annealed glass of the same thickness and configuration. When broken, the fragments are generally similar to that of annealed glass. Intended for general glazing when additional strength is desired but not requiring the strength of fully tempered glass.

NOTE 1—**Caution:** Monolithic heat-strengthened glass is not suitable for safety glazing as defined by ANSI Z97.1 or CPSC 16 CFR 1201.

5.2 *Kind FT*—Fully tempered glass is approximately four times as strong as annealed glass of the same thickness and configuration. When broken, by impact, fully tempered glass fractures into relatively small pieces meeting safety glazing requirements thereby greatly reducing the likelihood of serious cutting or piercing injuries in comparison with ordinary annealed glass. Fully tempered glass is intended for use in applications where its strength or safety characteristics may be required. For some applications, such as doors used for passage, tub and shower enclosures and fixed glass in close proximity to a walking surface, fully tempered glass is required by building codes and ordinances. It is often used for other applications where the properties of fully tempered glass are desirable such as table tops, counter tops, show case enclosures and similar applications.

## 6. Ordering Information

6.1 Purchasers should select the preferred options permitted in this specification and include the following information in procurement documents:

- 6.1.1 Title, number, and date of this specification.
- 6.1.2 Kind, condition, type, class, style, form, quality, finish, and pattern of glass as applicable (see Section 4).
- 6.1.3 Fabrication requirements (see 7.1).
- 6.1.4 Requirements for fittings and hardware (see 7.2).
- 6.1.5 Specific location of tong marks, when required (see 7.3).
- 6.1.6 Custom design or texture required (see 7.8).
- 6.1.7 Glass thickness (see 9.1).
- 6.1.8 Pattern-cut glass must be within the tolerances specified (see 9.3).
- 6.1.9 When surface or edge compression test is required for Kind HS or Kind FT glass (see 8.1.1).
- 6.1.10 When break safe characteristics are required for fully tempered (Kind FT) glass (see 8.1.2).
- 6.1.11 Color or tint of glass (see 8.2).
- 6.1.12 When either permanent or temporary identification marking is required (see Section 12).
- 6.1.13 Surface treatment or coatings for Condition B and Condition C glass (see 8.3 and 8.4).
- 6.1.14 When addition of fallout resistance capability is required for Condition A, Condition B, or Condition C glasses used as spandrels. (Normally achieved by adhering a reinforcing material to the glass surface.) (See 11.3.)

## 7. Fabrication

7.1 *Fabrication*—All fabrication, such as cutting to overall dimensions, edgework, drilled holes, notching, grinding, sandblasting, and etching, shall be performed before strengthening or tempering and shall be as specified (see Section 6 and 7.9). After the glass has been heat strengthened or tempered, it shall not be modified except as recommended by the fabricator; for example, some Condition C coatings. No modification shall be made that will affect its structural characteristics or integrity as specified in this specification.

7.2 *Fittings and Hardware*—Requirements for fittings and hardware shall be as specified (see Section 6) or as shown on plans or drawings. Fittings and hardware specified shall be compatible with glass fabrication limitations.

7.3 *Tong Marks*—The center of tong marks, when present, shall be located a maximum of 12.7 mm ( $\frac{1}{2}$  in.) from one edge of the glass on thicknesses up to and including 9.5 mm ( $\frac{3}{8}$  in.). On thicknesses over 9.5 mm, the center of tong marks, when present, shall be located a maximum of 19 mm ( $\frac{3}{4}$  in.) from one edge of the glass. Tong marks shall be located on a specific edge when specified (see Section 6). For location of tong marks on glass with special fabrication or irregular patterns, consult fabricators.

### 7.4 Distortion:

7.4.1 Thermally tempered and heat-strengthened glass is made by heating glass in a furnace to a temperature at which the glass becomes slightly plastic. Immediately after heating, the glass surfaces are rapidly cooled by quenching with air from a series of nozzles. The original flatness of the glass is slightly modified by the heat treatment, causing reflected images to be distorted. When viewing images through the glass, the distortion, in most glazing applications, is less than that of reflected images and is not as noticeable.

7.4.2 Fully tempered and heat-strengthened glass that has been made in a vertical furnace contains small surface depressions along one edge resembling dimples (tong marks) (see 7.3). Distortion will be observed in the areas surrounding the tong marks. Fully tempered and heat-strengthened glass that has been made in a horizontal furnace may contain surface distortion (for example, picture framing, heat distortion or roller wave distortion). Distortion will be detected when viewing images reflected from the glass surface.

7.4.3 Pressures, exerted around the periphery of glass by the glazing system, can also alter glass flatness thereby distorting reflected images. This is true regardless of whether or not the glass is heat treated.

7.4.4 Sealed insulating glass units also exhibit distortion regardless of glass type. Air or gas, trapped in the sealed airspace between the panes, expands or contracts with temperature and barometric changes, creating a pressure differential between the airspace and the atmosphere. The glass reacts to the pressure differential by being deflected inward or outward.

7.4.5 Regardless of glass flatness, the degree of reflected distortion perceived is largely due to the characteristics or symmetry of the object being reflected. Linear objects (such as building curtain walls and telephone poles) and moving objects

(such as cars) may appear distorted. Irregular and free-form objects such as trees and clouds will appear to have little perceived distortion.

7.4.6 Specified bow and warp limits may not adequately define, or control, the distortion that may become apparent after glazing. The factors, noted above, may have a larger influence on the perceived reflected distortion than that which is caused by bow and warp from the heat-treating process. Consultation with suppliers and the viewing of full-size mock-ups, under typical job conditions and surroundings, is highly recommended for user or architectural evaluation of the reflective distortion.

7.5 *Strain Pattern*—In heat-strengthened and fully tempered glass, a strain pattern, which is not normally visible, may become visible under certain light conditions. It is characteristic of these kinds of glasses and should not be mistaken as discoloration or nonuniform tint or color.

7.6 *Surface Particles*—The heat-treating process typically involves the transport of very hot glass on conveyor rollers. As a result of this soft glass-to-roller contact, some glass surface changes will occur. Minute glass particles (fines) from the glass cutting and edging process, typical manufacturing plant airborne debris or dust, refractory particles from the tempering oven roof, as well as external airborne dirt and grit carried into the plant by the large volumes of quench air used in the process, may adhere to one or both glass surfaces.

7.7 *Resistance to Wind Load*—The support system and the amount of glass deflection for a given set of wind-load conditions must be considered for design purposes. Consult the manufacturer to determine the appropriate thickness of heat-strengthened (Kind HS) or fully tempered (Kind FT) glass needed to satisfy the design wind load and probability of breakage design factor for the required glass.

7.8 *Special Surfaces, Types I or II*—Custom designs or textures shall be as specified (see 6.1.6) or as shown on plans or drawings.

7.9 *Fabrication Guidelines*—Heat-treated flat glass cannot be cut after tempering. Fabrication altering the stress distribution, surface or edge shape, or dimension must be performed before being heat treated. Consult suppliers for special edges or irregular patterns or, when required, on a specific type of edge. The following guidelines may be used for normal fabrication requirements.

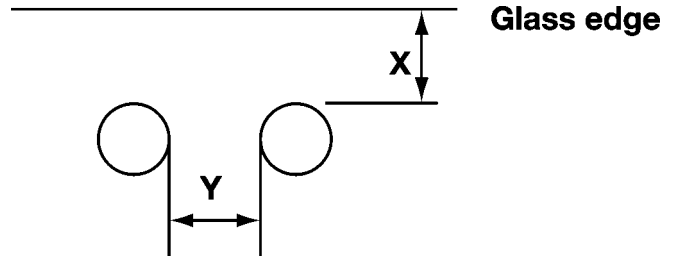
7.9.1 Heat-treated glass can be furnished with holes, notches, cutouts, and bevels.

7.9.2 *Placement of Holes:*

7.9.2.1 The minimum distance from any edge of the glass to the nearest point on the rim of a hole must be 6 mm (1/4 in.) or 2 times the thickness of the glass, whichever is greater (see Fig. 1).

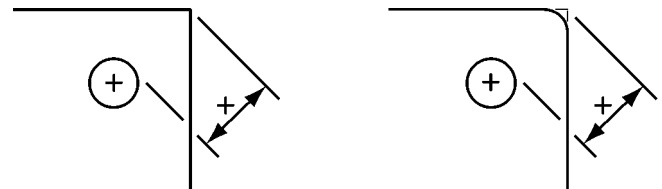
7.9.2.2 The minimum distance between the rims of adjoining holes must be 10 mm (3/8 in.) or 2 times the thickness of glass, whichever is greater (see Fig. 1).

7.9.2.3 Holes near corners must be located so that the nearest edge of the hole is a minimum of 6.5 times the thickness of the glass from the tip of the corner when the corner is 90° or more (see Fig. 2).



NOTE—  
 X = 6 mm (1/4 in.) or 2t, whichever is greater  
 Y = 10 mm (3/8 in.) or 2t, whichever is greater  
 Where:  
 X = Minimum distance between glass edge and rim of nearest hole  
 Y = Minimum distance between rims of adjoining holes  
 t = glass thickness

FIG. 1 Placement of Holes



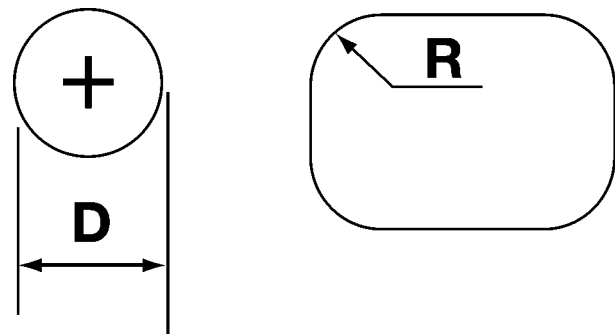
NOTE—  
 X = 6.5t  
 Where:  
 X = Minimum distance between glass corner and rim of nearest hole  
 t = Glass thickness.

FIG. 2 Location of Holes Near Corners

7.9.3 *Minimum Dimension of Holes*—Circular holes must have a minimum diameter of 6.4 mm (1/4 in.) or the thickness of the glass, whichever is greater. In other than circular holes, any corners must have fillets, the radius of which must be equal to or greater than the thickness of the glass (see Fig. 3).

7.9.4 *Dimensional Tolerances of Holes:*

7.9.4.1 Tolerance of hole diameter shall be ±1.6 mm (1/16 in.).



NOTE—  
 D = 6 mm (1/4 in.) or 1t, whichever is greater  
 R ≥ t  
 Where:  
 D = Minimum diameter of a hole  
 R = Radius  
 t = Glass thickness

FIG. 3 Maximum Dimension of Holes

7.9.4.2 Tolerance for dimensions of hole center from specified edges shall be  $\pm 1.6$  mm ( $1/16$  in.).

7.9.4.3 Tolerance for dimension between hole centers shall be  $\pm 1.6$  mm ( $1/16$  in.).

7.9.5 Chips and flakes at hole edges must not exceed 1.6 mm ( $1/16$  in.).

7.9.6 *Notches and Cutouts:*

7.9.6.1 Notches and cutouts must have fillets, the radius of which must be equal to or greater than the thickness of the glass (see Fig. 4).

7.9.6.2 Dimensional tolerance of notches and cutouts shall be:

$\pm 1.6$  mm ( $1/16$  in.) for glass thickness less than 12 mm ( $1/2$  in.).  
 $\pm 3$  mm ( $1/8$  in.) for glass thickness of 12 mm ( $1/2$  in.) and greater.

7.9.6.3 Inner surfaces of notches and cutouts must be smooth seamed or polished.

8. Other Requirements

8.1 *Strength Requirements:*

8.1.1 *Surface and Edge Compression Requirements* (see 11.7):

8.1.1.1 *Kind HS, Heat-Strengthened Glass*—Kind HS glass with thicknesses of 6 mm ( $1/4$  in.) and less shall have a surface compression between 24 to 52 Mpa (3500 and 7500 psi). Surface compression testing, when required (see 6.1.9), shall be done in accordance with 11.7.

NOTE 2—Heat strengthening of glass thicker than 6 mm ( $1/4$  in.) within narrow limits of surface compression is difficult. Consult manufacturer.

8.1.1.2 *Kind FT, Fully Tempered Glass*—Kind FT glass shall have either a minimum surface compression of 69 MPa (10 000 psi) or an edge compression of not less than 67 MPa (9700 psi) or meet ANSI Z97.1 or CPSC Standard 16 CFR1201 in accordance with 11.8. Surface compression or edge compression testing, when required (see 6.1.9), shall be done in accordance with 11.7.

8.1.2 *Break Test Requirement for Kind FT Glass*—When specified (see Section 6), the break requirements of Kind FT glass shall be tested and interpreted in accordance with 11.8.

8.2 *Color or Tint*—The color or tint for each kind, type, class, style, finish, or pattern shall be as specified in 6.1.11 and as follows:

8.2.1 *Tint*—Heat-absorbing glass and light-reducing glass are available in a variety of tints. These types of glass vary in tint between different manufacturers and from melt to melt so some variation in tint may occur.

8.2.2 *Color or Tint Samples*—The request and particular purpose of any color or tint sample shall be stated in the invitation for bid. Tint samples must be heat strengthened or fully tempered, as required, for the matching of tints as the heat-strengthened or fully tempered glasses may exhibit slight changes from the tint of annealed glass. Viewing of the color or tint samples should be performed with the glass in the eventual glazed position.

8.3 *Condition B*—Ceramic-coated spandrel glass, shall be Kind HS heat-strengthened or Kind FT fully tempered glass having a ceramic coating of a specified color which has been fused onto and made an integral part of the surface of the glass (see 6.1.13).

8.3.1 *Appearance*—When viewed in accordance with 11.9, scattered pinholes, screen marks, and small opaque particles in the ceramic coating are permissible.

8.4 *Condition C*—Other coated glass shall be Kind HS heat-strengthened or Kind FT fully tempered glass with a specified special coating designed to modify one or more environmental characteristic such as solar and visible light transmission reflection and absorption or surface emissivity or both (see Specification C 1376).

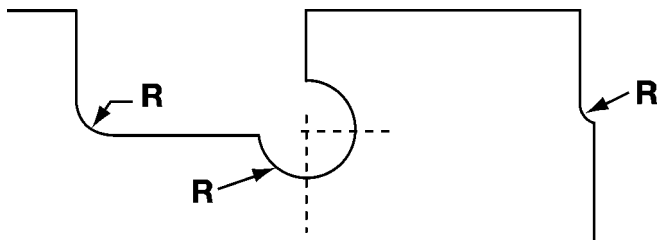
9. Dimension Requirements

9.1 *Thickness*—Substrates for heat-strengthened and fully tempered glass shall be in accordance with the thickness requirements of Specification C 1036 and as specified therein (see Section 6). Available sizes and thicknesses of HS and FT glass are subject to the processing limitations of each furnace. All thicknesses are not available in all conditions, types, and classes. Consult manufacturers or fabricators.

9.2 *Tolerance, Length, and Width for Rectangular Shapes for Conditions A, B, and C Glass*—See requirements in Table 1.

9.3 *Pattern-Cut*—Unless otherwise specified (see Section 6), dimensional tolerances for pattern-cut glass must be specified (see 6.1.8). Consult the manufacturer or fabricator for tolerances.

9.4 *Flatness*—Because of the nature of the processes used in manufacturing tempered and heat-strengthened glasses, these glasses are not as flat as annealed glass. The deviation for flatness depends on thickness, width, length, and other factors. Usually greater thicknesses yield flatter products (see 11.6).



NOTE 1—  
 $R \geq t$   
 $t$  = thickness of glass  
 $R$  = radius  
 See paragraph 7.9.6.

FIG. 4 Notch and Cutout Fillets

TABLE 1 Tolerance, Length and Width Requirements (8.2)

Glass thickness mm (in.)	Finished Size Tolerance Length and Width, plus or minus mm, (in.)
3.0 ( $1/8$ )	1.6 ( $1/16$ )
4.0 ( $5/32$ )	1.6 ( $1/16$ )
5.0 ( $3/16$ )	1.6 ( $1/16$ )
6.0 ( $1/4$ )	1.6 ( $1/16$ )
8.0 ( $5/16$ )	2.0 ( $5/64$ )
10.0 ( $3/8$ )	2.4 ( $3/32$ )
12.0 ( $1/2$ )	3.2 ( $1/8$ )
16.0 ( $5/8$ )	4.0 ( $5/32$ )
19.0 ( $3/4$ )	4.8 ( $3/16$ )

**TABLE 2 Overall Bow and Warp, Maximum**

Glass Thickness, mm (in.)	Edge Dimension, cm (in.)											
	0–50 (0–20)	>50–90 (>20–35)	>90–120 (>35–47)	>120–150 (>47–59)	>150–180 (>59–71)	>180–210 (>71–83)	>210–240 (>83–94)	>240–270 (>94–106)	>270–300 (>106–118)	>300–330 (>118–130)	>330–370 (>130–146)	>370–400 (>146–158)
	Maximum Bow and Warp, mm (in.)											
3 (1/8)	3.0 (0.12)	4.0 (0.16)	5.0 (0.20)	7.0 (0.28)	9.0 (0.35)	12.0 (0.47)	14.0 (0.55)	17.0 (0.67)	19.0 (0.75)	...	...	...
3 (1/8) Alternate Method <sup>A</sup>	2.0 (0.08)	2.0 (0.08)	2.0 (0.08)	3.0 (0.12)	5.0 (0.20)	6.0 (0.24)	7.0 (0.28)	8.0 (0.31)	10.0 (0.39)	...	...	...
4 (5/32)	3.0 (0.12)	4.0 (0.16)	5.0 (0.20)	7.0 (0.28)	9.0 (0.35)	12.0 (0.47)	14.0 (0.55)	17.0 (0.67)	19.0 (0.75)	...	...	...
5 (3/16)	3.0 (0.12)	4.0 (0.16)	5.0 (0.20)	7.0 (0.28)	9.0 (0.35)	12.0 (0.47)	14.0 (0.55)	17.0 (0.67)	19.0 (0.75)	...	...	...
6 (1/4)	2.0 (0.08)	3.0 (0.12)	4.0 (0.16)	5.0 (0.20)	7.0 (0.28)	9.0 (0.35)	12.0 (0.47)	14.0 (0.55)	17.0 (0.67)	19.0 (0.75)	21.0 (0.83)	24.0 (0.94)
8 (5/16)	2.0 (0.08)	2.0 (0.08)	3.0 (0.12)	4.0 (0.16)	5.0 (0.20)	6.0 (0.24)	8.0 (0.31)	10.0 (0.39)	13.0 (0.51)	15.0 (0.59)	18.0 (0.71)	20.0 (0.79)
10 (3/8)	2.0 (0.08)	2.0 (0.08)	2.0 (0.08)	4.0 (0.16)	5.0 (0.20)	6.0 (0.24)	7.0 (0.28)	9.0 (0.35)	12.0 (0.47)	14.0 (0.55)	17.0 (0.67)	19.0 (0.75)
12–22 (1/2 – 7/8)	1.0 (0.04)	2.0 (0.08)	2.0 (0.08)	2.0 (0.08)	4.0 (0.16)	5.0 (0.20)	5.0 (0.20)	7.0 (0.28)	10.0 (0.39)	12.0 (0.47)	14.0 (0.55)	17.0 (0.67)

<sup>A</sup> Values apply to 3 mm (1/8 in.) thickness only when the alternative checking procedure in 11.6 is used.

9.4.1 *Localized Warp*—Localized warp for rectangular glass shall not exceed 1.6 mm (1/16 in.) over any 300-mm (12-in.) span. Localized warp for strips shall not exceed 2.4 mm (3/32 in.) over any 300-mm (12-in.) span.

9.4.2 *Tong Kink*—Any localized kink centered at any tong location shall not exceed 1.6 mm (1/16 in.) in a 50-mm (2-in.) span.

9.4.3 *Overall Bow and Warpage Tolerances*—Overall bow and warpage tolerances shall not exceed the deviations shown in Table 2 when measured in accordance with 11.6.

## 10. Glass Quality and Finish

10.1 Glass qualities in this specification shall be in accordance with the applicable requirements for qualities q<sup>3</sup>, q<sup>4</sup>, q<sup>5</sup>, and q<sup>6</sup>, given in Specification C 1036 and as specified in Section 6.

## 11. Test Methods

11.1 *Expansion Fit Test for Ceramic Coating—Condition B, Ceramic-Coated Spandrel Glass:*

11.1.1 *Test Specimens*—Prepare and test in accordance with Test Method C 978.

11.1.2 *Test Results:*

11.1.2.1 The expansion match between the glass and ceramic enamel influences significantly the strength characteristics of spandrel glass. Proper match is essential to ensure that significant reduction in strength does not result due to the ceramic enamel coating.

11.1.2.2 When coated, cured, and well-annealed glass strips are tested in accordance with Test Method C 978, the stress measured in the glass at the ceramic-glass interface shall be a maximum of 1.52 MPa (220 psi) tension or compression.

11.2 *Durability Tests of Ceramic Coating:*

11.2.1 *Test Specimens:*

11.2.1.1 Specimens for durability tests shall have a representative thickness of ceramic coating of the same type and color as provided in specimens in 11.1.1. Specimens shall be fired in a normal manner with a production lot.

11.2.1.2 Specimens for tests in 11.2.2 and 11.2.4 may be of any convenient size.

11.2.2 *Test for Porosity*—Use either Test Method A or B.

11.2.2.1 *Test Method A—Gloss Test:*

(1) *Procedure*—With a glossmeter<sup>6</sup> conforming to Test Method C 346, check the gloss value. The glossmeter must be calibrated such that the gloss value reading with black glass (black Carrara or any similar product with polished surfaces) has a value of 54.5 (see Test Method C 346 for detailed discussion).

(2) *Test Results*—Penetration of water through porous ceramic can cause separation of the ceramic enamel from the base glass in freezing weather; ceramic with adequate gloss has been found to prohibit water entry, thus preventing such failure. When tested, the gloss value shall not be less than 35 at the time of manufacture.

11.2.2.2 *Test Method B—India Ink Test:*

(1) *Procedure*—Lightly scrape an approximate 25- by 75-mm (1- by 3-in.) area of the ceramic enamel coating with ten passes of a single-edge razor blade oriented toward the ten and four o'clock position at an angle of 45° to the surface of the specimen. Draw a line with India ink along the 75-mm (3-in.) dimension. After the ink has been on the specimen for 15 min, apply a fine abrasive paste over the line and scrub with an assay brush until the paste is removed from the line area. View the scrubbed area under a diffused light source with the unaided eye to determine if any residue remains in the ceramic enamel coating.

(2) *Test Results*—Residual deposits of ink indicate a porosity of the ceramic enamel coating that will allow water moisture penetration that may result in a discoloration of the ceramic enamel coating or a separation of the ceramic enamel coating and the glass substrate in freezing weather or both.

11.2.3 *Alkali Resistance Test*—Specimens for evaluation of resistance to alkali shall be prepared and tested in accordance with Test Method C 1203. The measured weight loss shall not exceed 0.0028 g/cm<sup>2</sup>.

<sup>6</sup> A glossmeter manufactured by Photovolt Corp., Hunter Associates Laboratory, Gardner Instrument Co., or others using a 45° search unit have been found suitable for this purpose.

11.2.4 *Acid-Resistance Test*—Specimens for evaluation of resistance to acid shall be tested in accordance with Test Method C 724. The acid resistance of the test specimen shall be five or better to be considered acceptable, and no visible stain shall be observed when the undecorated side of the sample is viewed over an opaque background.

11.3 *Fallout Resistance Test for an Assembly of Glass and Adhered Reinforcing Material*—Applies to Condition A, Condition B, or Condition C glasses when used as spandrels. (NOTE—Fallout resistance capability is optional and is intended to provide temporary retention of broken spandrels.) (See 6.1.14).

11.3.1 *Frequency of Tests*—Unless otherwise specified, the test for fallout resistance shall be performed with specimens taken from the initial production lot and thereafter only when changes are made in the assembly.

11.3.2 *Specimen Size*—Size of specimens shall be 863 by 1930 mm (34 by 76 in.) with a tolerance of  $\pm 1.6$  mm ( $1/16$  in.) on each dimension.

11.3.3 *Test Procedure*—Test for 100 cycles and repeat with no time delay between cycles. Perform each cycle in sequence as follows:

11.3.3.1 Hold for 1 h at  $-29^{\circ}\text{C}$  ( $-20^{\circ}\text{F}$ ) and ambient humidity.

11.3.3.2 During the next 3 h, increase temperature from  $-29$  to  $82^{\circ}\text{C}$  ( $-20^{\circ}\text{F}$  to  $180^{\circ}\text{F}$ ) with relative humidity at 95 to 100 % when above  $5^{\circ}\text{C}$  ( $41^{\circ}\text{F}$ ).

11.3.3.3 Then hold for 1 h at  $82^{\circ}\text{C}$  ( $180^{\circ}\text{F}$ ), 95 to 100 % relative humidity.

11.3.3.4 During the next 3 h, decrease temperature from 82 to  $-29^{\circ}\text{C}$  ( $180$  to  $-20^{\circ}\text{F}$ ) and ambient humidity.

11.3.4 *Sample Stabilization*—After completion of the test procedure of 11.3.3.4, the sample shall be allowed to rest for at least four h at temperatures between 20 and  $30^{\circ}\text{C}$  (68 and  $86^{\circ}\text{F}$ ).

11.3.5 *Test Apparatus*—Each specimen shall be mounted in a test frame as specified in ANSI Z97.1 or CPSC 16 CFR 1201 as modified to conduct pressure test of 11.3.7.

11.3.6 *Fracturing Glass*—While the specimen is in the test frame, break the specimen using a spring-loaded prick punch at the midpoint of either vertical edge and 25 mm (1 in.) inboard of the edge. Cracks and fissures that may develop are permissible.

11.3.7 *Wind Load*—Subject each specimen after breakage to ten cycles of positive and negative pressure at 200 Pa (4 psf) to simulate the action of wind load against a building. Each positive and negative pressure shall be of 5-min duration.

11.3.8 *Interpretation of Tests*—Although cracks and fissures that may have developed are permissible, no opening shall occur through which a 76.2-mm (3-in.) diameter sphere may be freely passed, nor shall there be single or multiple areas with a cumulative total area of more than  $58\text{ cm}^2$  ( $9\text{ in.}^2$ ) in which an attached film or other reinforcing material is detached from the glass.

11.4 *Wave, Ream, Strings, and Lines, Condition A and Condition C Glass, Type I*—Place sample in a vertical position at a distance of approximately 1 m (36 in.) from a brick wall or similar background showing essentially straight lines. Look

through the sample at a distance of approximately 1 m from the sample using daylight without direct sunlight or with background light suitable for observing each type of imperfection. View the sample at an angle to the surface of not less than the vision interference angle in the table for the applicable glass in Specification C 1036. The line of vision shall be perpendicular to the wall. Determine acceptability in accordance with the applicable table of blemishes in Specification C 1036.

11.5 *Scratches, Rubs, Stones, and Gaseous Inclusions:*

11.5.1 *Condition A and Condition C Glass, Type I*—Place samples in a vertical position approximately 1 m (36 in.) from the viewer's position for initial blemish detection. The viewer shall look through the sample using daylight without direct sunlight or with background light suitable for observing each type of blemish. Refer to Specification C 1036 Tables 2, 3, and 4 for evaluation criteria.

11.5.2 *Condition B, Ceramic Coated*—Spandrel glass shall be viewed by light reflected from the viewed surface. Place the spandrel glass sample against an opaque backup material in a vertical position. View the sample from a distance of approximately 1 m (36 in.) for initial blemish detection. Refer to Specification C 1036 Tables 2, 3, and 4 for evaluation criteria.

11.6 *Localized Warp and Overall Bow and Warp*—Place sample glass in a freestanding vertical position, resting on blocks at the quarter points. With the glass in this position, place a straightedge across the concave surface, parallel to and within 25.4 mm (1 in.) of the edge, and measure the maximum deviation with a taper, or feeler gage, dial indicator or fine scale ruler. When the above procedure is impractical for larger sizes of 3-mm ( $1/8$ -in.) thickness, place the glass on a flat surface, concave side down, and use a taper, feeler gage, dial indicator, or fine scale ruler, reading in 0.02-mm (0.001-in.) increments, to determine overall bow and warp. Overall bow and warp values shown on the second line of Table 2 apply to 3mm ( $1/8$  in.) when the alternative (horizontal) procedure is used.

11.7 *Surface and Edge Compression, Kinds HS and FT*—Examine specimens by the polariscopic or light refraction methods for surface or edge compression. When the range of the apparatus permits examination for edge compression only, obtain the averaged value for all midpoints of every edge. Accomplish this examination for Condition B spandrel glass by removing the ceramic coating with hydrofluoric acid or abrasive cloth. Index oil and a glass-slide cover plate may be necessary to eliminate the diffusing effect of the abraded surface and expose compression color bands.

11.7.1 *Surface Compression, Kinds HS and FT* (see 8.1)—Surface compression to be measured by light refraction methods such as GASP, DSR, or similar methods per Test Method C 1279. Two surface compression measurements shall be made in each of five locations, oriented in two directions at  $90^{\circ}$  to each other, for a total of ten readings on each specimen to be tested. Average the ten readings to determine the stress level of the test sample. The five locations to be examined are shown in Fig. 5.

11.8 *Break Test, Kind FT, Fully Tempered Glass*—Test and interpret in accordance with ANSI Z97.1 or CPSC 16 CFR 1201 as applicable (see 8.1.2).

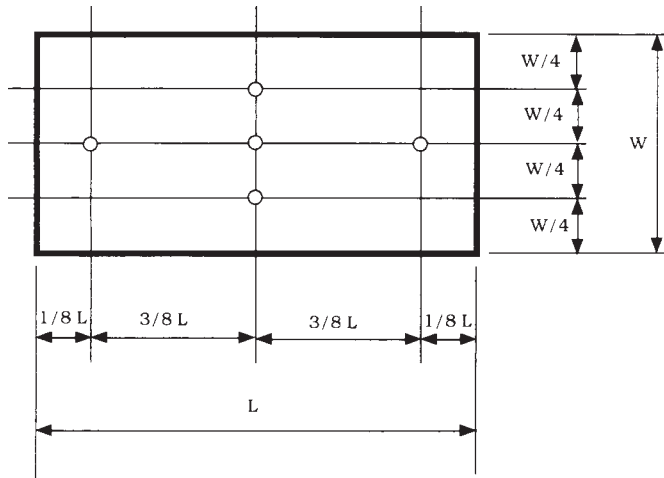


FIG. 5 Five Locations Examined

11.9 *Coating Criteria, Condition B, Ceramic Coated*—Spandrel glass shall be viewed by light reflected from the viewed surface. Place the spandrel glass sample against an opaque backup material and in a vertical position. View the sample from a distance of approximately 3 m (10 ft). Determine acceptability in accordance with 8.3.1.

11.10 *Coating Criteria Condition C*—See Specification C 1376.

**12. Product Marking**

12.1 The identification marking, when required, shall include the manufacturer’s name or trademark, the glass thickness, and the designation of heat strengthened or fully tempered, as applicable for Kind FT glass. The identification marking shall be either permanent or temporary, as specified. Heat-treated glass intended for use in vision areas (such as doors and windows) shall be permanently marked.

12.1.1 *Permanent Identification Marking*—Permanent identification marking shall be accomplished by sandblasting, etching, or fired-on ceramic decal or silk-screened imprint methods that do not introduce stresses. The marking shall be located at a corner of the glass where it shall be fully visible and legible when the glass is installed.

12.1.2 *Temporary Identification Marking*—Temporary identification marking shall consist of a label that is attached to the glass and can be removed after installation of the glass.

**13. Keywords**

13.1 edge compression; flat glass; heat-strengthened glass; heat-treated glass; surface compression; tempered glass

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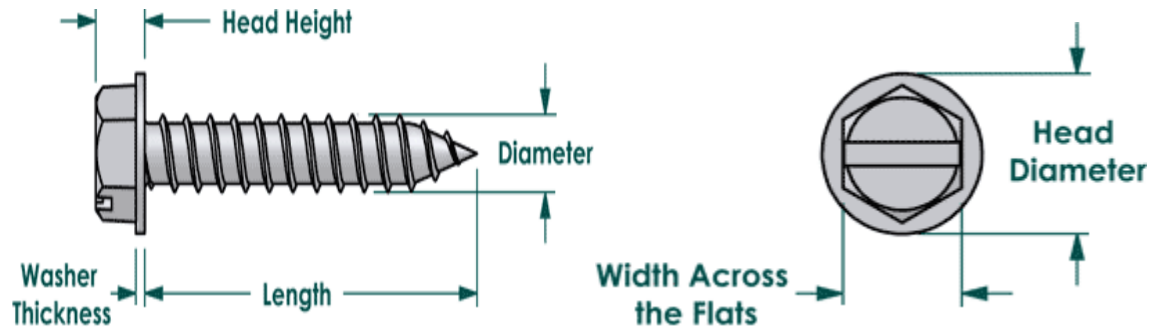
# Specification for Molecular Sieve 3A

## 3A-S

■Molecular formula:  $\langle 2/5K_2O * 3/5Na_2O * Al_2O_3 * 2SiO_2 * 9/2H_2O \rangle$

■Technical index:

Item	Standard		
Grade	3A-S		
Pore diameter	3 angstrom		
Appearance and color	pale yellow		
Grain diameter, $\phi$ mm	0.5-0.9MM	1.0-1.5MM	1.3-1.7MM
Density of loose packing, g/ml	$\geq 0.68$		
Water Ads. Capacity, %	$\geq 20.0$		
Crush strength, N/particle	-	14	16
Rate of friction loss,%	$\leq 0.10$		
Dust, NTU(PPM)	$\leq 30$		
Moisture-absorbing velocity, mg/g.min	$\leq 0.60$		
Static nitrogen-absorbing capacity, mg/g	$\leq 2$		
Granularity distribution,%	$\geq 98$		
Moisture content of packaged product,%	$\leq 1.5$		
Water Delta T , (10g/10ml)	$\geq 36^{\circ}C$		



## 18-8 Stainless Steel Flanged Hex Head Screws for Sheet Metal

Number 12 Size, 3/4" Long

Screw Size	No. 12
Screw Size Decimal Equivalent	0.216"
Length	3/4"
Head	
Width	0.313"
Height	0.194"
Flange Diameter	0.432"
Drive Style	External Hex/Slotted
Drill Bit Size	3/16"
Drill Bit Size Decimal Equivalent	0.1875"
Maximum Drilling Thickness	0.025"
Approximate Threads per Inch	11
Thread Direction	Right Hand
Threading	Fully Threaded
Tapping Method	Thread Forming
Tapping Screw Type	A/AB
Head Type	Hex
Hex Head Profile	Standard
Tip Type	Pointed
Shank Cross Section	Round
Screw Features	Flanged
System of Measurement	Inch
For Use In	Sheet Metal
RoHS	Compliant

**Add Value To Your Operable Skylight**

The Truth Skylight Operator System offers you the flexibility the marketplace demands, the quality your windows deserve, easy factory or field installation and a means to keep your skylight hardware inventories both cost effective and efficient. The Truth Skylight Operator system is easy to install and compatible with wood, metal or vinyl framed skylights.

Truth's special high gear reduction provides the low torque needed to lift a maximum sash weight of 140 pounds (63.6 kg.) with minimum effort. For ease of factory or field installations, the steel chain is detachable at the sash. The sprocket and chain are made from hardened steel to provide years of continuous, chatter-free operation. An acetal case liner keeps the chain and sprocket sliding smoothly, easing the force required to open the window. The high-pressure, zinc die-cast case is phosphate coated, electrostatically painted to provide a finish that resists chipping and flaking. The worm gear is made from hardened steel for lasting service.

**42.75 STRAIGHT DRIVE** (see Fig. 4)  
The Straight Drive is recommended for use in installations where pole operation is required (especially steep-pitched roofs). Recommended Screws: See Mounting Options in Fig. 2.

**42.65 ANGLE DRIVE** (see Fig. 3)  
The Angle Drive is recommended for easily accessible installations where the use of the standard crank handle is warranted. It may sometimes be used in pole applications (see application information for skylight pole systems and misc. hardware). Recommended Screws: See Mounting Options in Fig. 2.

**HANDLES** (see Fig. 12-13)  
**Drive Module components offer application flexibility...** Crank Handles come in standard and long versions. Each are zinc die-cast, finished to Truth's standards. They attach to the Drive Module with a set screw. They are available in bulk quantities, each individually bagged to protect the finish and to insure the set screw does not get lost. **NOT FOR USE WITH STRAIGHT DRIVE UNLESS HANDLE EXTENSIONS ARE USED.**

**11660 HAND KNOB & 11573 T-HANDLE** (see Fig. 14-15)

The Hand Knob and T-Handle are available for those who prefer to use something other than the standard Crank Handle, or where mini-blinds, sunshades, insect screens, etc. will not allow the Crank Handle to be used. The Hand Knob and T-Handle are zinc die-cast, and attaches with a set screw and painted to match the operator. **NOT FOR USE WITH STRAIGHT DRIVE UNLESS HANDLE EXTENSIONS ARE USED.**

**31000 EYELET ADAPTER** (see Fig. 17)

The Eyelet Adapter is for use where the pole operation is required. Available with a zinc die-cast or painted finish. Attaches with a set screw. The Eyelet Adapter is individually bagged in a bulk package. For use with poles that have a hook end.

**10453 HOOK ADAPTER** (see Fig. 16)

The Hook Adapter is for use where pole operation is required. Available with a zinc die-cast or painted finish. Attaches with a set screw. The Hook Adapter is individually bagged in a bulk package. For use with poles that have a hook end.

**40096 AND 40097 HANDLE EXTENSIONS** (see Fig. 9)

Handle/Adapter Extensions ensure that proper clearance is provided for either Handle Cranks or Hex and Hook Adapters. They are available in either 2" or 4" lengths, mount easily between the spline and Handle or Adapter and are painted to match.

**30662 HEX BALL DRIVE ADAPTER** (see Fig. 19)

The Hex Ball Drive Adapter is for use where pole operation is required. Available in a color to match the operator, the Hex Ball Drive Adapter is individually bagged in a bulk package. Attaches with a set screw. For use with poles that have a hex ball end.

**SKYLIGHT POLES** (see Fig. 8 & 11)

These rigid anodized aluminum Adjustable Skylight Poles feature free-turning ABS hand grips for years of reliable service and a locking collar to lock the pole at a desired length, or to reduce its size for convenient storage. Manual Skylight Poles are available in two different adjustable lengths - four to six feet, or six to ten feet with either Hook or Hex Ball Drives - each to provide easy access to remote operator locations. Optional three foot pole extensions **#30681** (see Fig. 8) are also available. For inventory convenience, master packages of 20 fully assembled skylight poles individually packaged in one master carton are available. Also available is Truth's **#30476** Clerestory Pole Crank (see Fig. 11). This pole operates by means of a flexible shaft inside a tubular metal housing. This product is to be used as an alternative to the hook pole and universal joint assembly in clerestory applications. This product must be used with the Adapter **#20550** (see Fig. 10) which is sold separately.

**WARRANTY:**

Protected under the terms of the Truth Warranty for Window and Door Manufacturers and Authorized Distributors. Refer to Truth's Terms and Conditions for further details.

**FINISH:** Electrostatically applied, durable coatings that provide excellent resistance to chipping, scratching and corrosion while maintaining color stability for years in direct sunlight. Please refer to Truth's Color Chart for examples of Truth's most popular finish options. Truth also offers a wide range of decorative "plated" finishes - contact Truth for additional information on availability of these finishes on specific product lines.

**ORDERING INFORMATION:**

- Select Drive needed:  
**42.75** Straight Drive (painted)  
**42.65** Angle Drive (painted).
- Specify finish number.
- Choose method of operation for Elevated Applications:  
**#10637** - Telescoping Pole (Hex Ball Drive),  
**#30662** - Hex Ball Drive Adapter, or  
**#10638** - Telescoping Pole (Hook Drive),  
**#31000** - Eyelet Adapter, or  
**#30476** - Clerestory Pole Crank,  
**#20550** - Adapter.  
Non-Elevated Applications:  
**#11454** - New Contour Handle (painted) or  
**#10579** - Long Handle (painted) or  
**#11660** - Hand Knob (painted).  
 Accessories:  
**#40096** - 2" Handle Extension (painted),  
**#40097** - 4" Handle Extension (painted).

**RECOMMENDED SCREWS:**

Operator: 4 - #19410 - #10 x 1 1/4" Phillips flat head, shank slotted, sheet metal screws. Sash Bracket: 2 - #10 Phillips flat head screws. Length and thread type to be determined by application.

**TRUTH TIPS:**

- To keep the Skylight operator operating efficiently and trouble free, Truth recommends that the operator chain be lubricated once a year with a spray silicone lubricant.
- The secret to a successful pole operated Skylight is to minimize the approach angle of the pole to the Skylight operator. This is most easily accomplished by using a Truth Straight Drive whenever pole operation is required. To figure the minimum angle of approach for a straight drive and a given pole system, subtract the maximum operational angle of a given pole system from the roof pitch (see Fig. 5). For an angle drive, do the same as with the straight drive and add 34 degrees. Pole length, Skylight height, and room layout will then determine what approach angle is needed for a particular application.
- The design of the Straight Drive does not allow a handle or hand knob to be applied directly to it. If it is desirable to operate a straight drive with a handle or hand knob, a handle extension can be used as an adapter.
- For accurate hardware placement in vinyl or metal applications, pre-drilling of the window profile is recommended.
- For metal window profiles, Truth recommends stainless steel machine screws. However, in most applications, stainless steel sheet metal screws will provide adequate holding power.
- For easy operation of a Hook or Hex Ball Pole, the operational angle between the pole and the window operator must not be exceeded.

**PRODUCT APPLICATION ASSISTANCE:**

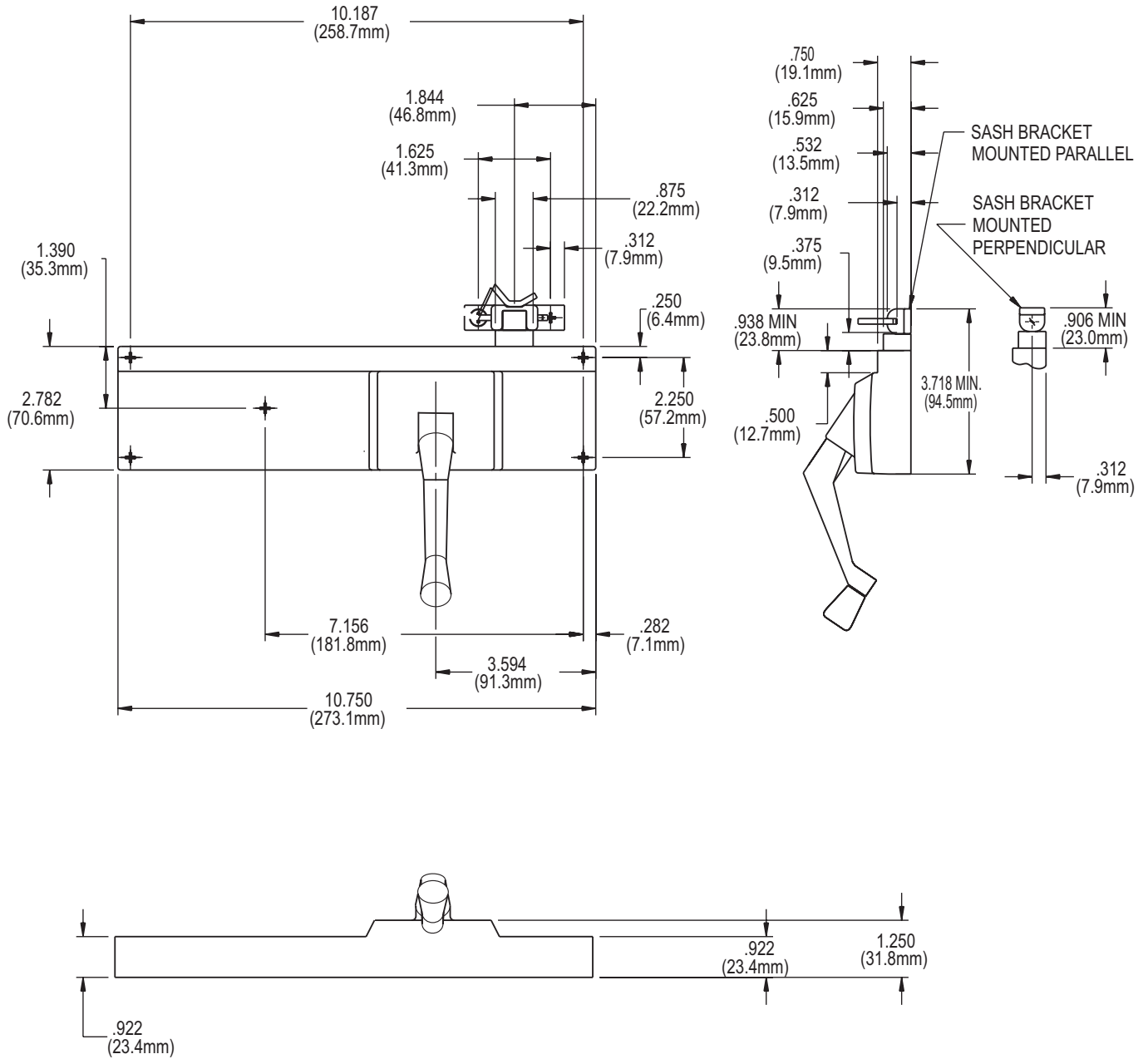
If you are designing a new window profile, or are having difficulty selecting hardware for your window, please contact Truth. Our highly trained Technical Service Staff can assist you with the selection of the appropriate hardware to meet your performance requirements, as well as providing personalized application drawings.

**INCLUDE TRUTH SPECS IN YOUR NEXT SKYLIGHT PROJECT:**

Skylight operating hardware should be suited for roof windows, and skylight installation for wood, PVC, and metal market. Skylight hardware shall be provided with a special high quality gear reduction (high output torque) to meet required maximum sash weight of 140 lbs. (63.6 kg.), unit to be constructed of high pressure zinc diecast case with phosphate finish, electrostatically painted and oven baked. Hardware to be complete with steel chain, sprocket, and detachable sash bracket. The steel chain design must include interlocking solid and u-links riveted in such a manner as to result in no more than .375" (9.5 mm) - .625" (15.9 mm) deflection. The chain sprocket shall be hardened steel and an acetal chain guide must be provided. Skylight hardware to be available with various means of control such as angle drive, straight drive, or motors. Skylight hardware shall be manufactured by Truth Hardware, Owatonna, MN.

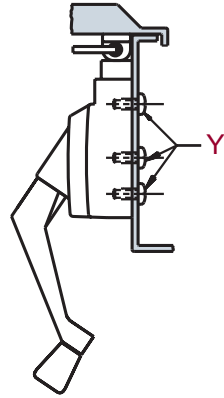
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FIG. 1 APPLICATION OF TRUTH 42.65 MANUAL SKYLIGHT OPERATOR



HARDWARE SHOWN
42.65 ANGLE DRIVE MODULE
10579 HANDLE

FIG. 2 MOUNTING OPTIONS

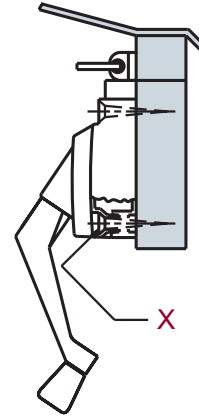


OPTION 1  
REAR MOUNT

SCREWS ENTER FROM BEHIND AND  
SCREW INTO BASE AT LOCATION **Y**.

RECOMMENDED SCREWS:

4-(P/N 19992) #12-24 X .500 PHILLIPS,  
PAN HEAD, THREAD FORMING,  
MACHINE SCREWS



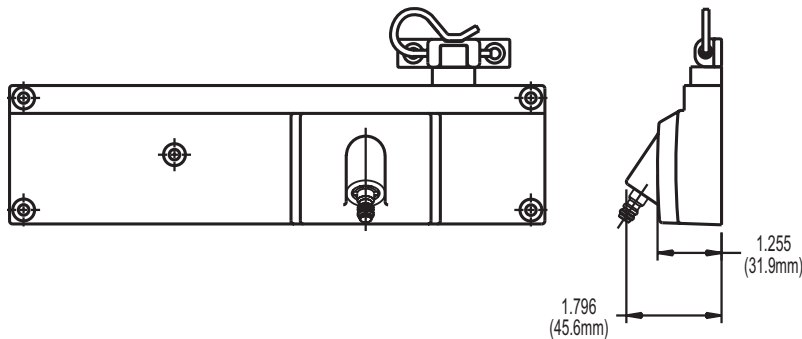
OPTION 2  
FRONT MOUNT

SCREWS ENTER FROM THE TOP AND  
SCREW INTO JAMB AT LOCATION **X**.

RECOMMENDED SCREWS:

5-(P/N 19410) #10 X 1.250  
PHILLIPS, FLAT HEAD,  
SHANK SLOTTED,  
SHEET METAL SCREWS.

FIG. 3 ANGLE DRIVE MODULE 42.65



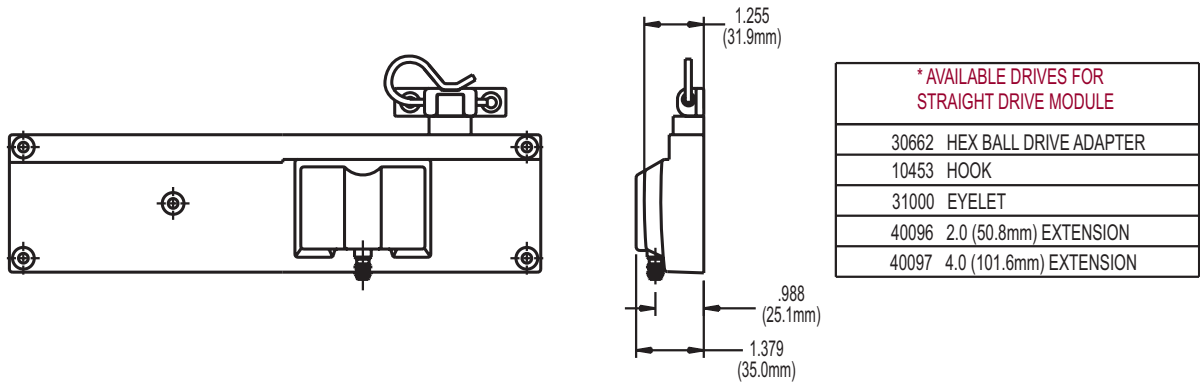
* AVAILABLE DRIVES FOR ANGLE DRIVE MODULE	
10024	HANDLE
10579	HANDLE
30662	HEX BALL DRIVE ADAPTER
10453	HOOK
31000	EYELET
40096	2.0 (50.8mm) EXTENSION
40097	4.0 (101.6mm) EXTENSION

RECOMMENDED SCREWS:

SEE MOUNTING OPTIONS IN FIG. 2

\* NOTE: SEE POLES AND MISC. SKYLIGHT  
HARDWARE FOR MORE INFORMATION

FIG. 4 STRAIGHT DRIVE MODULE 42.75



RECOMMENDED SCREWS:

SEE MOUNTING OPTIONS IN FIG. 2

\* NOTE: SEE POLES AND MISC. SKYLIGHT HARDWARE FOR MORE INFORMATION

FIG. 5 APPLICATION INFORMATION FOR POLE SYSTEMS AND MISC. HARDWARE

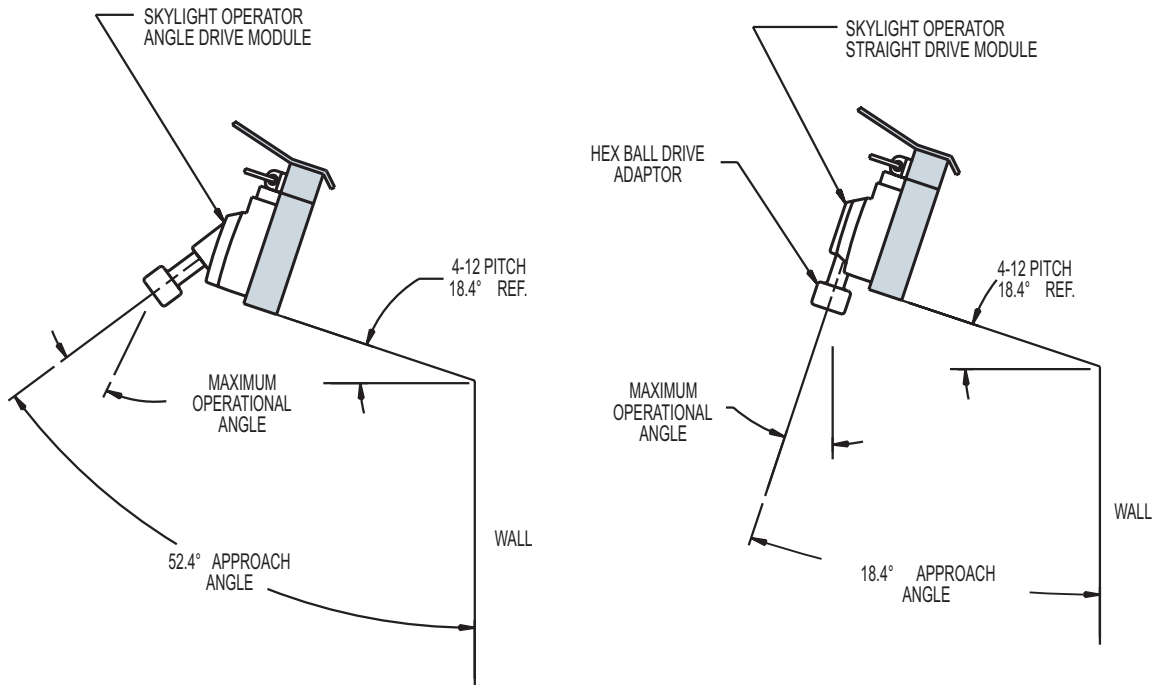


FIG. 6 SASH BRACKET 40470 AND DETACHABLE SASH PIN 20642

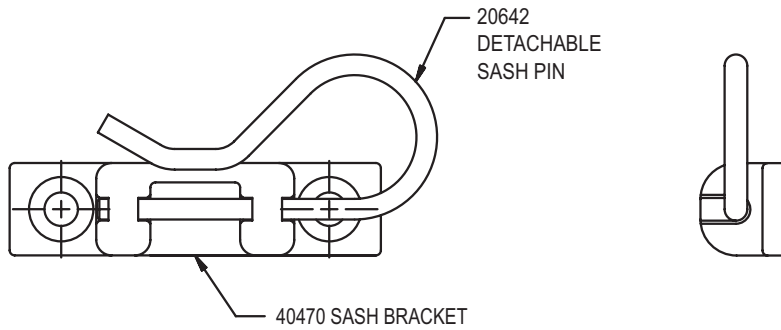
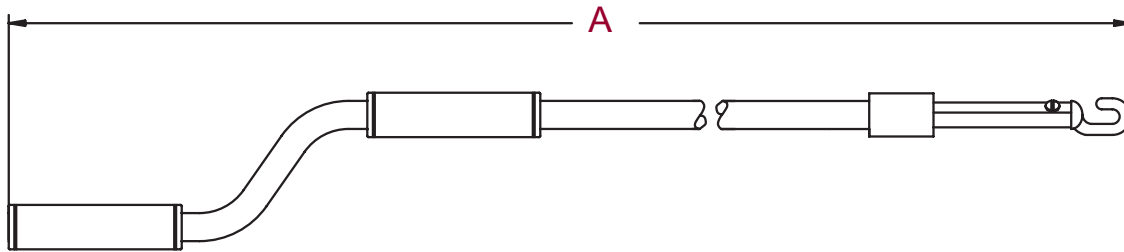
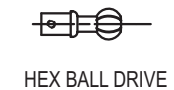


FIG. 7 TELESCOPING POLE CRANK: POLE WITH HOOK ADAPTOR 10638 (SHOWN)  
POLE WITH HEX BALL DRIVE 10637



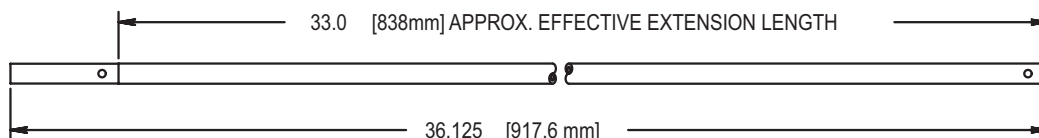
PART NO.	DRIVE	A DIMENSION		COMPATIBLE WITH
		EXTENDED	COLLAPSED	
10637	HEX BALL (INCLUDED)	115.75 (2940.1mm)	67.75 (1720.9mm)	30662 HEX BALL DRIVE ADAPTOR (SEE FIG. 11)
10638	HOOK (INCLUDED)	116.50 (2959.1mm)	68.50 (1739.9mm)	10453 HOOK (SEE FIG. 18) OR 31000 EYELET (SEE FIG. 19)
10864	HEX BALL (INCLUDED)	73.75 (1873.3mm)	47.75 (1212.9mm)	30662 HEX BALL DRIVE ADAPTOR (SEE FIG. 11)
10855	HOOK (INCLUDED)	74.50 (1892.3mm)	48.50 (1231.9mm)	10453 HOOK (SEE FIG. 18) OR 31000 EYELET (SEE FIG. 19)



NOTE:

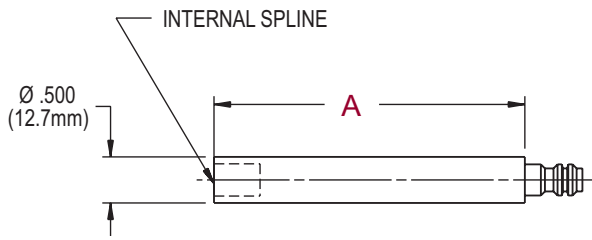
1. THE OPERATIONAL ANGLE OF HOOK POLE WHEN USED WITH A HOOK OR EYELET IS 45°.
2. THE OPERATIONAL ANGLE OF HEX BALL POLE WHEN USED WITH A HEX BALL ADAPTER IS 35°.

FIG. 8 3 FOOT POLE EXTENSION 30681 (Fits Telescoping Poles)



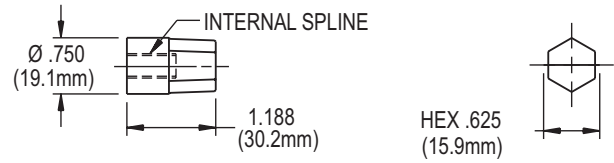
NO MORE THAN ONE EXTENSION SHOULD BE USED PER TELESCOPING POLE CRANK.

FIG. 9 HANDLE EXTENSIONS 40096.XX, 40097.XX



EXTENSION	A
40096	2.0 (50.8mm)
40097	4.0 (101.6mm)

FIG. 10 ADAPTOR 20550



NOTE:

THIS ADAPTER EASILY FITS OVER THE SPLINE OF THE WINDOW OPERATOR AND IS USED IN CONJUNCTION WITH TRUTH'S 30476 CLERESTORY POLE CRANK AS AN ALTERNATIVE TO TRUTH'S HOOK POLE AND UNIVERSAL JOINT ASSEMBLY.

FIG. 11 CLERESTORY POLE CRANK 30476

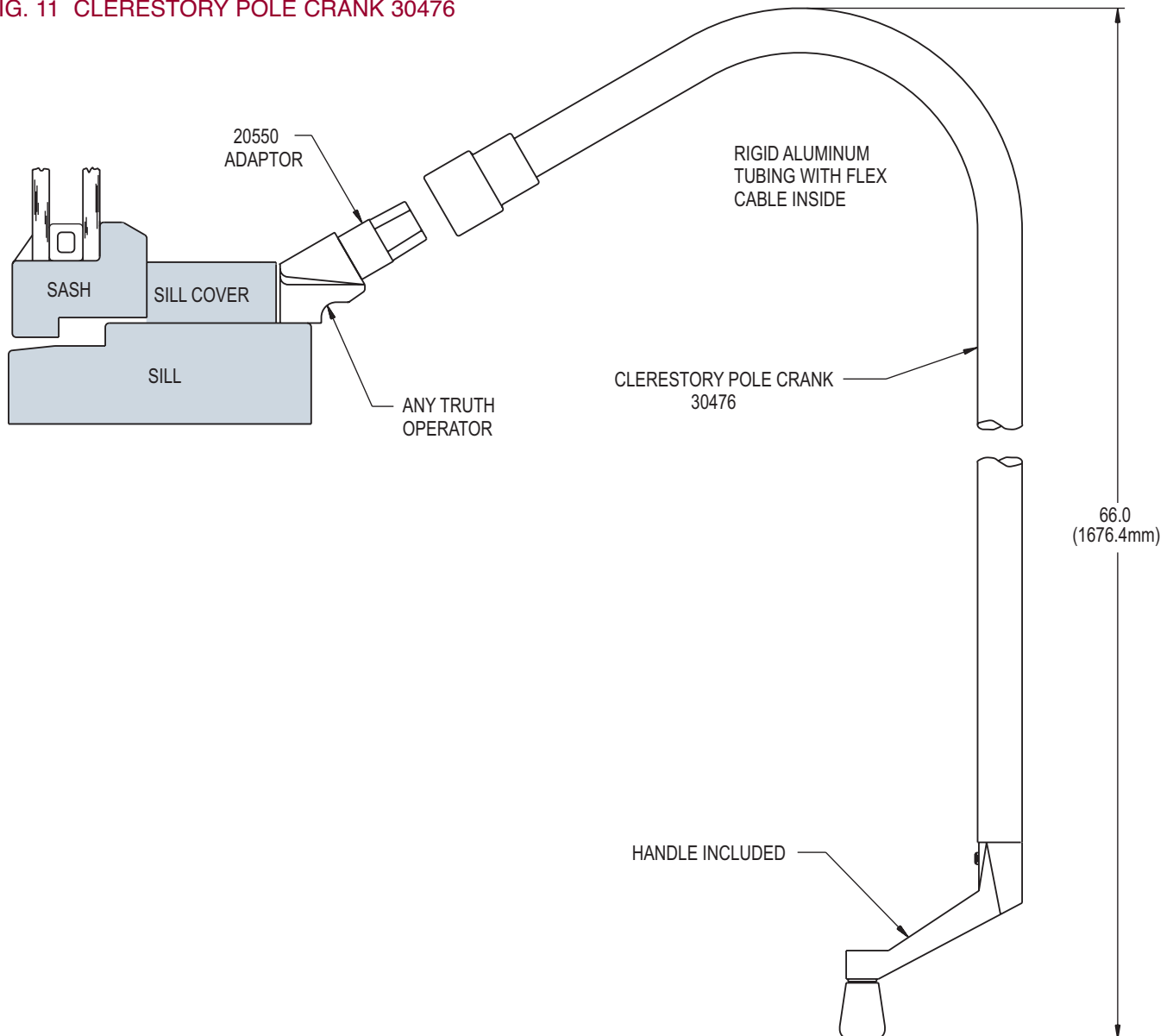
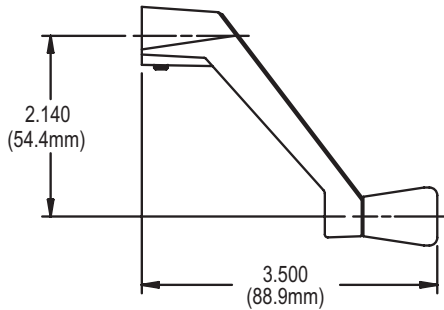


FIG. 12 HANDLE 10579.XX (Long Handle)



INCLUDES SET SCREW.

FIG. 13 CONTOUR HANDLE 11454.XX

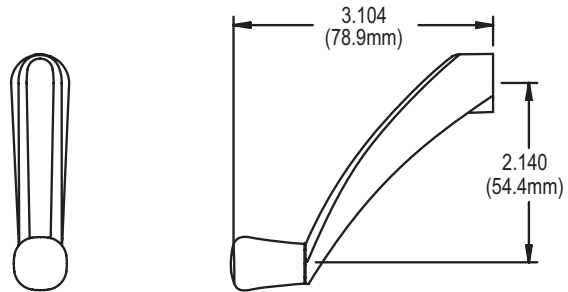


FIG. 14 HAND KNOB 11660.XX

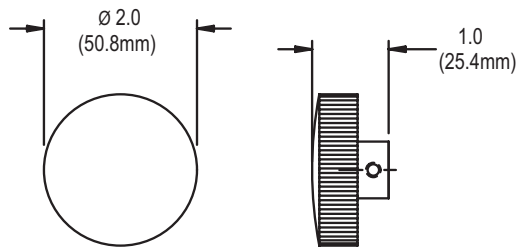


FIG. 15 T-HANDLE 11573.XX

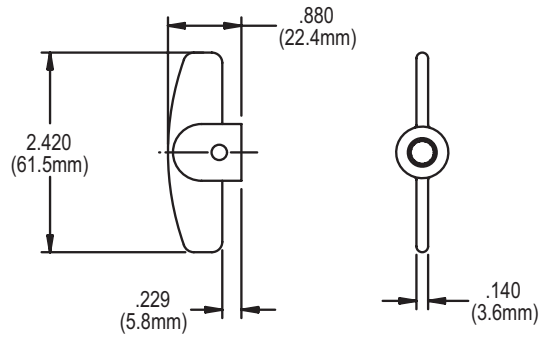
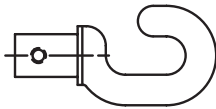
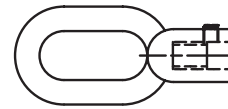


FIG. 16 HOOK 10453



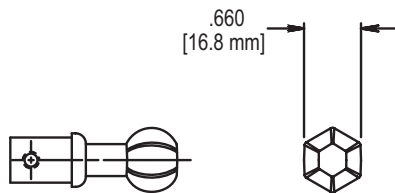
INCLUDES SET SCREW.

FIG. 17 EYELET 31000.XX



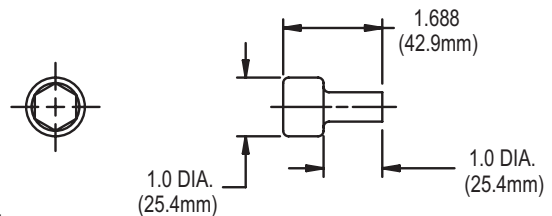
INCLUDES SET SCREW.

FIG. 18 HEX BALL DRIVE 30957



INCLUDES SET SCREW.

FIG. 19 HEX BALL ADAPTOR 30662.XX



NOTE:

1. HEX BALL ADAPTER FITS ALL TRUTH OPERATOR SPLINES. (SUPPLIED WITH SET SCREW)
2. AVAILABLE IN A COLOR TO MATCH THE OPERATOR, IS BULK PACKAGED AND INDIVIDUALLY BAGGED.
3. MAXIMUM OPERATIONAL ANGLE WHEN USED WITH A HEX BALL POLE IS 35 DEGREES.
4. FOR USE WITH THE DRIVE MODULES WHERE POLE OPERATION IS REQUIRED.

Introducing Truth's next generation of power window system...Sentry II HS® for heavy skylights. Based on the powerful and reliable mechanics from our previous SkySentry® motorization systems, we've added a new digital electronics package with built in power conversion to take this system to a whole new level of service and reliability.

The new electronics package provides many new features to enhance a homes comfort and its owner's peace of mind.

- **Quick and easy installation** of the skylight is possible when motor system is pre-installed and programmed by skylight manufacturer at their facility. The electrician needs only to connect line voltage power and the skylight is completely ready for operation - no further set up would be required by the installer or homeowner!
- **Power conversion** built right into the skylight mounted control package which accepts direct connection of line voltages from 100 to 240 VAC at 47 to 440 Hz. No more transformers to complicate and add expense to the installation.
- **Power Blind System compatible.** Centralized window control is now possible with Sentry II's ability to accept and control most 24 VDC power blind systems. The Sentry II RF remote or wall switch controls both skylight and blind motors for convenient, centralized control.
- **Power Protected Memory** eliminates the need to "reset" or retrain the control system after a power outage. Once the installation is complete the motor never needs further service or adjustments - even after prolonged power outages!
- **RF remote** compatibility built into all motor control packages as a standard feature. Simply order the optional remote to add new and exciting control capability for the homeowner.
- **Rain Sensor**, standard on all kits, automatically closes the skylight at the first sign of moisture. Corrosion resistant sensor decreases mechanisms cleaning requirements and extends service life.



- **Easily adapts** for new construction or retrofit applications. Please consult with your electrical contractor for a retrofit evaluation.
- **ETL Listed and CE Approved.** Meets all requirements for Class II installations.
- **Safety** - Automatic Motor Reversal has been engineered into the system which is intended to reverse the motor should an obstruction stop the skylight while closing. In addition, a screen interlock is provided which, when properly installed, electrically disconnects the motor when the screen is removed. These features are intended to help prevent personal injury which could result from reaching into the skylight area during its operation.
- **Synchronized Operation** of multiple motors is now standard on the HS motor system. The same Sentry II HS motor system can now be used on single motor applications or it can be ganged with up to four motor units on a large single skylight. Multiple motors on a single skylight add stability and capacity.

- **Awning Windows** – Can also be fitted with the Sentry II HS Motor System. Skylight hardware systems work great on awning windows with butt hinges.
- **Building Automation systems** can easily be tied into the control electronics for virtually limitless ventilation possibilities.

#### SENTRY II HS CAPACITY

Truth's Sentry II HS for heavy skylights is load rated at 80 lbs. at the chain. This equates to a total skylight hatch weight of 160 lbs. Sentry II HS power skylight system is rated at 50 watts.

#### CONTROL OPTIONS

The Sentry II HS motorization kit is available with a standard RF hand held remote for skylight control (order separately). The same remote can also accept and control most commercially available 24 VDC mini blinds (not provided by Truth Hardware). The motor unit provides feedback to the user via a status light (LED). This small LED shows when the motor is running, or if there are any problems during skylights operation. An optional wall control panel is also available.

## SENTRY II HS MOTOR SYSTEM

Up to 20 skylights can be controlled from a single control panel.

### REMOTE FEATURES INCLUDE:

- **Infinite Number** of windows & skylights can be controlled with a single remote.
- **9 Zones** or “unit codes” are available to allow units to be controlled in up to nine groups and organized to a users needs.
- **Motorized Blinds** can be controlled with the same remote.
- **Control windows and skylights from one remote** - the Sentry II HS (for heavy skylights) uses the same remote as the Sentry II WLS to allow coordinated ventilation throughout the entire home or building.
- **Built in Thermostat** allows skylights to open and close together, to help maintain a comfortable interior temperature. Take advantage of true “chimney effect” cooling to reduce energy demands.
- **Rolling Code Technology** proven in garage door openers is built into every remote to provide high security and peace of mind.

**WARRANTY:** The Sentry II family of products is warranted for one year against defects in materials and workmanship on all electronic and mechanical components.

### CONSUMER NOTICE:

The Sentry II HS for heavy skylights must be installed by a qualified electrician.

### PRODUCT APPLICATION ASSISTANCE:

If you need assistance with product configurations to meet your needs, please visit our website at [www.truth.com](http://www.truth.com). Under the “Technical Support” tab you will find all of the technical information needed to properly configure and specify all elements of an automated window installation, including installation instructions, pre-wiring and proper hardware requirements. You can also contact Truth’s highly trained Technical Service Staff who can assist you with the selection of the appropriate hardware. These

individuals are available during normal business hours (CST) at 800-324-4487.

### ORDERING INFORMATION:

Ordering of the new Sentry II HS systems is much easier than in the past. All hardware necessary for mounting on a skylight is now included in the same kit. Special Note: Motor covers are ordered separately to help keep your inventory costs down. Sentry II motor kit packaging includes additional space so cover can be added which allows the manufacturer to supply a complete kit to jobsite.

#### Sentry II HS for heavy skylights

Order 1 per skylight

**43.50.00.005** - Sentry II HS System

**12481.XX** - Cover (.xx denotes finish code)

Order 1 Hand Held Remote &/or Wall Switch

**43.53.00.002** - Hand Held RF Remote

**12539** - Wall Switch

Finish Codes: The “HS” cover is available in .01 Aluminum, .23 Chestnut Bronze, .24 Beige, & .32 White.

### TRUTH TIPS:

1. To help prevent personal injury from moving skylight parts, the skylight must be installed at least eight feet above the floor or an inside screen must be applied to the skylight with the provided screen interlock properly installed. Adherence to these safety requirements is the responsibility of the installer.
2. The Sentry II HS system is rated for use in indoor applications only.
3. When choosing between the non-synchronous or synchronous Sentry II HS motor system, consider the rigidity of the skylight panel. Since each motor system is designed to lift open and pull close at a single contact point, the skylight panel must be rigid enough in the closed position to ensure proper corner pull-in for a weather tight seal and rigid enough in the open position to provide proper skylight stability. The wider the skylight is, the more significant this issue can become. Therefore the rigidity of

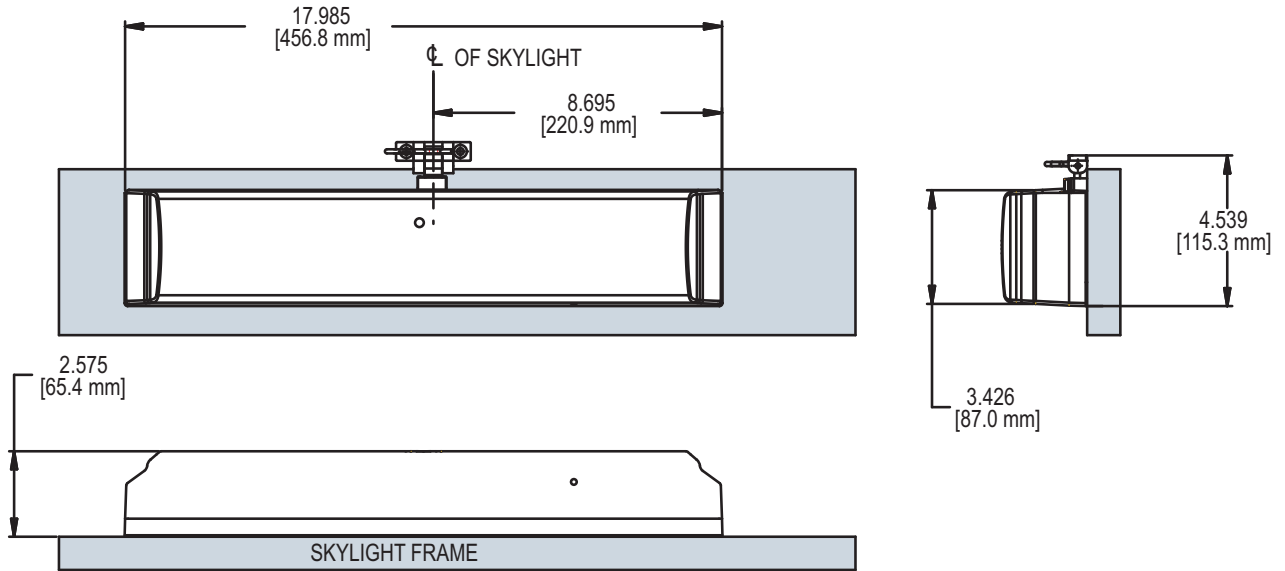
some skylight sizes may make it necessary to use two or more synchronous motor systems even though the weight of the skylight may only require a single motor system. For more assistance, contact Truth Hardware Technical Services.

4. The Sentry II HS requires 1 amp of 120 VAC.

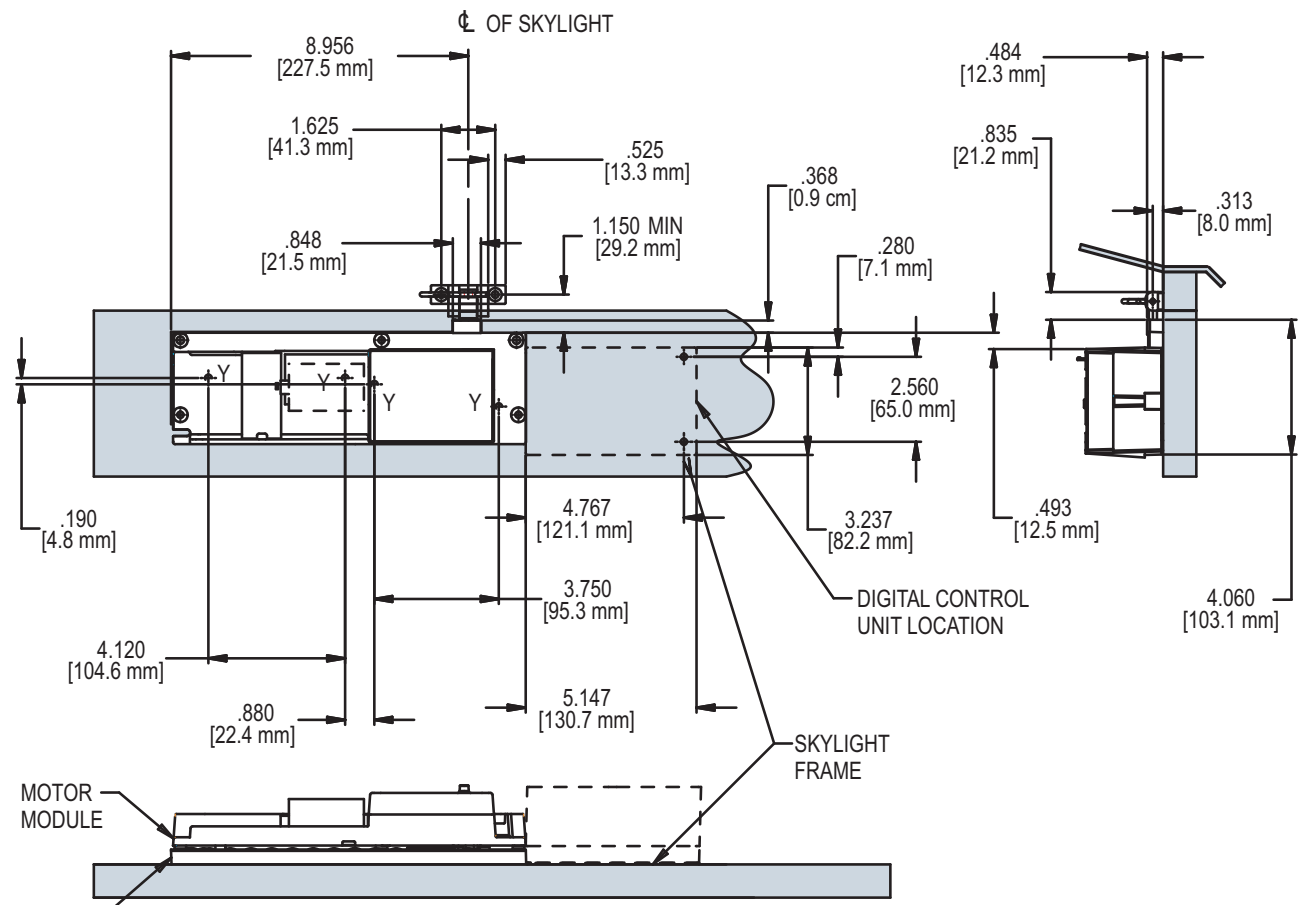
### INCLUDE TRUTH SPECS IN YOUR NEXT SKYLIGHT PROJECT

Skylight operating hardware should be suited for roof window, and skylight installation for wood, PVC, and metal materials. Skylight Bases shall be provided with a special high quality gear reduction (high output torque) to meet required maximum sash weight of 160 lbs. (72.6 kg.), unit to be constructed of high pressure zinc diecast case electrostatically painted. Each base is complete with steel chain, sprocket, and detachable sash bracket. The chain sprocket shall be hardened steel and an acetal chain guide must be provided. Base modules with a Motorized Drive shall be low profile in design. Unit to be available with snap-on, decorative ABS cover conveniently accessible to motor, mechanical, and electronic components. The mechanical closing pressure shall not exceed 70 lbs. Supply electronic circuitry for sensing rain and accommodation of remote control. Each unit shall be equipped with auxiliary contacts for additional thermostatic control, security, fire or smoke alarms, or computer control. The control system is to be supplied with standard line voltages from 100 to 240 VAC at 47 to 440 Hz (no transformer required). Motor kits to include motor, rain sensor, and hardware pack. Remote control shall operate at a minimum distance of 50 ft. from skylight operator. Power skylight system shall be “Sentry II HS” as manufactured by Truth Hardware, Owatonna, MN.

**FIG. 1 FINISHED DIMENSIONS OF THE SENTRY II HS MOTOR SYSTEM**



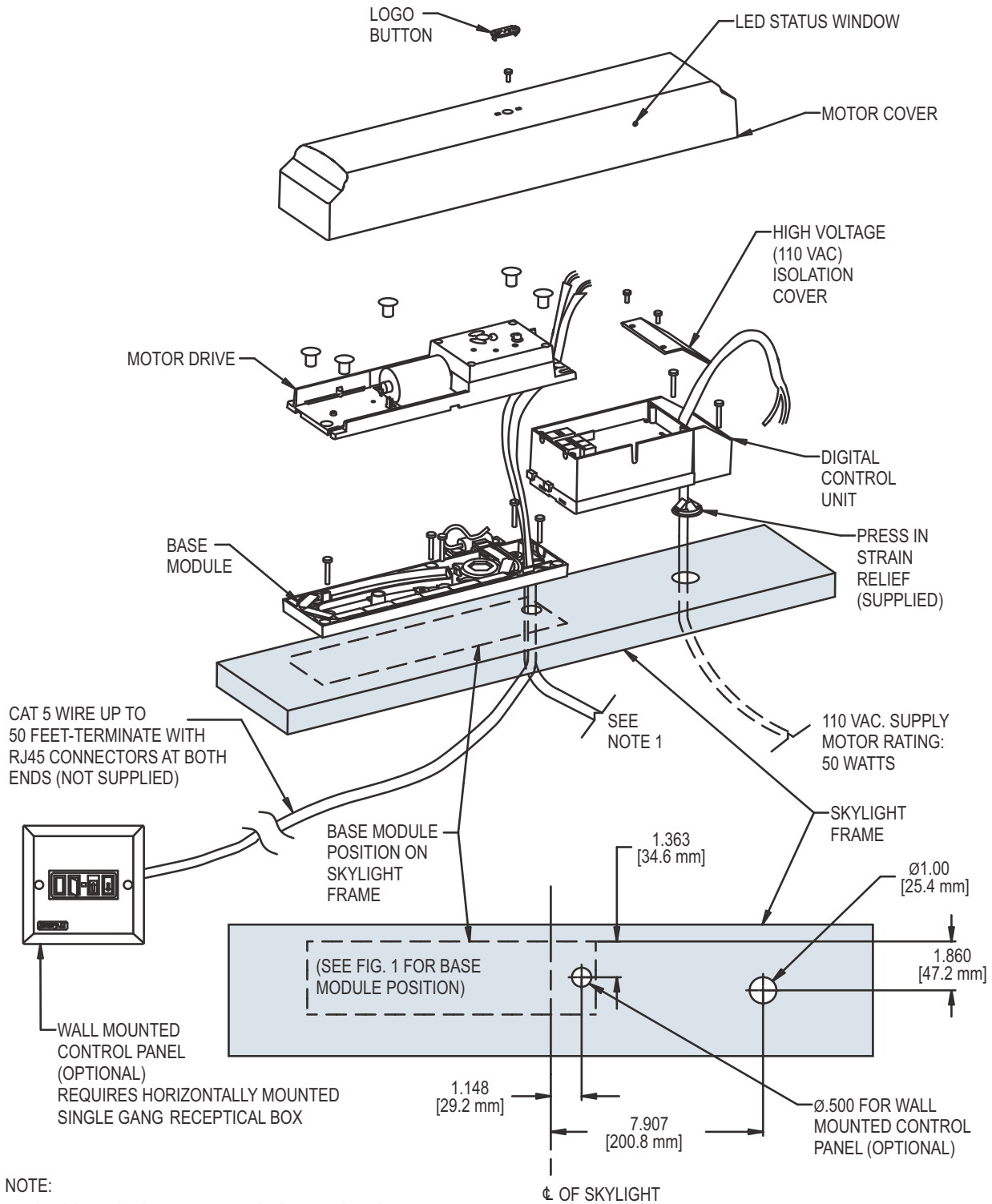
**FIG. 2 SENTRY II HS MOUNTING ILLUSTRATION**



- MOTOR MODULE**
- BASE MODULE**
- DIGITAL CONTROL UNIT TO SKYLIGHT FRAME  
(QTY 2) (P/N 19335) #10 X .750 PHILLIPS PAN HEAD SHEET METAL SCREWS
- BASE MODULE TO SKYLIGHT FRAME:  
(QTY 4) (P/N 19335) #10 X .750 PHILLIPS PAN HEAD, SHEET METAL SCREWS

# SENTRY II HS MOTOR SYSTEM

FIG. 3 SENTRY II HS PRE-WIRING DIAGRAM



**NOTE:**

1. FOR CONTROL OF MULTIPLE MOTOR UNITS FROM ONE WALL MOUNTED CONTROL PANEL, RUN A 2 CONDUCTOR WIRE BETWEEN EACH MOTOR UNIT. 22 GAGE OR HEAVIER IS SUFFICIENT.

# SJ135-OH SCREWJACK OPENER

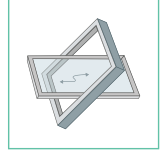
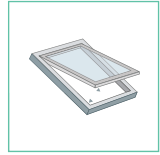
## MANUAL OPENERS

■ Applications  
Manual Window Control

■ Colours  
Polished Brass  
Chrome

### ■ SJ135-OH SCREWJACK OPENER

- Telescopic 310mm Screwjack opener suitable for pitched roof vents.
- Compatible with SJ87-OH Crank Handle operator, 1.0 - 4.0m versions available.



## TECHNICAL DATA:

CODE	SJ135-OH
OPENING STROKE	0 - 310mm
COLOURS	Brass / Chrome

## ACCESSORIES:

SJ80-7910  
Upper Bracket



SJ80-811  
Lower Bracket



SJ87-OH  
Crank Handle





## Hoffman Plastic Compounds, Inc.

16616 Garfield Ave. Paramount, CA 90723

Ph: 323.636.3346 Fax: 562.630.8200

info@hoffmanplastic.com www.hoffmanplastic.com

an ISO 9001:2000 company

### SPECIFICATION SHEET

#### V0-298 R4 NATURAL & COLORS

**APPLICATIONS: GENERAL PURPOSE EXTRUSION**

	TEST METHOD	VALUE
<b>PHYSICAL PROPERTIES</b>		
Specific Gravity (+/- 0.02)	ASTM D792	<b>1.45</b>
Hardness (Shore +/- 3)	ASTM D 2240	Instantaneous <b>75</b>
		10 second delay <b>70</b>

#### **MECHANICAL PROPERTIES**

Tensile Strength (PSI)	ASTM D638	<b>1575</b>
100% Modulus (PSI)	ASTM D638	<b>725</b>
Elongation (%)	ASTM D638	<b>325</b>
Low Temperature Brittleness (°F)	ASTM D746	<b>-30</b>
Meets UL 94 HB		

#### **Important**

We believe these tests to be reliable and accurate to the best of our knowledge but cannot warranty for processes and applications beyond our control.



# TECHNICAL DATA SHEET

## P009 - WH04

POLYESTER POLYURETHANE POWDER COATING  
FULL GLOSS SMOOTH  
WHITE

LS #:

RoHS Compliant

### POWDER PROPERTIES

SPECIFIC GRAVITY: 1.74 CALCULATED  
COVERAGE: 55.52 SQ.FT./LB. @ 2 MILS (100% EFFICIENCY)  
PARTICLE SIZE: 25 - 50 MICRONS AVERAGE  
STORAGE; STORE BELOW 80 DEGREES F, IN COOL DRY ENVIRONMENT  
SHELF LIFE: MINIMUM OF 1 YEAR  
CURE SCHEDULE: (METAL TEMPERATURE) 10 MINUTES @ 400 DEGREES F.

### CURED FILM PROPERTIES

ALL TESTS WERE PERFORMED AT A FILM THICKNESS OF: 2.0 to 4.0 mils

TEST	METHOD	RANGE
GLOSS @ 60 DEGREES:	D523	90% +/-5%
DIRECT IMPACT (INCH LBS.):	D2794	120 in.lbs.
INDIRECT IMPACT (INCH LBS.):	D2794	120 in.lbs.
PENCIL HARDNESS:	D3363	2H
CROSS HATCH ADHESION:	D3359B	4B
FLEXIBILITY (CONICAL MANDREL):	D1737/D522	100%

### CHEMICAL AND CORROSION EXPOSURE TESTS

CHEMICAL RESISTANCE: Good to excellent resistance to most solvents, oils, acids, and alkalis.  
OVERBAKE RESISTANCE: Slight yellowing is evident, especially in white and pastel colors.

All tests were performed on 24 gauge Bonderite 1000 panels

### APPLICATION

This product was designed to be applied by electrostatic spray, on steel, galvanized steel, or aluminum. Most powders can be reclaimed, sieved and recycled, if proper housekeeping is maintained.

### PRE TREATMENT

The substrate pretreatment prior to powder coating is a critical factor in developing maximum corrosion resistance and maximizing the lifetime of the product.

C.R.S. (Iron phosphate):	2 to 5 stages depending upon soil level, and quality desired.
C.R.S. (Zinc phosphate):	5 to 9 stages depending upon soil level, and quality desired.
Galvanized steel (Zinc phosphate):	5 to 7 stages depending on soil level, and quality desired. Galvanized steel must be degassed at 5 degrees above cure temperature to minimize gassing.
Aluminum (Chromate):	5 stage system is normally needed.
Aluminum (phosphate):	5 stage system is normally needed.

A11MS

**IMPORTANT: Warranty and Disclaimer** – The performance characteristics of these products vary according to the product application, operating conditions, materials applied to or use. Since these factors can affect results, we strongly recommend that you make your own tests to determine your satisfaction whether the product is of acceptable quality, has not been affected by storage or transportation and is suitable for your particular purpose under your own operating conditions prior to using any product in full scale production. Seller warrants the products to be free from defects in materials and workmanship. SUCH WARRANTY IS EXCLUSIVE AND IS IN LIEU OF ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OF FITNESS FOR A PARTICULAR PURPOSE. No representative of ours has authority to waive or change this provision, which applies to all sales of these products.

[www.cardinalpaint.com](http://www.cardinalpaint.com)

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Manufacturing**  
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**Arizona**  
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**Colorado**  
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**Missouri**  
tel 314.878.3010

**Pennsylvania**  
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**Washington State**  
tel 425.483.5665

**Northern California**  
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**Minnesota**  
tel 952.469.6021

**North Carolina**  
tel 336.882.9493

**Texas**  
tel 214.333.9801

**Hong Kong**  
tel 852.2410.8200

**SEALANTS**  
**33S SILICONE**

**PRODUCT NAME**

CRL 33S Silicone  
One-Component Silicone Elastomeric Sealant.

**PRODUCT DESCRIPTION**

CRL 33S Silicone is a one-component room temperature curing silicone elastomer. 33S Silicone is a proven construction sealant with various field applications in place that continue to perform and meet building needs.

CRL 33S Silicone complies with the following Federal Specifications:

- TT-S-001543A (COM-NBS) Class A, Federal Specification for Silicone Building Sealants
- TT-S-00230C (COM-NBS) Class A, Non-Sag Federal Specification for One-Component Sealants
- ASTM C920 Standard Specification for Elastomeric Joint Sealant as Type S, Grade NS, Class 25, Use NT, G, and A
- CAN/CGSB-19.13-M97

**BASIC USES**

CRL 33S Silicone is especially designed for joining and sealing a variety of structural materials (glass, aluminum, metal alloys, and many plastics). It will seal curtainwall joints, multi-pane windows, steel windows, aluminum windows, glass partitions and skylights. Indoor uses include sealing around bathtubs, showers and sanitary installations (clear, white, translucent white and tan colors contain an additive that makes the cured silicone resistant to mildew). CRL 33S Silicone in all colors meets the requirements of FDA regulation number 21CFR177.2600 for use in food-related applications such as walk-in freezers, refrigerated trucks, etc.

Certified by NSF to Standard 51-Plastic Materials and Components used in Food Equipment.

CRL 33S Silicone is a "UL Recognized Component".

**LIMITATIONS**

CRL 33S is not recommended for:

- Use as structural silicone, or insulating glass glazing.
- Concrete and stone expansion joints, horizontal decks, patios, driveway or terrace joints where abrasion or physical abuse is encountered.
- Sealing submerged joints, particularly where porous surfaces permit water infiltration to the bond surface.
- Interior or exterior structural sealing below the waterline in marine applications.
- Designs that will be painted after application of the sealant. Paint films bridge the sealant but do not adhere to the sealant.
- Tooling techniques using solvents or detergent soap solutions are not recommended.

- CRL 33S Silicone should not be applied in applications where appearance is critical without conducting a test to determine its compatibility and migration to the assembly surfaces.
- Totally confined spaces, because the sealant requires atmospheric moisture for cure
- Auto trim
- Appliance trim (i.e., adhesive trim)
- Black 33S (Cat. No. 33SBL) is recommended for glass-to-glass butt joints because butt joints sealed with clear sealant may contain small amounts of air that are trapped during the packaging and/or application of the sealant, as well as bubbles that can form during the curing of the silicone due to gas that is given off or movement of the glass before final cure. Appearance standards and subsequent repairs (e.g., limited to sight lines) should be established and agreed upon prior to sealant application, if clear is used.

**SURFACE LIMITATIONS**

CRL 33S Sealant should not be applied to the following surfaces:

- Not recommended for surfaces with special protective or cosmetic coatings without prior consultation of the manufacturer. Such surfaces include, but are not limited to, mirrors, reflective glass, surfaces coated with polyethylene or polypropylene where delamination is possible.
- Construction materials that may exude oils, resins, plasticizers or solvents. These include, but are not limited to, unfinished or impregnated woods, certain rubber or plastic gaskets and tapes, and failed non-silicone sealants or caulking compounds.
- Concrete, marble, limestone, lead or lead-coated surfaces, and copper are not acceptable substrates for CRL 33S Silicone.
- Unclean or wet surfaces.

**TECHNICAL DATA**

The physical properties of CRL 33S Silicone are shown in Table 1.

TABLE 1 - PHYSICAL PROPERTIES	
Property/Test Methods	Value
Shore A (Hardness) ASTM D-2240	25
Tensile Strength, ASTM D-412	350 psi
Lap Shear at 1/8" Thickness	120 psi
Tear Strength	.25 ppi
Elongation at Ultimate Break, ASTM D-412	500%
Elasticity Modulus at 100% psi, ASTM D-412	.75 psi
Consistency	Non-Flowing
Specific Gravity at 77°F (25°C)	1.04
Tooling Time	Varies with Temperature/RH
Tack Free Time ASTM C-679	20 Minutes
Curing Time	2 Days
(1/4" Bead @77°F (25°C)/50% Relative Humidity)	
Flow; Sag or Slump, ASTM C-639	Nil
UV Resistance, ASTM C-793	Excellent
Service Temperature	-80°F (-62°C) to 400°F (204°C)

**SEALANTS**  
33S Silicone

**7**

AUGUST 2005  
(Supersedes August 2002)  
**CRL**  
PROFESSIONAL QUALITY

**CRL**  
AUGUST 2005  
(Supersedes August 2002)

**7**  
**SEALANTS**  
33S Silicone

**PRINCIPLES OF JOINT DESIGN**

Figure 1 illustrates why a thin bead of silicone sealant will accommodate more movement than a thick bead. Obviously, the thin bead is the most desirable.

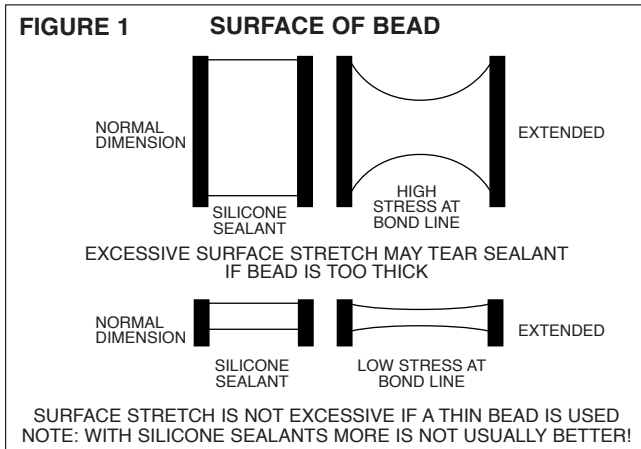
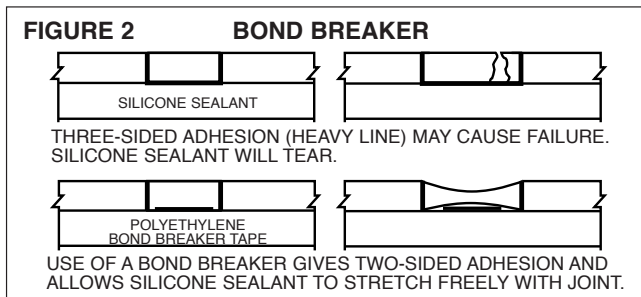


Figure 2 illustrates why silicone sealants need bond breaker tape to prevent undesirable three-sided adhesion.



**JOINT DIMENSIONS**

Joint width should be four times anticipated movement, but at least 1/4" wide. Maximum joint movement should not exceed 25% applicable to both horizontal and vertical joints. CRL 33S generally follows standard ASTM Specifications (2 to 1, width to depth ratio), when used at widths of 1/4" or more.

**INSTALLATION**

**CLEANING**

CRL 33S Silicone requires standard cleaning procedures prior to sealant application. Clean all joints and glazing area by removal of foreign matter and contaminants such as oil, dust, grease, frost, water, surface dirt, old sealants or glazing compounds, as well as any protective coatings. Porous substrates should be cleaned where necessary by grinding, saw cutting, blast cleaning (sand or water), mechanical abrading or a combination of these methods which will be required to provide a sound, clean and dry surface for sealant application. Metal, glass and plastic surfaces should be cleaned by a solvent procedure or by mechanical means. Detergent or soap and water cleaning treatments are not recommended. Protective films must be removed by a solvent recommended by the manufacturer of the component or other means which leave no residue. In all cases where used, solvents shall be applied with

one clean cloth or lint-free paper towel, and then wiped clean with a second cloth or towel. Cleaning solvents should not be allowed to air dry or evaporate without wiping.

Architectural coatings, paints and plastics shall be cleaned with a solvent approved by the manufacturer of that product. Cleaning of all surfaces should be done on the same day in which sealant is applied.

TABLE 2 - PRIMER RECOMMENDATIONS		
Surface	Surface Pre-Treatment	Primers for CRL 33S
<b>Steel</b> (Galvanized, Red Lead, Primed, Cold Rolled)	Solvent Wipe	SIL2100
<b>Stainless Steel</b>	Solvent Wipe	SIL2100
<b>Aluminum</b> (Light Alloys)	Solvent Wipe	SIL2100
<b>Copper</b> (Brass, Bronze)		Not Recommended
<b>Concrete and Masonry</b>		Not Recommended
<b>Wood</b> (Unfinished, Hard Woods)	Solvent Wipe	SIL2100
<b>Painted Surfaces</b>	Solvent Wipe	SIL2100
<b>Glass</b>	Solvent Wipe	Primer Not Needed
<b>Commonly Used Thermoplastics</b>	Solvent Wipe	SIL2100

**MASKING**

Areas adjacent to joints should be masked to assure neat sealant lines. Do not allow masking tape to touch the clean surfaces to which the silicone is to adhere. Tooling should be completed in one continuous stroke immediately after sealant application and before a skin forms. Masking should be removed immediately after tooling.

**PRIMING**

A bead of silicone sealant applied to the material surface at the job site or manufacturing location to test adhesion prior to general job use is always recommended. Primers are required for some surfaces. See Table 2 for primer recommendations. Primers must be applied according to manufacturer's printed instructions. Priming is not usually required on glass, standard aluminum finishes and most metals.

**APPLICATION**

- Install backup material or joint filler, setting blocks, spacer shims and tapes as specified.
- Apply CRL 33S Silicone with hand gun or pressure equipment according to FGMA standards in a continuous operation using a positive pressure adequate to properly fill and seal the joint. Tool or strike the sealant with light pressure to spread the material against the backup material and the joint surfaces. A tool with concave profile is recommended to keep the sealant within the joint.
- In glazing, tool the sealant applied at the sill so rain, melting snow and cleaning solutions will not pool.

**7 SEALANTS**  
33S Silicone

**CRL**  
AUGUST 2005  
(Supersedes August 2002)

**CRL**  
AUGUST 2005  
(Supersedes August 2002)

**7 SEALANTS**  
33S Silicone

- CRL 33S Silicone can be applied at extremely low outdoor temperatures provided that surfaces are clean, dry and frost-free. It can be applied in temperatures as low as -35° F (-37° C) and as high as 140° F (60° C).
- Excess sealant should be wiped clean from glass, metal and plastic surfaces while still uncured and followed with a commercial solvent such as xylol, toluol, or methyl ethyl ketone. CRL Silicone Remover Cat. No. SR200 cleans uncured silicone sealant. Should sealant accidentally contact and begin to cure on adjacent porous surfaces, the excess sealant should be allowed to progress throughout the initial cure of setup. It should then be removed by abrasion or other mechanical means.

If CRL 33S Silicone is used in direct contact with any other sealant or elastomer, a compatibility test must be conducted by purchaser or user prior to acceptance. The suitability of this product, for each intended use, must be determined by the purchaser prior to acceptance.

**SHELF LIFE/STORAGE**

Store at or below 80°F (27°C). Dispose of empty containers in accordance to federal, state and local regulations.

33S has a shelf life of 24 months.

**WARRANTY LIMITATIONS**

The warranty specifically excludes sealant failure due to:

1. Appearance changes due to deposits of dirt and other materials.
2. Decomposition of the underlying substrates.
3. Excess movement of the structure which exceeds published specification for movement caused by building settlement, design error, or construction error.
4. Mechanical damage caused by external sources.
5. Natural disasters such as fires, lightning, earthquakes, tornadoes, or hurricanes.

**MAINTENANCE**

No maintenance should be needed. If silicone sealant becomes damaged, replace damaged portion. Clean surfaces in damaged area and repair with fresh 33S Silicone Sealant.

**PACKAGING**

33S Silicone Sealant is packed in 10.3 fluid ounce plastic cartridges that have been tested and proven to prolong freshness and shelf life. 30 cartridges per case, which fit cartridge caulking guns. Also available in 4.5 gallon pails and 52 gallon drums.

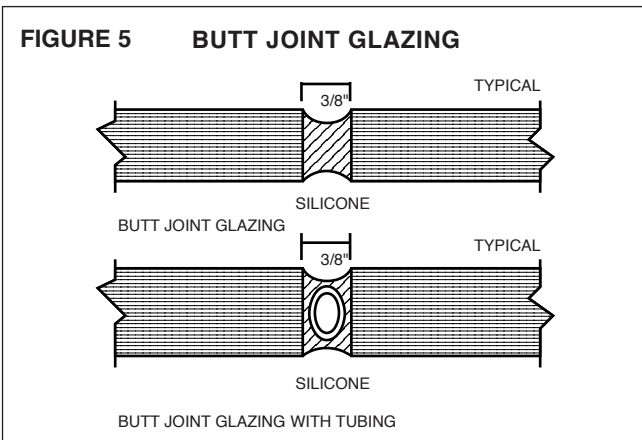
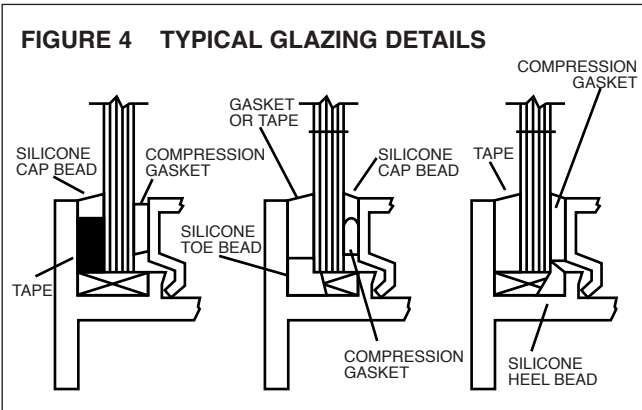
**TECHNICAL SERVICE**

Complete technical information and literature is available from C.R. Laurence Co., Inc. Any technical advice furnished by the company or any representative of the company concerning any use or application of any sealant is believed to be reliable, but the company makes no warranty, expressed or implied, for any use or application for which such advice is furnished.

**SEALANTS**  
33S Silicone

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**CRL**  
PROFESSIONAL QUALITY  
AUGUST 2005  
(Supersedes August 2002)



Cured sealant is usually very difficult to remove without altering or damaging the surface to which it has been misapplied. CRL Cat. No. SR200 Sealant Remover may assist cured sealant removal in many cases.

**PRECAUTION**

Read Material Safety Data Sheet before using product for the first time. Uncured sealant may irritate the eyes. Avoid contact with eyes and skin. Contact lens wearers take appropriate precautions.

IN CASE OF CONTACT, FLUSH EYES WITH WATER, CALL A PHYSICIAN. Remove from skin with dry cloth or paper towel. KEEP OUT OF REACH OF CHILDREN.

**CRL**  
PROFESSIONAL QUALITY  
AUGUST 2005  
(Supersedes August 2002)

**SEALANTS**  
33S Silicone

**LIMITED WARRANTY NOTICE**

CRL and its manufacturer warrant our products to be of good quality and will replace or, at our election, refund the purchase price of any products proved defective. Satisfactory results depend not only upon quality products but also upon many factors beyond our control in the application process. Therefore, except for such replacement or refund CRL and its manufacturers make no warranty or guarantee, expressed or implied, including warranties of fitness or merchantability, respecting its products. CRL and its manufacturers shall have no other liability with respect thereto. User shall determine the suitability of the product for his intended use and assume all risks and liability in connection therewith. Any authorized change in the printed recommendations concerning the use of our products must bear the signature of the CRL Product Manager.

**COOPERATIVE TESTING**

Materials submitted for testing should be sent to:

C.R. Laurence Co., Inc.  
 Technical Sales Department  
 PO Box 58923  
 Los Angeles, CA 90058-0923

This program is intended to eliminate potential field problems by pretesting CRL construction sealants with samples of the building materials on which the sealant will be applied. The test will aid in determining the proper surface preparation method, effective solvents for cleaning and whether priming is necessary to achieve optimum adhesion. Following this procedure will remove many of the unknown variables which affect field success.

Test samples of substrates should be identified as to manufacturer, origin, designed use, building project, person and firm originating the request. Appropriate sketches or drawings showing the intended use can be helpful.

**C.R. LAURENCE CO., INC. LOCATIONS**

**United States**

**Los Angeles, California**  
 2503 E Vernon Avenue  
 Los Angeles, CA 90058-1897  
 Phone: (323) 588-1281

**Boston Area**  
 97 Robert Treat Paine Drive  
 Taunton, MA 02780-1267  
 Phone: (508) 880-5600

**Phoenix, Arizona**  
 640 S. 54th Avenue  
 Phoenix, AZ 85043-4731  
 Phone: (602) 269-7500

**CRL Australia**

**Sydney Area**  
 9 Shale Place  
 Eastern Creek, NSW 2766  
 Phone: (02) 9851-3444

**Dallas, Texas**  
 2080 Lone Star Drive  
 Dallas, TX 75212-6390  
 Phone: (214) 634-7305

**Orlando, Florida**  
 6950 Presidents Drive  
 Orlando, FL 32809-5668  
 Phone: (407) 857-7900

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 4120 Sobb Avenue  
 Las Vegas, NV 89118-6857  
 Phone: (702) 253-0211

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 42 Enterprise Drive  
 Rowville, VIC 3178  
 Phone: (03) 9764-8322

**Chicago Area**  
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 Elk Grove Village, IL  
 60007-5069  
 Phone: (847) 437-8320

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 Phone: (303) 373-9988

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 4420 Windfern Road  
 Houston, TX 77041-8918  
 Phone: (713) 462-6300

**San Francisco / Oakland Area**  
 33200 Dowe Avenue  
 Union City, CA 94587-2013  
 Phone: (510) 475-1000

**Seattle Area**  
 23000 64th Avenue SW  
 Kent, WA 98032-1838  
 Phone: (253) 850-5800

**Miami Area**  
 14290 N.W. 4th Street  
 Sunrise, FL 33325-6226  
 Phone: (954) 846-9233

**Atlanta, Georgia**  
 600 Wharton Drive  
 Atlanta, GA 30336-4040  
 Phone: (404) 696-3445

**Cleveland Area**  
 31600 Carter Street  
 Solon, OH 44139-3551  
 Phone: (440) 248-0003

**San Diego, CA**  
 10280 Camino Santa Fe  
 San Diego, CA 92121-3105  
 Phone: (858) 678-8984

**New York City Area**  
 211 County Avenue  
 Secaucus, NJ 07094-2006  
 Phone: (201) 770-1077

**Philadelphia Area**  
 1511 Lancer Drive  
 Moorestown, NJ 08057-4232  
 Phone: (856) 727-1022

**Charlotte Area**  
 780 Celriver Road  
 Rock Hill, SC 29730-7419  
 Phone: (803) 366-8326

🍁 **CRL Canada** 🍁

**Vancouver Area**  
 11920 Horseshoe Way  
 Richmond, BC V7A 4V5  
 Phone: (604) 448-9344  
 Fax: (604) 448-9322

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 Anjou, QC H1J 3B3  
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 Fax: (514) 352-1017

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 Concord, ON L4K 5E4  
 Phone: (905) 303-7966  
 Fax: (905) 303-7965

**Calgary, Alberta**  
 4200 116 Avenue SE  
 Calgary, AB T2Z 4B5  
 Phone: (403) 250-5783  
 Fax: (403) 291-3260





# TECHNICAL DATA SHEET

## P004 - BR23

POLYESTER POLYURETHANE POWDER COATING  
SEMI GLOSS SMOOTH  
BRONZE

LS #:

RoHS Compliant

### POWDER PROPERTIES

SPECIFIC GRAVITY: 1.65 CALCULATED  
COVERAGE: 58.55 SQ.FT./LB. @ 2 MILS (100% EFFICIENCY)  
PARTICLE SIZE: 25 - 50 MICRONS AVERAGE  
STORAGE: STORE BELOW 80 DEGREES F, IN COOL DRY ENVIRONMENT  
SHELF LIFE: MINIMUM OF 1 YEAR  
CURE SCHEDULE: (METAL TEMPERATURE) 12 MINUTES @ 400 DEGREES F.

### CURED FILM PROPERTIES

ALL TESTS WERE PERFORMED AT A FILM THICKNESS OF: 1.5 to 3.0 mils

TEST	METHOD	RANGE
GLOSS @ 60 DEGREES:	D523	40% +/-5%
DIRECT IMPACT (INCH LBS.):	D2794	100 in.lbs.
INDIRECT IMPACT (INCH LBS.):	D2794	100 in.lbs
PENCIL HARDNESS:	D3363	2H
CROSS HATCH ADHESION:	D3359B	4B
FLEXIBILITY (CONICAL MANDREL):	D1737/D522	100%

### CHEMICAL AND CORROSION EXPOSURE TESTS

CHEMICAL RESISTANCE: Good to excellent resistance to most solvents, oils, acids, and alkalis.  
OVERBAKE RESISTANCE: Slight yellowing is evident, especially in white and pastel colors.

All tests were performed on 24 gauge Bonderite 1000 panels

### APPLICATION

This product was designed to be applied by electrostatic spray, on steel, galvanized steel, or aluminum.  
Most powders can be reclaimed, sieved and recycled, if proper housekeeping is maintained.

### PRE TREATMENT

The substrate pretreatment prior to powder coating is a critical factor in developing maximum corrosion resistance and maximizing the lifetime of the product.

C.R.S. (Iron phosphate): 2 to 5 stages depending upon soil level, and quality desired.  
C.R.S. (Zinc phosphate): 5 to 9 stages depending upon soil level, and quality desired.  
Galvanized steel (Zinc phosphate): 5 to 7 stages depending on soil level, and quality desired.  
Galvanized steel must be degassed at 5 degrees above cure temperature to minimize gassing.  
Aluminum (Chromate): 5 stage system is normally needed.  
Aluminum (phosphate): 5 stage system is normally needed.

110MS

**IMPORTANT: Warranty and Disclaimer** – The performance characteristics of these products vary according to the product application, operating conditions, materials applied to or use. Since these factors can affect results, we strongly recommend that you make your own tests to determine your satisfaction whether the product is of acceptable quality, has not been affected by storage or transportation and is suitable for your particular purpose under your own operating conditions prior to using any product in full scale production. Seller warrants the products to be free from defects in materials and workmanship. SUCH WARRANTY IS EXCLUSIVE AND IS IN LIEU OF ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OF FITNESS FOR A PARTICULAR PURPOSE. No representative of ours has authority to waive or change this provision, which applies to all sales of these products.

[www.cardinalpaint.com](http://www.cardinalpaint.com)

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**Missouri**  
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**Pennsylvania**  
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**Texas**  
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